Individual teacher learning in a context of collaboration in teams

Meirink, J.A.

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ICLON

Leiden University Graduate School of Teaching

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Promotores
Prof. Dr. N. Verloop
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Copromotor
Dr. P.C. Meijer

Overige leden
Dr. H.H. Tillema (referent), Universiteit Leiden
Prof. Dr. A. Aelterman, Universiteit Gent
Prof. Dr. M.L.L. Volman, Vrije Universiteit Amsterdam

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Chapter 1

Chapter 1
General introduction

This thesis reports on studies aimed at examining individual teacher learning in a context of collaboration in interdisciplinary teams in the workplace. We explored *how* and *what* teachers learn when they collaborate with colleagues with different subject matter backgrounds, and how group and organizational characteristics influence this learning. This first chapter deals with the context, the main underlying theoretical perspectives, the research questions, and the design of the study. Finally, we provide a short description of the studies as presented in Chapters 2 to 5.

1.1 Background to the study

Lifelong learning has become a well-known concept in our present knowledge-based society. Professionals from various career fields are required to pay constant and close attention to latest developments, to anticipate emerging technologies, to increase their competences, and to advance in their careers (Alejandro, 2001; Van Veen, 2007). In order to support and optimize professionals' continuous development it is important to comprehend how professionals learn. Consequently, teacher learning has become an important research topic in the field of education (e.g., Hammerness, Darling-Hammond, Bransford, Berliner, Cochran-Smith, McDonald, & Zeichner, 2005; Putnam & Borko, 1997; Richardson & Placier, 2001; Wilson & Berne, 1999). Many studies have focussed on student teacher learning or on in-service teacher learning in formal settings 'outside' teaching practice. Formal programs can be divided into more traditional training programs in which an expert tells teachers, for example, how to implement a new instructional method, and programs in which teachers organize and plan their own development. For a long time these programs took place outside schools, for example, in summer courses or at conferences (Grossman, Wineburg, & Woolworth, 2001; Richardson & Placier, 2001). In recent years, a growing interest in stimulating teacher professional development in the workplace has become apparent (e.g., Kwakman, 2003). Situating teacher professional development in the workplace can foster instant experimentation with newly acquired knowledge and skills in the teachers' own teaching practice. However, research into how teachers' learning processes occur in the workplace is incomplete. Knowledge of how and when teacher learning takes place in the workplace is of great importance for the implementation of future educational reforms. Educational reforms call for changes in teachers' teaching methods and in their ways of thinking about student learning. Gaining more insight

into teacher learning in the workplace can help in supporting and facilitating teachers in the implementation of future reforms in their own practices.

In 2003 a large Dutch research project was initiated in which 100 experienced secondary education teachers were investigated over a period of one year; the aim was to develop an empirically funded theoretical model of teacher learning in the workplace (Bakkenes, Hoekstra, Meirink, & Zwart, 2004). Teacher learning in the workplace was examined in three different environments: (1) collaboration in interdisciplinary teams, (2) reciprocal peer coaching, and (3) an informal learning context in which there was no systematic support for teacher professional development. These three environments were chosen to attain a broad and typical view of experienced teacher learning in the workplace. In this thesis we report on the research project in which individual teacher learning was examined in the first-mentioned learning environment: collaboration in interdisciplinary teams.

1.1.1 Teacher learning in a context of collaboration in interdisciplinary teams

Working in teams is becoming more and more common in school organizations. It is widely acknowledged that collaboration between professionals can be a powerful way of learning. From previous research it is known that teachers themselves consider interaction with colleagues useful in their own development as professionals (Johnson, 2003; Kwakman, 1999; Lohman, 2005). Hammerness, et al. (2005) argue that teacher learning can take place along two dimensions: an efficiency dimension and an innovative dimension. When these dimensions are related to teacher collaboration, collaboration in the first dimension can be aimed at making teachers' existing teaching routines more efficient and elaborate. This type of collaboration and learning is not difficult to achieve. Collaboration aimed at innovative teacher learning, on the other hand, involves giving up old routines and transforming prior beliefs, and is much more complicated. Despite this, for teachers to be professionals, it is important that they have the skills and a will to continuously evaluate and change their current practice in collaboration with colleagues. When teachers have had positive experiences of developing and changing their teaching in collaborative contexts, it is to be expected that they will ask for feedback from colleagues more often in future.

In studies of teacher learning in collaboration, there has been a strong focus on the conditions under which collaboration is most effective for the professional development of teachers (Schwarz McCotter, 2001; Little, 1990; Borko, Mayfield, Marion, Flexer, & Cumbo, 1997). For example, shared goals and the creation of high levels of interdependence between teachers are assumed to stimulate teacher learning in collaboration. However, research addressing how

teachers actually learn within settings aimed at innovation and studies in which teacher learning in collaborative settings is described in detail are lacking (Hasweh, 2003; Wilson & Berne, 1999). The research project presented in this thesis was aimed at providing an understanding of what, how, and under what conditions teachers learn within a context of collaboration in interdisciplinary teams, by making such detailed descriptions. These descriptions might assist optimization of the conditions for teacher professional development in the workplace by policymakers, school principals, and coaches in teacher professional development trajectories. They may also be useful for teachers themselves as they can use this knowledge in becoming more conscious of ways in which they can continuously change and innovate their teaching.

1.1.2 Fostering active and self-regulated student learning as a context for learning

The teachers which were investigated in this research project all collaborated in teams on a topic related to 'stimulating active and self-regulated learning of students'. In order to prepare students for lifelong learning, a large educational reform was implemented in Dutch upper secondary education in 1998. In higher education, students are supposed to be able to regulate their own learning. In secondary education, teachers are, therefore, encouraged to use a pedagogical approach which focuses, in addition to teaching subject matter, more on fostering active and self-regulated student learning. Teachers, while remaining experts in their specific school subjects, need to expand their repertoire and become coaches of students' learning processes also, and stimulate students to learn how to become responsible for their own learning processes. For a successful implementation of this reform it is important that teachers endorse a student-oriented approach to teaching and learning. Such an approach stimulates students to take responsibility for their own learning processes and the regulation of these, and also stimulates them to work and learn together (see, among others, Bolhuis & Voeten, 2004; Oolbekkink-Marchand, Van Driel, & Verloop, 2006a; Waeytens, Lens, & Vandenberghe, 2002). As for most experienced teachers these reforms require changes in their ways of thinking about teaching and student learning and their teaching behavior (i.e., learning along an innovative dimension), we reasoned that this would be a good context to investigate teacher learning in a context of collaboration in teams in the workplace.

1.2 Theoretical framework

1.2.1 Characterization of collaboration in interdisciplinary teams

We examined teams that included teachers of different subjects. Given that interdisciplinary collaboration is not common practice in Dutch secondary

education, we assumed that this type of collaboration could create many new learning opportunities for teachers. Most teachers only work together with colleagues from the same subject department (Van Wessum, 1997; Witziers, Sleegers, & Imants, 1999). We reasoned that interdisciplinary collaboration can foster teachers' acquaintance with a broader variety of ideas and teaching methods as teachers from different subject matter departments to some extent use diverse teaching methods. These methods may be based on different ways of thinking about how students learn and may be related to characteristics of the subject matter content. This can stimulate teachers to reflect on their own practice and, subsequently, to experiment with the (adjusted) methods of colleagues to alter and elaborate on their own practical knowledge of teaching. Instead of being provided with formal theoretical knowledge of teaching developed outside actual teaching, teachers who participate in such interdisciplinary settings are stimulated to develop and adjust their knowledge of their own teaching practices (Verloop, Van Driel, & Meijer, 2001). The collaboration in these teams can best be characterized using images of 'knowledge *in* practice' and 'knowledge *of* practice' (Cochran-Smith & Lytle, 1999, p. 250-262). Cochran-Smith and Lytle use three images that represent the three most prominent conceptions of teacher professional development: knowledge *for* practice; knowledge *in* practice; and knowledge *of* practice. These three images of knowledge are related to specific forms of teacher learning and have led to different ideas about how teacher professional development should be fostered in order to change and improve education.

In the 'knowledge *for* practice' image, it is assumed that researchers produce formal knowledge and theory *for* teachers which can be used to improve practice. In this perspective, it is argued that acquiring more knowledge leads to a better teaching practice. In teacher professional development programs which are based on this conception of teacher learning, the focus is on acquiring new or additional knowledge and skills related to a specific content area.

In the image of 'knowledge *in* practice', teachers' practical knowledge takes a central position. From this perspective, "it is assumed that teachers learn when they have opportunities to probe the knowledge embedded in the work of expert teachers and/or to deepen their own knowledge and expertise as makers of wise judgments and designers of rich learning interactions in the classrooms" (p.250). In their everyday teaching practice, teachers are continuously confronted with challenging situations which require an almost immediate appropriate reaction. Through 'considered and deliberative reflection' they acquire the knowledge they need to teach well. Professional development programs founded on this image of teacher learning aim at stimulating teachers to become more conscious of their own assumptions, and their own ways of reasoning and decision-making.

The image of 'knowledge *of* practice' does not distinguish formal knowledge from practical knowledge. In the related conception of teacher learning, it is assumed that the knowledge teachers need to teach well can be derived from intentional investigation of own teaching practices in combination with using knowledge produced by others to interpret own practices. In addition, teachers are assumed to learn in collaboration with colleagues in inquiry communities or networks. These communities can consist of novice and expert teachers, facilitators, and researchers. An important notion is that all participants are considered fellow learners and researchers who collaborate in changing their teaching practices, schools, and societies.

The teacher teams participating in this study were stimulated to think collectively of ways to foster active and self-regulated student learning, and to experiment with new methods in their own teaching practice. We expected that exchanging ideas and experiences with colleagues would encourage teachers to critically examine and reflect on their own practices; collaboratively examining and reflecting on their individual practices might result in changes in individual teachers' ways of thinking about student learning or in changes in their teaching practices.

1.2.2 Conceptualization of teacher learning

Based on the arguments mentioned in the previous section, we reasoned that teacher learning takes place in teachers' daily teaching practice and in interaction with peers. This way of thinking is based on a 'situative' perspective on cognition and learning (Putnam & Borko, 2000). From this perspective it can be drawn that teacher learning cannot be separated from the context in which it takes place. 'How a person learns a particular set of knowledge and skills, and the situation in which a persons learns, become a fundamental part of what is learned' (p. 4). Teacher learning is considered to be intertwined with ongoing teaching practices and should, therefore, be grounded in this practice. Also, the importance of interaction with others (colleagues, students, etc.) in both what is learned and how learning occurs is highlighted in this perspective on learning (cf. Salomon & Perkins, 1998). It is argued that teachers can participate in discourse communities which can stimulate them to critically reflect on their current practices and support them in experimenting with alternative teaching methods.

In order to investigate teacher learning in a context of collaboration in interdisciplinary teams, we considered 'teacher learning' to be *an ongoing work-related process of undertaking activities that leads to a change in cognition or behavior, or both.* This description is derived mainly from an acquisition perspective, and partially from a participation perspective on learning (Sfard,

1998). Regarding the acquisition metaphor of learning, we regarded learning primarily as a continuous active individual process of personal construction of cognition or behavior, or both. In order to examine learning from this perspective, changes of cognition or behavior, or both, can be considered evidence of learning. In addition, we expected teachers to continuously change and adjust their knowledge and skills in order to align with latest developments and demands from society. Furthermore, based on the participation metaphor of learning, we endorsed that "learning and learning activities should not be considered separate from the context in which they take place" (Sfard, 1998, p.6). Therefore, the team and school environment was taken into account as well. We aimed to include *what* teachers learn by looking mainly at changes in cognition, and *how* teachers learn by examining teachers' learning activities that resulted in such changes in cognition. The *environment* of teacher learning was also included: we examined how teachers start up and develop collaboration in interdisciplinary teams and the influence of group and organizational variables on how and what teachers learn in a context of collaboration in teams.

With *learning activities* we refer to individual activities that teachers undertake both in and outside the workplace, and which they consider relevant to their own development in fostering active and self-regulated student learning. In particular, *changes in cognition* (knowledge, beliefs, attitudes, emotions) were examined because they can lead to changes in teaching practice (Fishman, Marx, Best, & Tal, 2003). Successful implementation of the educational reform requires teacher acceptance and adherence to the principles of 'active and self-regulated student learning' (Oolbekkink-Marchand, et al., 2006a). In other words, changes in teachers' beliefs are needed to enable them to focus on the stimulation of their students' active and self-regulated learning in addition to teaching their subject matter. Changing teacher beliefs, however, is considered to be a difficult task. For instance, Pajares (1992) concludes that "teachers' beliefs generally are not easy to change even when, based on opposing evidence, it is logical or necessary for them to do so" (p. 317). Student teachers tend to use new information to confirm and strengthen rather than change their current beliefs (Tillema, 1998). Tillema and Knol (1997) argued that in order to change student teachers' beliefs, it is important to take their existing beliefs as a starting point. Subsequent to recognizing one's beliefs in relation to new ideas, investigation and experimentation are necessary for student teachers to decide if new ideas are plausible. Based on such experimentation, student teachers can decide to change and reconstruct their existing beliefs. In this study, we focused specifically on belief changes in experienced teachers who have been confronted with many educational reforms in recent years. We examined how and why the beliefs of some experienced teachers

change, but not those of other teachers. Additional insight into the reasons for and details of changes in beliefs in experienced teachers might be of help in supporting these teachers in implementing future educational reforms.

In addition to examining changes in beliefs, we also examined teachers' preferences for learning activities and changes in these preferences. Participants collaborated with colleagues in interdisciplinary teams, which was a new way of professional development for these teachers. They also collaborated on a new pedagogical approach, namely, 'fostering active and self-regulated student learning'. In such a context, it might be expected that teachers would change not merely their knowledge and skills with regard to teaching and student learning, but also their own (preferences for) ways of learning. Exploring teachers' preferences for learning activities and changes in these preferences can be of use in designing and optimizing future teacher professional development.

From the participation metaphor of learning we derived that teacher learning cannot be separated from the context in which it takes place. Therefore, *teachers' work environment* was taken into account.

In the four studies presented in this thesis we examined individual teacher learning in a context of collaboration in interdisciplinary teams using the various perspectives as discussed above, and, therefore, different elements of teacher learning are highlighted and combined. For the studies presented in this thesis, we formulated the following research questions:

1) What learning activities do teachers undertake in collaboration in interdisciplinary teams and what do they report to learn from it during a period of one year?
2) How are learning activities that teachers undertake in a context of collaboration in interdisciplinary teams related to changes in their beliefs with respect to the topic 'active and self-regulated student learning' during a period of one year?
3) How are learning activities that teachers undertake in a context of collaboration in interdisciplinary teams related to changes in their preferences for learning activities during a period of one year?
4) How do teachers collaborate in interdisciplinary teams and how does this relate to teacher learning with respect to the topic 'active and self-regulated student learning'?

1.3 Design of the study

We examined individual teacher learning in a context of collaboration in interdisciplinary teams. The teachers collaborated on a specific topic related to fostering active and self-regulated student learning. Five interdisciplinary teams

(ranging in size from four to nine teachers) in five different schools were examined for a period of one year. In total, thirty-four teachers participated. All five interdisciplinary teams began working together at the start of this study. Both quantitative and qualitative data collection instruments were used to obtain detailed information on *what* and *how* teachers learned during the year they were investigated. To collect data on *what* teachers learned, we asked them to complete a questionnaire on their beliefs about teaching and learning. This questionnaire was administered at the beginning and end of the year in order to determine possible changes in these beliefs. To obtain information on *how* teachers learn, we mapped individual learning activities teachers were engaged in using their reports on six learning experiences in digital logs. The teachers also completed a questionnaire on their preferences for learning activities. Like the questionnaire on teachers' beliefs, this questionnaire was administered both at the beginning and end of this study in order to examine whether teachers changed their preferences for ways of learning as a result of participating in an interdisciplinary team for the period of one year. In addition, team meetings were observed to examine the collaboration in teams. The teachers also completed questionnaires on how they perceived the team and school in which they worked; this was to further characterize the interdisciplinary teams. With regard to teachers' perception of their teams, they completed a questionnaire in which they had to evaluate elements of the team they had participated in, such as group cohesion. On a more general level, a questionnaire aimed at measuring teachers' views on school organizational variables was administered. We expected that knowledge of the interconnectedness of these data sources might enable a better understanding of individual teacher learning in a context of collaboration in teams in the workplace.

1.4 Outline

In Chapters 2 to 5, four studies are presented which were all aimed at gaining a more comprehensive understanding of how teacher learning takes place in a context of collaboration in interdisciplinary teams.

Chapter 2 addresses the first research question. In this chapter, an in-depth qualitative study *(study 1)* is described, focusing on reported learning activities and outcomes with respect to active and self-regulated student learning resulting from collaboration in teams. For this study, we conducted in-depth interviews with one or two teachers from each team, in total six teachers, after each meeting in order to gain insight into what they learned from that meeting and which learning activities during the team meeting caused this learning. In addition to these interviews, teachers' digital logs were analyzed to gain insight into what and how these teachers learned from collaboration with colleagues. The results of

both the interviews and the digital logs were combined in order to examine what and how teachers learn from collaboration in teams during a period of one year.

Chapter 3 addresses the second research question and presents a study *(study 2)* in which individual teacher learning was examined within a broader scope. For a period of one year, thirty-four teachers reported on at least six learning experiences in digital logs which in their view were important for their own professional development with respect to fostering active and self-regulated student learning. In addition, the teachers completed a questionnaire on their beliefs about teaching and learning at the beginning and the end of the year. The learning activities reported in these logs were related to changes that occurred in the teachers' beliefs about teaching and learning between the first and second time they filled in the questionnaire, in order to examine connections between how and what individual teachers learn in the workplace.

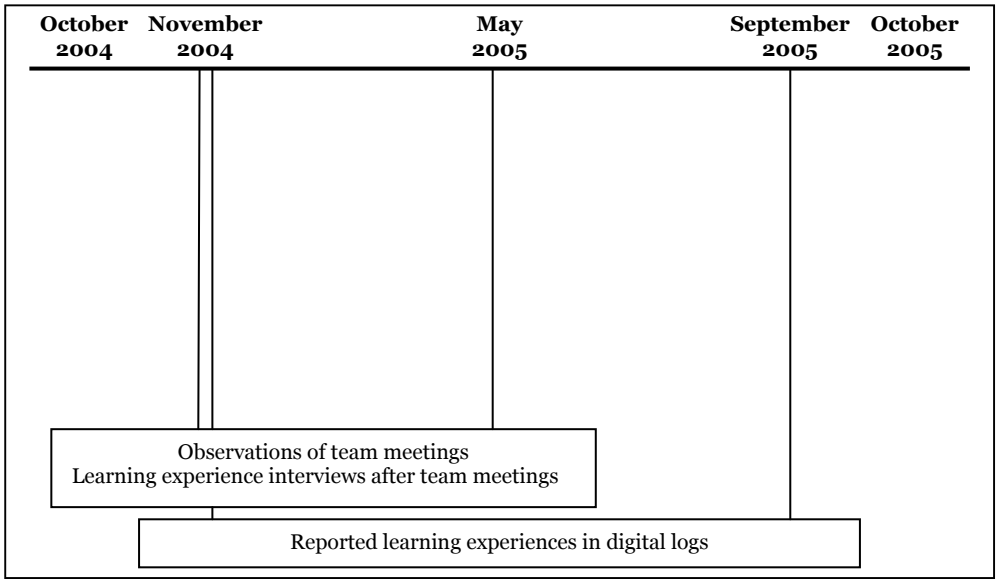
Chapter 4 deals with the third research question and describes a study *(study 3)* in which changes in teachers' preferences for ways of learning were examined. The thirty-four participating teachers completed a questionnaire on their preferences at the beginning and the end of the year. To explain why some teachers' preferences for learning activities changed while those of others remained the same, we examined the teachers' learning activities in the workplace reported in their digital logs.

C*hapter 5* addresses the fourth research question on the characterization of collaboration in the five interdisciplinary teams, and how this collaboration relates to teacher learning *(study 4)*. We explored how teachers started up and developed collaboration in interdisciplinary teams, and how this related to changes in teachers' beliefs with respect to the topic 'active and self-regulated student learning'. Additionally, the influence of group and organizational characteristics, such as group cohesion, shared vision, and decision-making, on collaboration and teacher learning in interdisciplinary teams was explored.

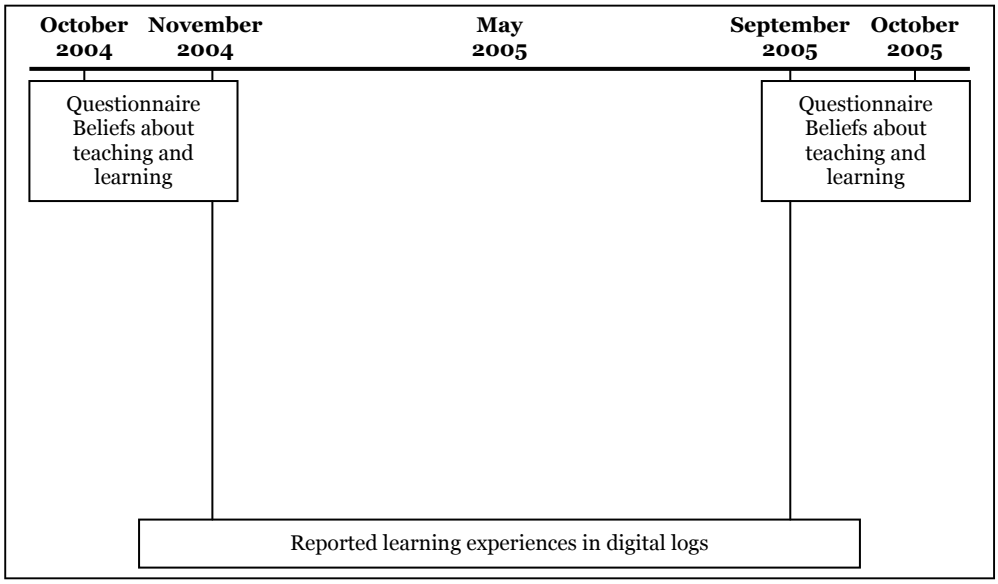
In *Chapter 6,* we summarize the main findings and conclusions of the four studies. Limitations of the studies are also discussed. We conclude with a discussion of the implications of the findings and suggestions for future research on teacher learning in the workplace, and particularly in the context of collaboration in interdisciplinary teams.

On the following pages we provide figures of the data collection of each of the four studies presented in chapter 2 to 5 separately, and one figure for the total data collection of this research project.

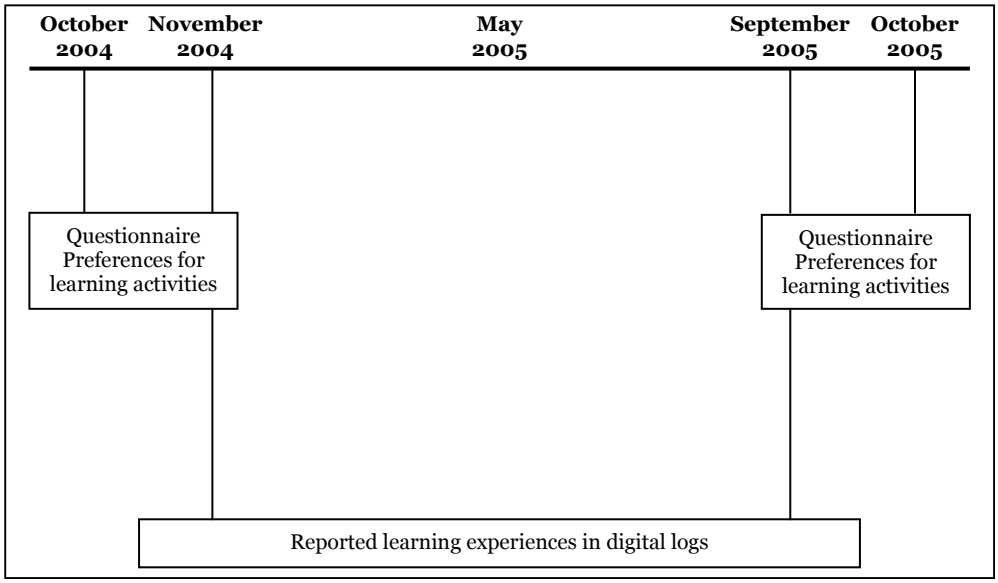
Study 1: What learning activities do teachers undertake in collaboration in interdisciplinary teams and what do they report to learn from it during a period of one year?



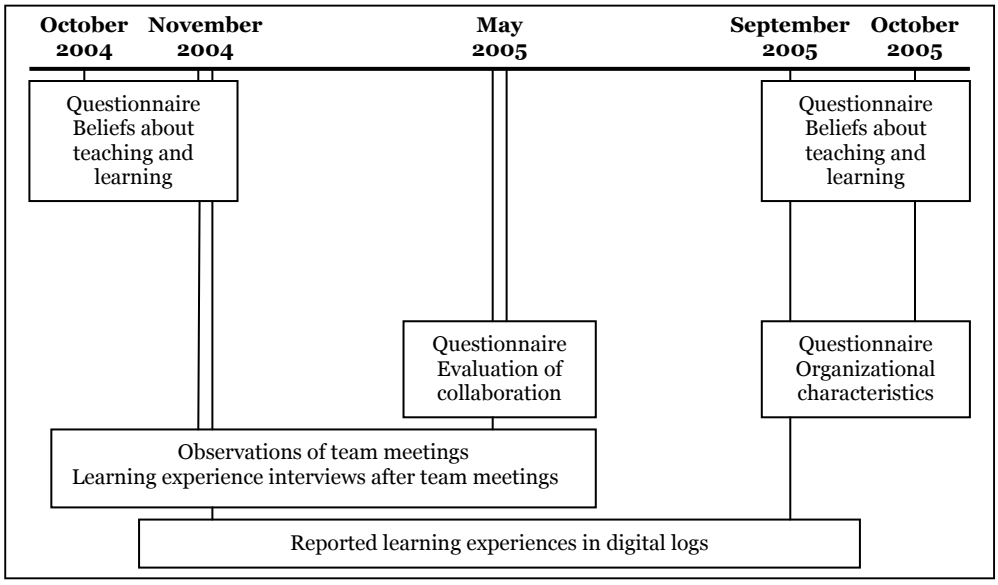
Study 2: How are learning activities that teachers undertake in a context of collaboration in interdisciplinary teams related to changes in their beliefs with respect to the topic 'active and self-regulated student learning' during a period of one year?



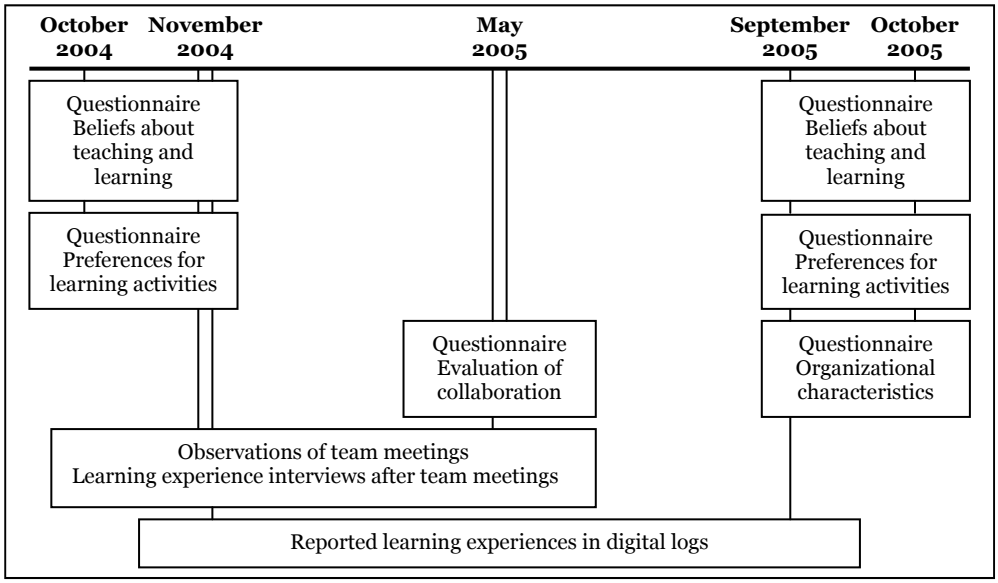
Study 3: How are learning activities that teachers undertake in a context of collaboration in interdisciplinary teams related to changes in their preferences for learning activities during a period of one year?



Study 4: How do teachers collaborate in interdisciplinary teams and how does this relate to teacher learning with respect to the topic 'active and self-regulated student learning'?



Total data collection



Chapter 2

Ann, digital log number 1

My first learning experience started off during our first team meeting. Just before the meeting I had marked a test of one of my classes who had got really low grades. [...] Something had to change in that class. My first thought was: the students don't learn, they underestimate the subject matter. [...] My goal was to control students' homework very strictly in future and to confront them with the fact that they did not study well since I could point out in their textbooks and assignments exactly where they could have found the corrects answers to the test questions. [...] During the meeting I realized that it would be worthwhile to examine first why students caught on to the subject matter so badly, because it is a rather quick conclusion to say that they just do not work hard enough. [...] In this meeting, colleagues often mentioned motivation and positive feedback as the key to activate students' learning. I realized that this was the problem in my own teaching practice. I formed the intention to control homework but mainly to compliment students in order to improve the atmosphere and work climate. So far, I do not have new grades to prove that this approach is working, but the atmosphere has improved and I notice that students are indeed more motivated when they receive a compliment. Actually, I knew this for years, but the consultation with colleagues has opened my eyes and stimulated me to use this knowledge in my teaching practice.

Iris, digital log number 3

I went to Eric in his class as I had a question. It was so much fun that I decided to stay (just by coincidence, I had a free hour). [...] The students had to individually show Eric what they had done for the drawing teacher. When a student had not done the work, it was immediately agreed that it had to be done by the next class. This was done with a joke, but thereafter order and clarity and he wants immediate explanation from the students. The students who did do the work were asked to explain what the assignment entailed and how they interpreted it. The rest of the class watches and discusses as well. [...] Good atmosphere, involvement, and clarity. I left the classroom with the idea that I should have attention for every student, good or bad but in a positive manner, because then you can do almost anything. My learning experience is that you can confront students with their failures and also compliment them with their product as long as you do that with humor and clarity. And the students learn from each other: how things should be done and what is expected of them.

Jeff, digital log number 6

Three weeks ago, we were in an Education Group meeting to prepare the first study afternoon. [...] One of my colleagues introduced the concept 'visible learning' that requires a high level of action for both the teacher and the students during a lesson. [...] In a short enumeration of possible teaching methods for 'visible learning,' my colleague mentioned the 'half-time conversation'. The teacher asks small groups of students to briefly talk with him or her about what has been done during the past few lessons. The students can learn from each other in such a manner and are, of course, forced to put aspects of the subject matter into words. [...] In the two weeks following this preparatory meeting, I used the half-time conversations in four lessons and they really worked! Of course, you have to ask the right questions. [...] A pleasant side effect is that you can pay more personal attention to the students in a serious environment.

Susan, digital log number 1

This year I wasn't very pleased with my own method of controlling students' homework. I want students to do their homework as asked, but I don't want to use punishment exercises. I would rather motivate them to do their homework in a different manner. In the second term of this school year, I started off with a different method. I got the idea by visiting schools in France and observing a teacher at one school. This teacher pulled out a number out of a bag at the start of each lesson and asked the student whose number on the student list corresponded to this number, to write his or her homework on the blackboard. [...] I don't control students' homework anymore, but I let chance decide which student has to write down his or her answer to a homework assignment on the blackboard. [...] Students think it is important to have their homework in order when it

Chapter 2
Collaboration in teams: Teacher learning activities and self-reported outcomes[1]

A considerable amount of current research on teaching and teacher education focuses on teacher collaboration. Teacher collaboration is presumed to be a powerful learning environment for teachers' professional development. However, empirical research about how teachers actually learn in collaboration is lacking. In this study, learning activities were explored in relation to reported changes in cognition or behavior, or both, of six teachers that collaborated with colleagues in teams. These six teachers were interviewed after team meetings and also asked to report learning experiences in a digital logbook six times during a period of one year. Qualitative analyses of both data sources resulted in seven configurations of (successions of) learning activities and reported changes in cognition or behavior. A closer look at these configurations showed that (successions of) learning activities in collaboration resulted mostly in reported changes in cognition. These reported changes in cognition often concerned confirmation of own ideas or teaching methods. The high number of confirmations of own ideas or teaching methods may be explained by the reform context in which these teachers work. Teachers who are experimenting with new teaching methods can feel insecure about these newly acquired methods and, therefore, seek confirmation from their colleagues.

[1] This chapter has been published in adapted form as:
Meirink, J.A., Meijer, P.C., & Verloop, N. (2007). A closer look at teachers' individual learning in collaborative settings. *Teachers and Teaching: Theory and Practice, 13,* 145-164.

2.1 Introduction

Present knowledge-based society requires continuous development of professionals. Professionals are expected, for example, to anticipate emerging new technologies, to be informed about latest developments, and to be able to work in teams. In response to these demands, several educational reforms have been implemented during the last two decades in order to prepare students for this knowledge-based society. As these reforms require educational professionals who can give shape to these ideas in practice and are also able to pay constant attention to self-improvement, teacher professional development has become a central topic in the research literature about teaching and teacher education (Orland-Barak & Tillema, 2006). Teachers are expected to stimulate active and self-regulated learning of students during their teaching practice instead of focussing solely on teaching their students subject matter. As a result of these reforms, teachers are expected to concentrate more on their role as coach/activator or stimulator in the learning process of students (e.g., Bolhuis & Voeten, 2004). For most teachers, this reform requires a change in beliefs and attitudes towards the learning process of students and also a change in their own classroom behavior. In order to advocate such changes, programs organized in the working context of teachers, often collaborative settings such as learning communities (Shulman & Gamoran Sherin, 2004), are nowadays preferred (Grossman, et al., 2001; Richardson & Placier, 2001). Teachers perceive discussions with colleagues in collaborative settings as relevant and valuable for the improvement of their own teaching practice (e.g., Dunn & Shriner, 1999; Kwakman, 1999). In collaboration they can exchange ideas or experiences, develop and discuss new materials, and receive feedback from colleagues (Butler, Novak Lauscher, Jarvis-Selinger, & Beckingham, 2004; Putnam & Borko, 2000).

Though collaboration is considered a powerful professional development program for teachers, little empirical research has been done into how teachers learn in collaborative settings (Borko, 2004). Instead, there has been a strong focus in the literature on what teachers learn from collaboration and on the conditions under which collaboration is most effective for the professional development of teachers (e.g., Borko, et al., 1997; Little, 1999; Schwarz McCotter, 2001). Thus, it remains unclear what teachers actually do in collaboration that leads to learning, or in other words, which processes take place in such settings. This may be due to the difficulties researchers face when analyzing learning in interaction in collaborative settings. Little (2002), for example, showed that learning is difficult to locate in the interaction between teachers in collaborative settings. In her study, analysis of the interaction between teachers in episodes provided merely speculation about what might have been learned instead of what (apparently) had been learned.

We aimed to contribute to existing theories about teacher learning in a (formal) program at the workplace, and we present here the results of a one-year study into teachers' individual learning from collaboration in teams. In order to gain insight into how teachers learn in such teams, we took the view that learning is a result of being engaged in learning activities such as, reading books, attending conferences, or discussing with colleagues. Mapping these learning activities was a necessary first step in understanding how teachers learn in collaboration with colleagues. Because we regarded learning as undertaking activities that result in changes in cognition or behavior, or both, the second step consisted of combining learning activities with what teachers learn. Accordingly, the following research question was formulated:

- What learning activities do teachers undertake in collaboration in interdisciplinary teams and what do they report to learn from it during a period of one year?

As teacher learning in collaboration has not yet been examined from a point of view in which learning activities related to changes in cognition or behavior, or both, take a central position, we decided to conduct an in-depth study with six teachers. Including only six teachers in the study would make it possible to analyse learning activities and changes in cognition and behavior in more detail, which we hoped would result in a more comprehensive understanding of how teachers learn in collaboration. Owing to the small number of teachers, the results of this study are (for the most part) described in a qualitative manner.

2.2 Conceptual framework

2.2.1 Collaboration as a context for teacher learning

In research on teacher learning, learning is often conceptualized as a change in cognition (knowledge, beliefs, attitudes, emotions) that can lead to changes in teaching practice (e.g., Fishman, et al., 2003). Richardson and Placier (2001), in a literature review on teacher change, showed that during the last three decades research on teacher learning focussed more and more on the first part of the conceptualization of teacher learning, that is, changes in teacher cognition. In this cognitive perspective, teachers, like students, are seen as 'active constructors of knowledge who make sense of the world and learn by interpreting events through their existing knowledge and beliefs (Putnam & Borko, 1997, p.1227). Based on these insights, we defined teacher learning in this study as an active process in which teachers undertake learning activities that lead to a shift in their cognition or behavior, or both. Teachers who, for example, aim to extend their knowledge about ways to motivate students can read books about this topic, ask colleagues for

information, or experiment in their own classes with different teaching methods. In other words, they can undertake different sorts of learning activities in order to change their cognition or behavior, or both. Changes in cognition and behavior are considered separately in this conceptualisation of learning. A change in cognition does not necessarily have to result in a change in behavior to be labelled as 'learning'. Likewise, a change in behavior does not have to result in a change in cognition in order to be identified as 'learning'. Furthermore, we conceptualize teacher cognition as an integrated unit of theoretical and practical insights, beliefs, and orientations (personal goals, emotions, expectations, and attitudes) (e.g., Fenstermacher, 1994; Korthagen, 2001; Putnam & Borko, 1997). Changes in behavior are described in terms of changes in classroom behavior.

We examined learning activities that result in changes in cognition or behavior, or both, in a context of collaboration in teams, as research on teacher learning has shown positive effects of teacher learning communities on teacher professional development. Such learning communities appear to stimulate changes in teachers' cognition and improvements in teaching practice (Briscoe & Peters, 1997; Palinscar, Magnusson, Marano, Ford, & Brown, 1998; Perry, Walton, & Calder, 1999). It is commonly assumed that exchanging ideas, conceptions, opinions, knowledge, and experiences enhances learning. It is also assumed that, in collaboration, people can generate or create things which could not have been generated or created by one individual (e.g., Peters & Armstrong, 1998). In collaboration, teachers can become aware of or question their own (tacit) beliefs and understandings. Also, new knowledge can be created and existing knowledge extended. Learning in teams is particularly enhanced when people with different ideas, conceptions, and opinions interact (Putnam & Borko, 2000). Teachers can use the expertise of colleagues either to adjust or improve their own teaching practice or to adjust, extend, expand, substitute, or supplement their own beliefs (Borko, et al., 1997).

It is still largely unclear, however, how exactly teachers learn in and from this collaboration in teams. Descriptions of what teachers do in collaboration and how this might lead to changes in cognition or behavior remain general. Moreover, learning activities undertaken in collaboration and changes in cognition or behavior are seldom investigated in relation to each other.

2.2.2 Learning activities in teacher collaboration

Compared to studies of *students'* learning processes, considerably fewer studies have focussed on *teachers'* learning processes. Student learning processes are investigated mostly from a cognitive-psychological perspective in which *learning activities* that result in changes in cognition or behavior have a central position

(e.g., Ten Dam & Vermunt, 2003). As the contexts in which teachers learn are quite different from the contexts in which students learn, it cannot be assumed that *teacher learning activities* are similar to *student learning activities* (Putnam & Borko, 1997). Teachers' working contexts are often also their contexts for learning. In other words, teachers often learn by doing their job, for example, by preparing their lessons, looking up information on instructional formats on the World Wide Web, or conducting discussions with colleagues in meetings. Only in recent years have teacher learning activities at the workplace been investigated. We looked for comparable studies in which learning activities at the workplace were examined. We found three studies in which teachers were asked to report learning activities they undertook at the workplace that resulted in learning. All three studies resulted in well-organized categories of learning activities and were used as a starting point for describing teacher learning activities in this study (Table 2.1).

In the bottom row of Table 2.1 we combined learning activities categories derived from the three studies (see also Bakkenes, et al., 2004). Firstly, we separated 'doing' from 'experimenting', because 'doing', in contrast to 'experimenting', often does not imply an intention to learn. Secondly, we preferred the label 'reflecting' to the label 'thinking', because the first is more specific. Thirdly, we labelled category 4 with the more general term 'learning from others without interaction', because in addition to learning from reading texts written by others, teachers also learn from observing colleagues or listening to presentations at conferences. Category 5 includes teacher learning activities such as talking, discussing, and brainstorming with others and can be characterized by the presence of interaction between people.

Table 2.1 Learning activities categories found in three studies and starting learning activities categories for the present study

Studies				
Kwakman (1999)	Doing/ Experimenting[a]	Reflection	Reading	Collaboration
Van Eekelen, Boshuizen & Vermunt (2005)	Doing	Thinking	Reading	Learning in interaction
Lohman & Woolf (2001)	Experimenting		Environmental scanning	Knowledge exchanging
Present study	Doing Experimenting	Reflecting	Learning from others without interaction	Learning from others in interaction

a) Not described as separate activities

2.3 Method

2.3.1 Enlisting schools to participate

In February/March 2004, the principals or managers of forty-five schools for secondary education in the western part of the Netherlands received a letter in which, first, the aim and design of this study were briefly explained. Second, they were asked if they were interested in participating in the study, implicating that during the school year 2004/2005 a team of six or seven teachers of different subjects would collaborate in working on a topic related to 'stimulating active and self-regulated learning of students'. This topic was chosen to link up with the recent educational reform in Dutch upper secondary education. In order to connect as much as possible with the needs or concerns within each school, schools were given a large amount of freedom in further specifying the topic of discussion in the team of teachers. In total, nine schools responded to our letter, of which five schools were selected to participate in this study. In May/June 2004 introductory meetings were arranged with all five participating schools in order for the researcher (first author) to meet the participating teachers. These meetings also provided an opportunity for the teachers to ask more specific questions about the study and to explore whether the topic they wanted to work on fitted within the boundaries of this study. Agreements were made about the frequency of team meetings (a minimum of five meetings during the school year), and which meetings would be videotaped and attended by the first author. Team A planned seven meetings, and team B aimed to hold weekly meetings, in which in addition to the topic 'active and self-regulated student learning', problems with individual students would also be discussed. Teams C and E planned five meetings, and team D planned six team meetings.

2.3.2 Characterization of collaboration in teams

Team meetings were attended by an experienced coach, who paid attention to the process of collaboration in the teams. A study team approach was used as a guideline for monitoring the collaboration process (Tillema & Van der Westhuizen, 2006). Three stages are distinguished in this approach: (1) Reflection; raising problem awareness by explicating knowledge and beliefs, (2) Study; investigation, or enquiry using different perspectives, and (3) Change; generation of conceptual artifacts (2006, p. 54/55). The coach kept these three stages in mind when monitoring the collaboration in the teams.

2.3.3 Participants

Six teachers (one or two teachers from each team) were selected for an in-depth study. Table 2.2 shows the fictional names, teaching subjects, and years of

experience of these six teachers. It also shows the teams in which they participated, and the amount of data we gathered in our study.

Table 2.2 Teacher characteristics and quantity of data collection

Teacher	Teaching subject	Years of experience	Team	Number of interviews	Number of digital logs
Tom	Science	30	A	5	4
Susan	Mathematics	5	A	5	6
Iris	English language	16	B	6	6
Isabel	Culture & arts education	6	C	6	6
Jef	Economics	17	D	5	6
Nick	History	23	E	5	4

2.3.4 Data collection

Two instruments were used to obtain information about learning activities and learning outcomes: semi-structured interviews and digital logs.

Interviews

We aimed to conduct a semi-structured interview after each team meeting. Table 2.2 shows that the number of interviews conducted with each teacher does not correspond with the earlier-mentioned number of team meetings. This difference in number of meetings and number of interviews can be explained by teachers being absent (e.g., due to illness) at some of the meetings. Even though the team in which Iris participated had had a larger number of meetings than the other teams, we chose to interview her no more than six times, equally spread over the eleven meetings, in order to have a comparable amount of data for each teacher. We intended to conduct the interviews on the same day on which the team meeting took place. Owing to the full agendas of the participating teachers, however, this was not possible in about half of the cases. In these cases, the interviews were conducted within one or two days after the meeting.

In order to reactivate their memory of a particular meeting, the teachers were asked to tell what happened in the meeting and which topics were discussed. The teachers were then asked what they had learned from the meeting, for example, whether they had discussed things in the meeting that they wanted to consider more deeply, or whether methods were discussed which they intended to experiment with in their own teaching practice. Depending on whether the teachers reported something they had learned from the meeting, they were asked to indicate

the moment in the meeting at which the 'learning experience' had taken place and tell what happened at that moment: what did they do or what did others do? These questions made it possible to understand the connection between reported learning activities and learning outcomes (reported changes in cognition or behavior, or both).

Digital logs

The six participating teachers were asked to send six digital logs during the period of study. The right column of Table 2.2 shows the number of digital logs actually sent in by each teacher. The teachers were given instructions about writing a digital log at the beginning of the research project. Other teachers' logs, collected in a pilot study, were used as examples to show how to write a log and what kind of information a log should contain.

In line with our conceptualization of cognition as an integrated unit of theoretical and practical insights, beliefs, and orientations (personal goals, emotions, expectations, and attitudes), the teachers were first asked to describe what they had learned. They were then asked to describe thoughts, feelings, and aims that went together with their learning experience. Both questions should give information about changes in cognition and behavior. Furthermore, the teachers were asked to describe how their learning experiences were related to the topic of stimulating active and self-regulated learning of students. The purpose of this question was to connect the reported learning experiences with the implemented educational reform, on the one hand, and with the topic of the teacher teams, on the other hand. Finally, the teachers were asked what had caused the learning experiences, how they had learned, and whether other people had been involved in the learning experiences, in order to gain insight into learning activities. In order to get a rich description of their learning experiences, the teachers were asked to combine their answers to these questions and write the result in a story-like manner. As a reminder when writing their logs, the teachers used a card with a visualization of the information a log should contain (see Appendix 2.1).

2.4 Analysis

To better understand teacher learning in collaboration during a period of one year, we combined data from the interviews and the digital logs and analyzed it in a qualitative way. Combining and analyzing both data sources required a five-phase procedure. We describe these phases below, and where applicable illustrate the phases using examples from the data.

In the *first phase*, we selected fragments of each transcribed interview in which a learning outcome (=change in cognition or behavior, or both) was

reported. Often these fragments were answers to the first two interview questions (1. What happened in the meeting?, and 2. What did you learn from it?). The following is an example of such an answer:

> **Susan, interview 1 (December 2004)**
> For example, that as a teacher you always check, and that's my learning experience, students that did not do their homework, but we actually never check students who did do their homework. In other words, we punish but we don't reward. The thing I became very aware of at that moment was that I don't pay attention to students who do things well or maybe that I didn't pay enough attention, that I might do it but not enough and not consciously. Maybe I made compliments unconsciously but not consciously. And then I think to myself, that's something I neglected while I find it very important. It is a subject that I have taken home, I have given it some thought, and now I teach and think, oh yes, now I see what I am doing. I am more conscious of what I am doing and I don't want it that way, I want to do it differently.

In this fragment, in which Susan answered the question about what she learned from the meeting, she indicates that she has become more aware of her own teaching method (= reported change in cognition) and formulates an intention to change her teaching method (= reported intention to change behavior). Occasionally, teachers gave either additional information about the same learning outcome or reported a second change in cognition or behavior in a later part of the interview. In the next step, we identified the fragments from the interviews in which the teachers reported learning activities related to the earlier-reported changes in cognition or behavior. For example,

> **Susan, interview 1 (December 2004)**
> In my view we talked about teaching students how to self-regulate their learning. That was the discussion, self-regulated learning or self-regulated working without losing the depth of learning. Then we started making an inventory of what went wrong and what already went well… so we made two lists. We also talked about motivating and punishing students…..I think Lisa said it, she mentioned 'giving positive attention to students'. And then I thought, yes, that's it. It hadn't been in the foreground for a while for me, I think. It was a sudden insight for me.

The fragments on reported learning activities were combined with the corresponding fragments on reported changes in cognition or behavior, or both. Next, for each teacher separately, selected fragments from all interviews were combined into a time-ordered matrix to get an overview of *what* (changes in

cognition or behavior, or both) and *how* (learning activities) these six teachers learned during the period of one year (Miles & Huberman, 1994).

The *second phase* consisted of the analysis of the digital logs. This analysis required similar steps to those followed for the interviews. First, we selected fragments concerning reported changes in cognition or behavior, or both. Second, fragments concerning related learning activities were identified. Both types of fragments were combined in another time-ordered matrix for each teacher separately.

The *third phase* in analysis consisted of integrating both matrices for each teacher. The resulting matrix provided an overview of all changes in a teacher's cognition or behavior, or both, and related learning activities reported in the interviews and in the digital logs.

For the *fourth phase* of analysis we conducted within-case analyses on the 'overview' matrix (phase three) for each teacher (Miles & Huberman, 1994). The first step in these within-case analyses consisted of combining *how* and *what* teachers learned. For that reason, we made *configurations* of all reported learning activities and changes in cognition or behavior. We use the label 'configuration' firstly to indicate that activities and changes are related to each other, and secondly to illustrate in what way these two elements in a configuration are related. Learning activities and changes in cognition or behavior appear in particular sequences and these sequences can vary under different circumstances. Appendix 2.2 presents an illustration of how we converted original fragments concerning reported learning activities and changes in cognition or behavior from the interviews and digital logs into configurations. We use dotted arrows in the configurations to indicate that learning activities which result in a change in cognition or behavior occur in succession and should not be interpreted as plain causal relations between two activities. The second step in the within-case analyses was to search, in each time-ordered matrix, for similar configurations of learning activities and changes in cognition or behavior, or both, and describe these comparable configurations on a more general level. Configurations that occurred only once in one case were also described on a general level.

In the *fifth phase* we conducted a cross-case analysis to explore which configurations of learning activities and related changes in cognition or behavior, or both, could be retrieved for all or most teachers, and which configurations were specific to only one of the participating teachers. We decided that a configuration should at least occur for two of the six teachers in order to include it in our analysis. Configurations that were specific to one teacher were not taken into account.

2.5 Results

Our research question consisted of two parts: (1) What learning activities do experienced teachers undertake in collaboration in teams? and (2) What do teachers report to learn from these activities? We start with the results for the first part of the research question.

2.5.1 Learning activities in teacher collaboration

The selection of fragments concerning learning activities from the interviews and digital logs, and the formation of time-ordered matrices (phases one, two, and three in the procedure of analysis) resulted in a broad variety of learning activities in teacher collaboration (Table 2.3).

Table 2.3 Specifications of teachers' learning activities categories

Categories	Specifications
Experimenting	- Experimenting with an adjusted teaching method of a colleague - Experimenting with a copied teaching method of a colleague - Experimenting with a self-invented teaching method - Experimenting with an teaching method developed in a team meeting
Reflecting	- Relating/comparing teaching methods or theories to own teaching method - Selecting discussed teaching method suitable for own teaching practice - Thinking about how to implement an teaching method - Reflecting on collaboration in study team or on own experiments in teaching practice - Valuing an experiment - Valuing elements in colleagues' teaching methods - Becoming aware of/Recognizing own conceptions or shortcomings/good practices in own teaching method - Becoming aware of earlier plans to use a similar teaching method in own teaching practice
Learning from others, without interaction	- Observing colleagues' teaching methods - Listening to presentations of experts - Reading articles - Reading colleagues' written reports
Learning from others in interaction	- Brainstorming - Discussing - Exchanging (experiences with) teaching methods - Asking questions about colleagues' experiences or experiments - Receiving feedback from colleagues on own experiences or experiments

All activities found in the data could be placed in the categories of experimenting, reflecting, learning from others without interaction, and learning from others in interaction. Activities fitting in *category 1*, doing (cf. Table 2.1), were not found in the data we used for this study. This category entails activities that take place in teachers' daily teaching practice, such as explaining subject matter to students, designing and checking students' tests, or coaching students. Activities in this category are often undertaken without the intention to learn. The teachers in this study all collaborated in teams in which activities are undertaken with an intention to learn. A second result is that we found a distinction in *category 2* between four sorts of experimenting. These four sorts of experimenting can be typified by the amount of a teacher's own contribution to a teaching method, with experimenting with a copied method at the one extreme and experimenting with a self-invented method at the other. Reflecting, *category 3*, was further specified as 1) reflecting on exchanged teaching methods (selecting discussed methods suitable for own teaching practice and valuing elements in colleagues' methods), 2) reflecting on own teaching practice (relating and comparing teaching methods or theories to own teaching method, thinking about how to implement a method, and valuing an experiment), 3) reflecting on processes in study team (reflecting on collaboration in study team), and 4) becoming aware of own teaching practice (becoming aware of and recognizing own conceptions or shortcomings or good practices in own teaching method, and becoming aware of earlier plans to use a similar method in own teaching practice). Learning activities fitting in with *category 4*, learning from others without interaction, were divided into three types of activities: 1) observing, 2) listening, and 3) reading, and were in line with the examples given by Lohman & Woolf (2001) for what they label as 'environmental scanning'. Finally, *category 5*, learning from others in interaction, was further specified as brainstorming, discussing, exchanging (experiences with) teaching methods, asking questions about colleagues' experiences or experiments, and receiving feedback from colleagues on own experiences or experiments.

2.5.2 Succession of learning activities

Combining learning activities reported by teachers in the interviews and digital logs over the period of one year made it possible to explore if and what learning activities succeeded each other that resulted in a reported change in cognition or behavior, or both. In the studies on teachers' learning activities listed in Table 2.1, learning activities were described separately. We found, however, that learning activities in the five categories are interrelated and need to be described in connection with each other as a first step in understanding more fully how teachers learn in teams. For example, exchanging teaching methods (category 5) was often

pursued by comparing a colleague's teaching method with own methods (category 3), or by valuing elements in colleagues' methods (category 3). A second step would be to connect these successions in learning activities with changes in cognition or behavior (i.e., making configurations of these two elements).

2.5.3 Configurations: types and frequencies

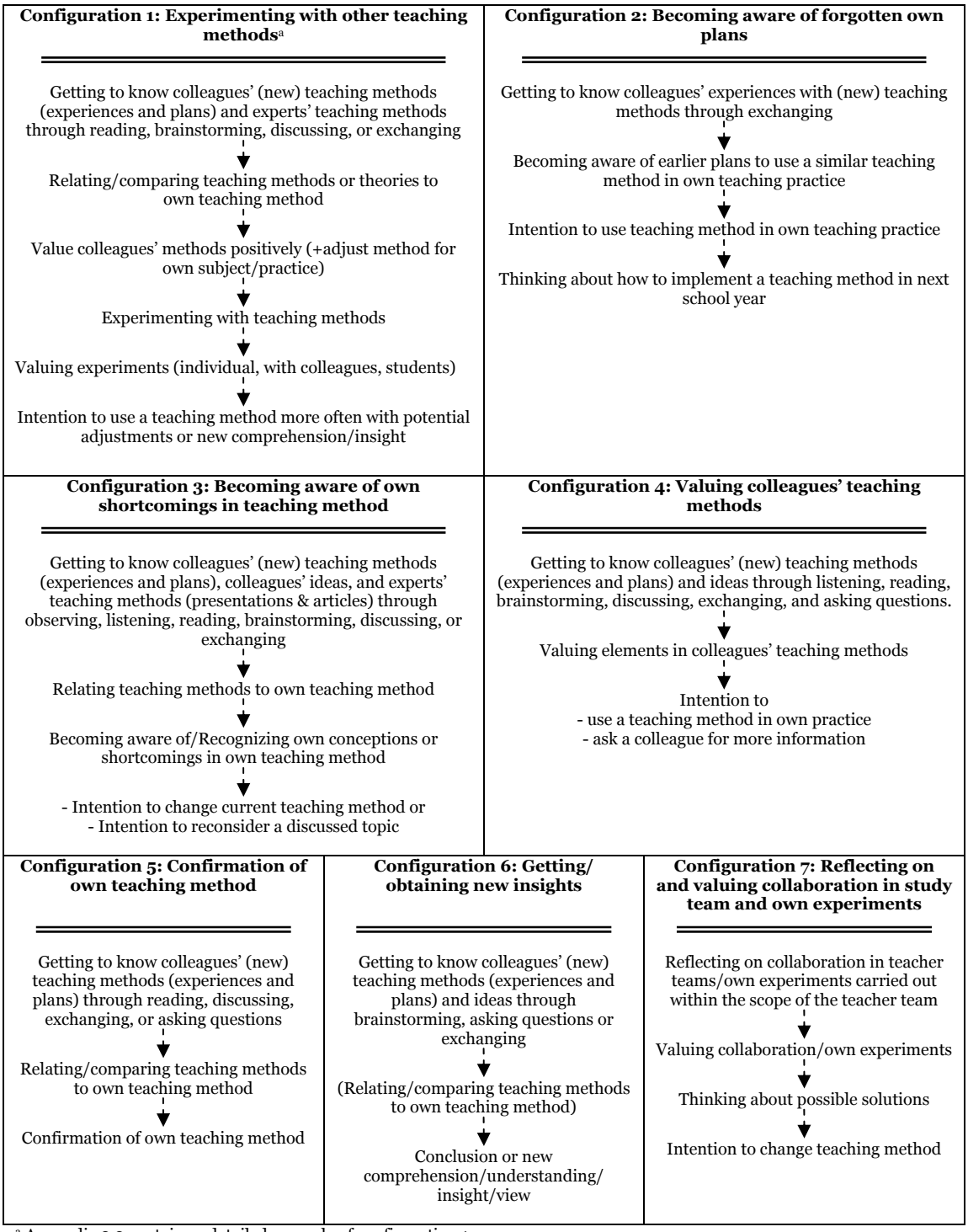
In phases four and five of the procedure of analysis, the within-case and cross-case analyses, we described similar and single configurations of reported learning activities and changes in cognition or behavior at a more general level, and subsequently examined which configurations could be found in two or more cases. These within-case and cross-case analyses resulted in seven configurations of reported learning activities and changes in cognition or behavior (Figure 2.1).

Table 2.4 shows how often the configurations could be found in the interviews and digital logs of the six teachers in our study.

Table 2.4 Frequencies of configurations

	Configuration							**Total**
	1	**2**	**3**	**4**	**5**	**6**	7	
Tom	1	-	1	2	2	-	1	7
Susan	2	-	2	1	-	-	1	6
Iris	1	-	-	2	1	-	-	4
Isabel	-	1	-	1	2	1	-	5
Jef	1	1	2	1	1	-	-	6
Nick	-	-	-	1	3	2	2	8
Total	5	2	5	8	9	3	4	36

From Table 2.4 it can be seen that configurations 4 and 5 occurred most frequently, and that only configuration 4 was found in all six cases. Configurations 2 and 6 occurred for just two of the six teachers.



[a] Appendix 2.2 contains a detailed example of configuration 1

Figure 2.1 Configurations of reported learning activities and changes in cognition or behavior

2.5.4 Similarities and differences in configurations

Comparison of the seven configurations showed that in six configurations 'getting to know other teaching methods' was the starting activity. We look first at the similarities and differences between these first six configurations, and then explore the similarities and differences between the first six configurations and the seventh.

A closer look at the first six configurations, which all started with teachers 'getting to know other teaching methods', shows that only configuration 1 includes the learning activity 'experimenting' in teaching practice. Like the other five configurations, this configuration starts with teachers getting to know colleagues' teaching methods and succeeds with teachers relating or comparing these to their own teaching practices. In contrast to the other five configurations, configuration 1 continues with teachers selecting a teaching method to experiment with in their own practice, which we interpreted as a reported change in classroom behavior. Valuing these experiments finally results in changes in cognition. Configurations 2 to 6 also result in reported changes in cognition, for example, intentions to use a format in their own teaching practice, or confirmation of their own teaching practice. However, the data did not provide information about whether these reported changes in cognition are preceded or followed by an experiment.

Exploration of the differences and similarities between configurations 2 to 6 showed that in the first three configurations (2, 3, & 4), getting to know colleagues' teaching methods resulted in an intention to use a format in their own teaching practice, which we interpreted as a reported intention to change classroom behavior.[2] In configurations 5 and 6, on the other hand, getting to know colleagues' formats resulted in teachers finding confirmation of their own formats, or new insights, without the intention to change classroom behavior.

Configuration 7 is described as valuing or reflecting on the collaboration in the study team or experiments within the scope of this collaboration. Teachers reported this configuration mainly at the end of the school year. Based on their valuing of positive and negative aspects of the collaboration or elements in experiments, teachers formulated intentions for changes in either collaboration in the study team or experiments in their own teaching practice. Although this configuration has similarities with, for example, configuration 3, we consider it a separate configuration, because reflecting on or valuing collaboration in a study team or one's own experiments throughout a school year is a more comprehensive way of reflecting on or valuing, compared to, for example, reflecting on one specific experiment.

[2] We regard an intention to change classroom behavior as a change in cognition since the teacher has not (yet) actually changed his or her practice.

2.6 Conclusions and discussion

The first conclusion to be drawn from our findings in relation to the research question, 'What learning activities do teachers undertake in collaboration in teams and what do they report to learn from it during a period of one year?', is that teachers learnt from getting to know colleagues' (experiences with) teaching methods (e.g., Butler, et al., 2004; Putnam & Borko, 2000), which can take place in different forms of interaction. Getting to know colleagues' (experiences with) teaching methods was often the starting point for a succession of learning activities teachers undertook in teams. Differences between teachers became visible in (successions of) learning activities they engaged in after exchanging their ideas about teaching methods and experiences with them. These differences in (successions of) learning activities also resulted in different learning outcomes. Based on these differences in activities and outcomes, we described reported learning activities in relation to changes in cognition or behavior, or both, which resulted in seven configurations that give a closer look at how teachers learn in collaboration.

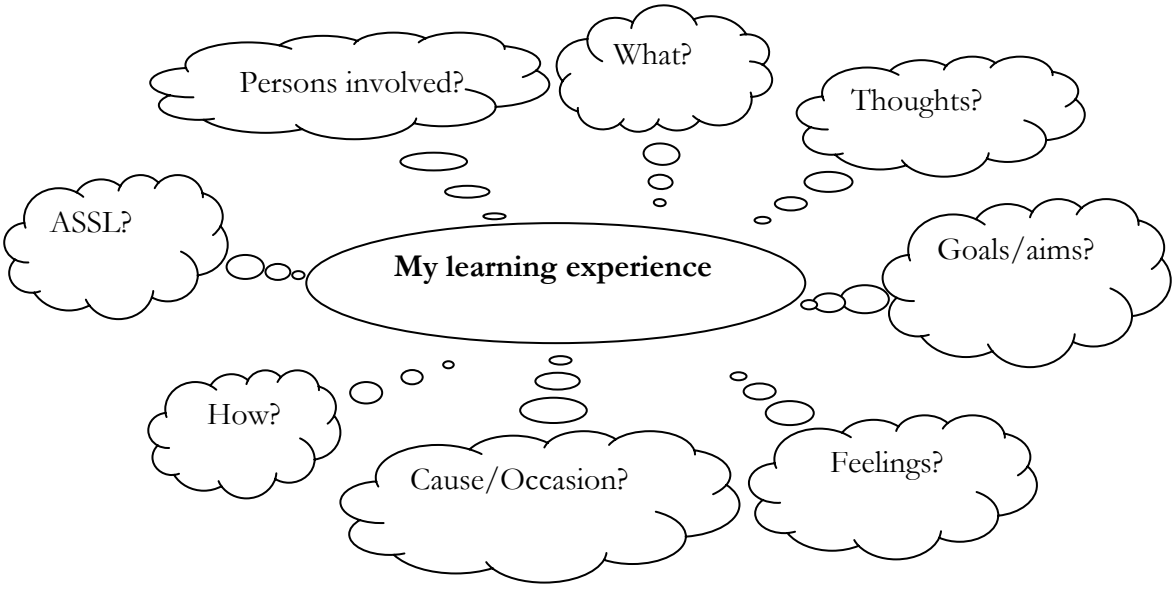
A second conclusion is that teachers reported more changes in cognition than changes in behavior. Reported changes in teaching method (behavior) can only be found in configuration 1, which was found only five times in the interviews and digital logs analyzed. In configuration 1, teachers get to know colleagues' teaching methods and make practical applications of this knowledge for their own teaching practices. We reason that when teachers report experiments with new teaching methods they most likely have changed their classroom behavior. In all other learning experiences (configurations 2 to 7), teachers did not report experiments with teaching methods they got to know as a result of collaborating with colleagues. However, most professional development programs are aimed at achieving improvements in student learning which require changes in teachers' classroom behavior (Guskey, 2002). Why, then, did the teachers report only a small number of practical applications of the methods they had got to know during their collaboration with colleagues? A possible explanation is that teachers do not experiment with colleagues' methods because of the year plans they have to follow. Participating teachers occasionally reported a wish to postpone an experiment until the following school year, because they had just completed work on a subject for which a certain method would be most appropriate. Thus, teachers intended to experiment with other methods, but the experiments did not appear in the period in which we conducted our study. Another possible explanation can be found in the methodology we used for this study. Due to the use of interviews and digital logs, we only have access to *reported* changes in cognition and behavior. Use of a different method of data collection, for instance, observations in classrooms, might

have resulted in different findings. We might argue that teachers are not aware of the changes in their classroom behavior and, therefore, self-reports of teachers can result in incomplete information on their changes in behavior. On the other hand, it is also possible that no changes in classroom behavior occurred, as differences can exist between what teachers say they do and what they actually do. Finally, the period in which we examined these teachers might have been too short as changes in behavior require time and effort (Guskey, 2002). An important implication of this result for the practice of teacher professional development is that coaches of teacher teams might focus more on stimulating teachers to make practical applications of colleagues' methods for their own practice and actually experiment with these methods. Such coaches could also help teachers to remember the plans they made in preceding school years in order to convert intentions to change behavior into actual changes in behavior.

The final result we would like to address is the high frequency of configuration 5. In collaboration teachers can use colleagues' expertise to adjust, extend, expand, substitute, or supplement their own beliefs and practices (cf. Borko, et al., 1997). The learning outcome of configuration 5 is different. That is, teachers often reported to use colleagues' ideas and methods to confirm their own ideas and methods. The high frequency of this configuration (see Table 2.4) can possibly be explained by the reform context in which these teachers work. Perhaps teachers are still struggling with the educational reforms which have been implemented in recent years and feel insecure about their newly acquired teaching methods. In this light, it is not surprising that teachers are searching for confirmation of new beliefs and behavior. Although it is also possible that confirmation of own teaching methods is typical for teachers who don't want to change their beliefs and practices, in our view, this explanation does not do justice to the teachers who participated voluntarily in our study. A will to participate in a study on teacher learning can be interpreted as a will to change existing beliefs and practices.

To validate possible explanations for differences between configurations, additional empirically funded research is needed, preferably in a larger sample of teachers, and over a longer period of time. Focusing on only six teachers enabled us to conduct a qualitative in-depth analysis of reported learning activities and changes in cognition or behavior in collaboration and the relation between those two concepts.

Appendix 2.1 Visualization of the information asked for in the digital log



Explanation of figure

What?	What did you learn?
Thoughts?	What were you thinking? (before, during, or after the experience)
Goals/aims?	What was your goal/aim?
Feelings?	How did you feel? For example, did you feel angry, happy, hurt, disappointed?
Cause/Occasion?	What led to this learning? Did it happen spontaneously or did you deliberately create the situation in order to learn? Did you tell anyone else you were going to create the situation?
How?	What were you doing or what were other people doing that made you learn this?
ASSL?	What, in your perception, is the relation between what you learned and the support of Active and Self regulated Student Learning?
Persons involved?	Were there other persons involved? If so, who were they? For example, students, colleagues, parents?

Appendix 2.2 Example of how the original data from interviews and digital logs was converted into configurations

Fragments from interview 2 and digital log 3 of Susan, March 2005	**Configuration**	**Categories of learning activities[a]**
Next, we started discussing our 'homework'; exchanging formats for discussing tests with students after they have taken them. I think Lisa started off with her experience in 6VWO[b]. The other teachers then exchanged their experiences; everybody took about 5 minutes, and next we talked about reoccurring general features in all experiences. We discussed some other things afterwards (interview 2).	Listening to colleagues' experiences with discussing tests with students afterwards. ⇣	Learning from others in interaction
At the time I was talking about it, I also pointed it out later, I did not experiment with discussing tests afterwards in my own classes, but while I was listening to the others, I thought, well, I do have a test now that I would really like to discuss afterwards with my students (interview 2). While I was listening, I realized I had just marked the tests of 5VWO[c] students, who had got really low grades. Besides, all this subject matter will show up again in the next test week, so discussing this test with the students is really important (digital log 3).	Realizing that it is important after all to discuss a test (with low student grades) afterwards in one of her own classes. ⇣	Reflecting
Well, it is actually a result of what Lisa said (….) at the point in the meeting where she talked about how remarkable the students' honesty and clarity was, I thought, "Yes, that's it", that's the reason for doing it again in a similar way in my own class (interview 2).	Selecting one of the exchanged teaching methods that would fit best with this particular test ⇣	Reflecting
Because I did not have much time, I wasn't able to make a complete evaluation form with all students' grades (like Lisa did) (digital log 3). In the past hour, I have been busy composing an evaluation form for my 5VWO students. I will see them tomorrow and use this form. They took a test, which resulted in dramatic grades (…) I'm going to use Lisa's format in which she lists the points scored and the maximum points students could score alongside each other. She asks students to indicate why they did not score the maximum points, to say what went wrong, and to indicate what they can do to avoid making the same mistakes next time (interview 2).	Adjusting selected teaching method (=evaluation form) for her own students. ⇣	(Preparing for) experimenting

Appendix 2.2 *(continued)*

Fragments from Interview 2 and Digital Log 3 of Susan, March 2005	**Configuration**	**Categories of learning activities**
I composed a form on which they could place the points they scored alongside the maximum points they could have scored. They could also indicate what errors they made. Next, they had to answer some general questions, in particular whether they liked this way of discussing a test afterwards. They also received a form with the correct answers (without the grading system) and the test itself (digital log 3).	Experimenting with adjusted teaching method (=evaluation form) in her own class ⇣	Experimenting
The students had been working really actively, which gave me lots of time to answer questions and to discuss their mistakes. It felt really good to see students examine themselves and their ways of working in the past period in a really critical way. Most students thought it was a useful format for discussing their tests afterwards and also indicated that they thought it was a better way than merely checking their own tests. It did not take much time, but it did provide me with a good evaluation. Now I am curious to find out whether they will get much higher grades in the test week. Anyway, they evaluated their own work critically (digital log 3).	Valuing experiment with new teaching method (indicate good elements in teaching method) ⇣	Reflecting
I have learned that discussing a test afterwards can result in a nice, quiet lesson. Discussing test questions with all students at the same time and keeping all students concentrated requires a great deal of energy from a teacher. For example, half of the students might have given the correct answer to a test question. These students are unlikely to pay attention when that particular test question is being discussed. This new format has many advantages; the students are occupied with their own mistakes, which leaves time for me to respond to questions and remarks. Moreover, reading their evaluation marks afterwards gives me the opportunity to understand them more fully and to coach them better in the future (digital log 3).	Comprehension of/Understanding positive effects when applying this teaching method	Reported change in cognition

a) cf. Table 2.1
b) final year in pre-university education
c) pre-final year in pre-university education

Chapter 3

Ann, digital log number 1

My first learning experience started off during our first team meeting. Just before the meeting I had marked a test of one of my classes who had got really low grades. [...] Something had to change in that class. My first thought was: the students don't learn, they underestimate the subject matter. [...] My goal was to control students' homework very strictly in future and to confront them with the fact that they did not study well since I could point out in their textbooks and assignments exactly where they could have found the corrects answers to the test questions. [...] During the meeting I realized that it would be worthwhile to examine first why students caught on to the subject matter so badly, because it is a rather quick conclusion to say that they just do not work hard enough. [...] In this meeting, colleagues often mentioned motivation and positive feedback as the key to activate students' learning. I realized that this was the problem in my own teaching practice. I formed the intention to control homework but mainly to compliment students in order to improve the atmosphere and work climate. This year, I do not have new grades to prove that this approach is working, but the atmosphere has improved and I notice that students are indeed more motivated when they receive a compliment. Actually, I knew this for years, but the consultation with colleagues has opened my eyes and stimulated me to use this knowledge in my teaching practice.

Iris, digital log number 3

I went to Eric in his class as I had a question. It was so much fun that I decided to stay (just by coincidence, I had a free hour). [...] The students had to individually show Eric what they had done for the drawing teacher. When a student had not done the work, it was immediately agreed that it had to be done by the next class. This was done with a joke, but thereafter order and clarity and he wants immediate explanation from the students. The students who did do the work were asked to explain what the assignment entailed and how they interpreted it. The rest of the class watches and discusses as well. [...] Good atmosphere, involvement, and clarity. I left the classroom with the idea that I should have attention for every student, good or bad but in a positive manner, because then you can do almost anything. My learning experience is that you can confront students with their failures and also compliment them with their product as long as you do that with humor and clarity. And the students learn from each other: how things should be done and what is expected of them.

Jeff, digital log number 6

Three weeks ago, we were in an Education Group meeting to prepare the first study afternoon. [...] One of my colleagues introduced the concept 'visible learning' that requires a high level of action for both the teacher and the students during a lesson. [...] In a short enumeration of possible teaching methods for 'visible learning,' my colleague mentioned the 'half-time conversation'. The teacher asks small groups of students to briefly talk with him or her about what has been done during the past few lessons. The students can learn from each other in such a manner and are, of course, forced to put aspects of the subject matter into words. [...] In the two weeks following this preparatory meeting, I used the half-time conversations in four lessons and they really worked! Of course, you have to ask the right questions. [...] A pleasant side effect is that you can pay more personal attention to the students in a serious environment.

Susan, digital log number 1

This year I wasn't very pleased with my own method of controlling students' homework. I want students to do their homework as asked, but I don't want to use punishment exercises. I would rather motivate them to do their homework in a different manner. In the second term of this school year, I started off with a different method. I got the idea by visiting schools in France and observing a teacher at one school. This teacher pulled out a number out of a bag at the start of each lesson and asked the student whose number on the student list corresponded to this number, to write his or her homework on the blackboard. [...] I don't control students' homework anymore, but I let chance decide which student has to write down his or her answer to a homework assignment on the blackboard. [...] Students think it is important to have their homework in order when it

Chapter 3
The relations of teacher learning activities to changes in beliefs about teaching and learning[3]

In this study, the relations between the learning activities of teachers and changes in their beliefs about teaching and learning were examined. Thirty-four experienced secondary school teachers were asked to complete a questionnaire regarding their beliefs about teaching and learning on two occasions with an intermediate period of one year. During this year, the teachers were also asked to report on activities that they undertook and resulted in a learning outcome. This was done in six digital logs. For twenty-one teachers, significant changes in their beliefs about teaching and learning were found. Changes in beliefs could be divided into changes that were congruent with the aims of an educational reform intended to stimulate more active and self-regulated student learning and changes that were not congruent with the aims of the reform. Those teachers who had changed their beliefs in a direction *congruent* with the aims of the reform were found to more often report experimentation with the teaching methods of colleagues than other teachers. Those teachers who changed their beliefs in a direction that was *not congruent* with the aims of the reform often reported experimentation with alternative teaching methods due to discontent with the effectiveness of current methods and/or student knowledge, skills, and attitudes. Those teachers who *did not change* their beliefs reported mostly learning experiences that involved the observation of students during the performance of a standard assignment.

[3] This chapter has been submitted in adapted form as:
Meirink, J.A., Meijer, P.C., Verloop, N., & Bergen, T.C.M. *Understanding teacher learning: The relations of teacher activities to changes in beliefs about teaching and learning*.

3.1 Introduction

Teacher learning has been given considerable attention in recent research on the practice of teaching and teacher training programs. Little is known, however, about how participation in particular activities promotes changes in beliefs on the part of teachers. Does involvement in different types of activities, for example, result in different types of belief change? The answer to this question can provide a more comprehensive understanding of how teachers learn, and thereby facilitate the design of professional development programs in the future. In addition, determination of just how particular activities undertaken in the workplace relate to specific changes in teachers' beliefs over time and how these relations can best be explained is required for successful educational reform.

3.1.1 Perspectives on teacher learning

In studies of teacher learning, differences exist in what, exactly, is meant by and accounted for as learning. The concepts of acquisition, construction, and participation are often used to characterize teacher learning (Cobb & Bowers, 1999; Cochran-Smith & Lytle, 1999; Hodkinson & Hodkinson, 2005; Putnam & Borko, 2000; Sfard, 1998). Teacher learning construed in terms of the concept of acquisition involves the mastery of new knowledge or skills, or both, by teachers in order to fill any gaps in their knowledge. This perspective on learning is often associated with 'passive reception of knowledge' and alterations or changes of knowledge and skills are considered evidence of learning. Teacher learning construed in terms of the concept of construction involves teachers as the "active constructors of knowledge who make sense of the world and learn by interpreting events through their existing knowledge and beliefs" (Putnam & Borko, 1997, p. 1227). Studies of learning based on this perspective often focus on the learning processes rather than on the outcomes of these processes. Often, learning is considered a continuous process without a clear ending point. Most of the literature on the professional development of teachers draws upon such a constructivist approach to learning (Hodkinson & Hodkinson, 2005). Finally, from a participation perspective it is argued that "learning and learning activities should not be considered separate from the context in which they take place" (Sfard, 1998, p.6). Becoming a member of a certain community, such as a working community, counts as evidence of learning (Lave & Wenger, 1991). Learning is considered an integral part of the daily work process.

Sfard (1998) argues that the choice of either an acquisition or a participation approach to learning "can have major consequences and that pluralism should lead to better research and a more satisfactory practice" (p.10). Along these lines, Hodkinson and Hodkinson (2005) argue that a "combination of

the construction and participation approach of teacher learning might be helpful in understanding and improving teacher learning" (p. 112).

In the present study, we viewed learning as an ongoing work-related process of engagement in *activities* that leads to a *change in cognition*. More specifically, we looked at *changes* in teacher beliefs. For this conceptualization of learning we used the three perspectives on learning discussed above: acquisition, construction, and participation. Firstly, we considered changes in individual teacher beliefs to correspond to the acquisition perspective in which learning outcomes take a central position. Secondly, by examining activities, we aimed to account for the construction perspective on learning. We focused primarily on individual teacher learning processes by exploring individual learning activities. Thirdly, by describing these activities in a certain context, that is, teachers' working environment, we also aimed to account for the participation perspective. Note that taking merely teachers' working environment into account is only a small part of the participation perspective. In the following sections we elaborate further on the two central concepts of our conceptualization of learning: (changes in) beliefs and learning activities.

3.1.2 Teacher beliefs about teaching and learning

Different concepts are employed in the literature on teacher cognition. Authors often speak of teacher knowledge and beliefs (e.g., Calderhead, 1996; Meijer, Verloop, & Beijaard, 1999; Pajares, 1992; Tillema, 1998; Van Driel, Bulte, & Verloop, 2007), teacher conceptions (e.g., Boulton-Lewis, Smith, McCrindle, Burnett, & Campbell, 2001; Kember, 1997), or teacher perspectives (Pratt, 2002). Beliefs generally refer to suppositions or commitments, and are based on evaluation and judgement (Calderhead, 1996; Pajares, 1992). Teacher conceptions and perspectives are used interchangeably and described as an interrelated set of intentions, beliefs, and actions (Pratt, 2002). In the present study, we were primarily interested in teacher beliefs about teaching and learning.

Teacher beliefs about teaching and teacher beliefs about learning can be discussed separately (Boulton-Lewis, et al., 2001; Kember, 1997; Trigwell & Prosser, 1996). According to Boulton-Lewis, et al., however, "teachers hold predominantly congruent beliefs about teaching and student learning" (p. 46). A commonly used distinction in the study of teachers' beliefs about teaching and learning concerns two prototypic ideologies: 1) teacher- or subject-matter-oriented beliefs, and 2) learner-oriented beliefs, i.e., beliefs focussed on supporting student learning. As the term implies, subject-matter-oriented beliefs place a strong emphasis on imparting subject matter and the reproduction of knowledge by students. Teachers are largely held responsible for the regulation of student

learning processes. Also, learning is considered to be a primarily individual process. In contrast, student-oriented beliefs about teaching and learning involve teaching students how to learn, and the emphasis is on the construction of knowledge. Students are stimulated to take responsibility for their own learning processes and the regulation of these, and are also stimulated to work and learn together (see, among others, Bolhuis, 2000; Bolhuis & Voeten, 2004; Oolbekkink-Marchand, Van Driel, & Verloop, 2006b; Waeytens, et al., 2002). Subject-matter-oriented beliefs about teaching and learning are sometimes referred to as 'traditional beliefs', while student-oriented beliefs are sometimes referred to as 'progressive beliefs.' Here, however, we speak of subject-matter- and student-oriented beliefs about teaching and learning, as the words 'traditional' and 'progressive' imply a value judgment which we prefer to avoid (Denessen, 1999).

In the context of an educational reform, teacher beliefs about teaching and learning must shift in a direction that is coherent with the aims of the reform. Given that one of the aims of a recent educational reform in upper secondary education in the Netherlands is to promote more active and self-regulated student learning, teachers are similarly expected to gradually endorse a more student-oriented approach to teaching and learning. However, teachers can also become more negative towards a student-oriented belief about teaching and learning in the context of such a reform, or even develop a stronger preference for a more subject-matter-oriented belief. In the present study, we were particularly interested in the possible associations between teacher participation in particular activities and concomitant changes in their beliefs about teaching and learning. For this reason, all types of changes in both subject-matter-oriented and student-oriented beliefs about teaching and learning were considered important.

3.1.3 Teacher learning activities

In studies of Van Eekelen, et al. (2005), Kwakman (1999), Lohman and Woolf (2001), teachers were asked to report on activities that—in their opinion—promoted their professional development. In all three studies, a general classification of the relevant teacher activities was presented. When combined, the classification systems revealed the following five general categories of activity: doing, experimentation, reflection, learning from others without interaction, and learning from others in interaction (Bakkenes, et al., 2004). In chapter 2, we described these activity categories in more detail for teachers collaborating in teams. From Table 2.3 it can be seen that an activity such as experimentation was further divided into experimentation with an adjusted teaching method adopted from a colleague, experimentation with a teaching method copied directly from a colleague, experimentation with a self-invented teaching method, or

experimentation with a teaching method collaboratively developed in a team meeting. The different types of experimentation were found, moreover, to lead to different reported cognitive changes, which led to the conclusion that such fine-grained classification may be critical for the study of teacher learning. In addition, it was concluded that teacher activities that promote reported changes in cognition also occur in particular sequences. For example, experimentation with a new teaching method that resulted in learning was often preceded by acquaintance with the methods of colleagues and succeeded by reflection on the results of the experimentation—either individually or in interaction with colleagues or students, or both.

3.1.4 The present study

In order to determine just how participation in particular activities promotes belief changes on the part of teachers, the activities of teachers in the workplace must first be mapped. In the context of the present study, the focus was on the activities of teachers who, in addition to their regular school activities, collaborated with colleagues in teams. While teachers report that they learn considerably from colleagues and, thus, from the exchange of ideas, experiences, teaching methods, and feedback (Butler, et al., 2004), the importance of such everyday collaborative activities for changes in teacher cognition is not completely apparent.

Data on the changes that occurred in teachers' beliefs in the context of an educational reform introduced eight years ago in the Netherlands were gathered for the present study. Given that one of the major aims of the educational reform was to promote more active and self-regulated student learning, considerable changes in teachers' beliefs and the behavior of the teachers were required. The teachers could no longer just teach subject matter; they now had to coach the student learning process as well. Additionally, teachers were expected to stimulate students to construct their own knowledge instead of reproducing knowledge, and to work and learn together with other students instead of learning mostly individually. Successful implementation of the educational reform requires teacher acceptance and adherence to the principles of 'active and self-regulated student learning' (Oolbekkink-Marchand, et al., 2006b), and thus some major belief changes on the part of the teachers. The modification of teacher beliefs is assumed to be indispensable for the successful implementation of educational reforms. The results of previous research, however, show the task of modifying teacher beliefs to be very difficult. Pajares (1992) concludes that "teachers' beliefs generally are not easy to change even when, based on opposing evidence, it is logical or necessary for them to do so" (p. 317).

Findings of research on conceptual change suggest that motivational constructs such as goal orientation, values, efficacy beliefs, and control beliefs are mediators in the process of conceptual change (Patrick & Pintrich, 2001; Pintrich, Marx, & Boyle, 1993). Pintrich, Marx and Boyle also argue that prior knowledge and beliefs play a paradoxical role in conceptual change. They can impede conceptual change when students/learners possess strong alternative frameworks, and they can facilitate learning by providing a framework for understanding and judging the validity of new information. Motivational constructs such as goal orientation, values, efficacy beliefs, and control beliefs are assumed to be mediators in the process of conceptual change. From studies on teacher education programs aimed at changing student teachers' beliefs, and, therefore, conceptual change, it is known that student teachers tend to use new information to confirm and strengthen their current beliefs (Tillema, 1998). It is argued, therefore, that in order to accomplish meaningful learning and reflective inquiry for student teachers it is important to take pre-existing beliefs as a starting point to further extend their knowledge base. Tillema and Knol (1997) propose the use of a four-phased procedure to achieve belief change: 1) recognition and attention to current beliefs, 2) evaluation and investigation, 3) decision to change, and 4) reconstruction and building-up of a revised knowledge structure. Furthermore, they assume that carrying out these steps in interaction with other student teachers can be helpful. In addition, Kember (1997) found "approaches which operated over an extended period and operated within the framework of either a course or a project" (p. 272) to be particularly successful. For this study, we formulated the following research question:

- How are learning activities that teachers undertake in a context of collaboration in interdisciplinary teams related to changes in their beliefs with respect to the topic 'active and self-regulated student learning' during a period of one year?

Understanding the relation between teachers' engagement in learning activities and belief changes can facilitate the implementation of future educational reforms. We therefore investigated teachers working in a context of collaboration in interdisciplinary teams during a period of a year, and the specific contributions of various daily activities to the occurrence or non-occurrence of particular belief changes.

3.2 Method

3.2.1 Participants

School principals in the western part of the Netherlands were enlisted to participate in a study on teacher learning in a context of collaboration in teams.

Principals interested in participating in the study were asked to search for teachers in their staff who were willing to collaborate with colleagues with different subject matter backgrounds on a project aimed at collectively thinking of ways to foster active and self-regulated student learning. Five schools were willing to participate. In each school, one teacher team was formed. In total, thirty-four experienced secondary school teachers were investigated over a period of one year. Their teaching experience ranged from three to thirty-four years, with a mean of sixteen and a half years. The five schools in which these teachers worked were all secondary schools for senior general secondary education or pre-university education, or both. In order to be as responsive as possible to the educational needs of the participating teachers and schools, we made it clear that each team was free to further specify the topic of 'active and self-regulated student learning' as it wished. One of the teams, for example, chose to collaboratively consider ways to get students to reflect more on mistakes in their tests. The members of this team were not satisfied with the effectiveness of their current teaching method aimed at stimulating students to learn from their mistakes in tests. The teams all held at least five meetings during the course of the school year. All five teams began their collaboration simultaneously with the start of the study. In each team, an equal number of team meetings was attended during the school year by an experienced coach who paid explicit attention to the process of collaboration in the teams. In most team meetings, teachers shared ideas and teaching methods, and discussed their experiences of experimentation with alternative methods in their own teaching practice.

3.2.2 Data collection

Questionnaire 'Beliefs about teaching and learning'

The teacher beliefs about teaching and learning were measured at both the beginning and the end of the study year (in October 2004 and October 2005). On both measurement occasions, the teachers completed a questionnaire with eight scales addressing their beliefs about teaching and learning. The questionnaire 'Beliefs about teaching and learning' was based on a previous study on teacher beliefs about teaching and learning in Dutch secondary education (Bolhuis & Voeten, 2004). In this study, three central issues of active and self-regulated learning were included in a questionnaire to examine whether teachers' beliefs were congruent with a student-oriented view of teaching and learning. The three issues pertained to 1) self-regulation of learning, 2) learning as active construction of knowledge, and 3) the social nature of learning. We further divided the issue of self-regulation of learning into cognitive and affective regulation of learning (Vermunt & Verloop, 1999).

Table 3.1 Questionnaire 'Beliefs about teaching and learning'

Scale	Sample item	Number of items per scale	Cronbach's alpha (2004)	Cronbach's alpha (2005)
Student-oriented beliefs			.931	.921
Internal cognitive regulation	*Students learn better when they have to check learning progress themselves*	10	.824	.812
Internal affective regulation	*Students learn better when they gain insight into their emotions*	10	.835	.801
Construction of knowledge	*It's important that the teacher allows students to relate the different aspects of the subject matter themselves*	9	.793	.708
Collaborative learning	*It's important that the teacher stimulates students to learn from each other*	7	.825	.816
Subject-matter-oriented beliefs			.892	.897
External cognitive regulation	*It's important that the teacher makes sure that students know exactly how to work best on an assignment*	7	.688	.704
External affective regulation	*It's important that the teacher reassures students before they take a test*	8	.547	.568
Reproduction of knowledge	*Students learn better when they adopt the main and side issues from the teacher*	8	.855	.815
Individual learning	*Students learn better when they work individually on tasks*	10	.806	.853

Four of the scales concerned the student-oriented beliefs about teaching and learning currently promoted by the educational reform. The scales labelled 'internal cognitive regulation' and 'internal affective regulation' refer to the first issue: student or self-regulation of learning. The scale 'construction of knowledge' refers to the second issue, and the scale 'collaborative learning' to the third issue. The other four scales concerned subject-matter-oriented beliefs about teaching and learning, and were labeled 'external cognitive regulation', 'external affective regulation', 'reproduction of knowledge', and 'individual learning'.

Each of the scales included both items measuring teacher beliefs about teaching and teacher beliefs about learning. The items used to measure teacher beliefs about teaching all start with "It is important that a teacher…". The items used to measure teacher beliefs about learning all start with "Students learn better when…". The teachers scored all of the items on a five-point scale (1= totally disagree; 5= totally agree). In Table 3.1, a sample item is presented along with the measures of internal consistency (Cronbach's alpha) for each of the eight scales. Given the low reliability scores for the External affective regulation scale, this scale and relevant items were omitted from further analysis.

Digital logs

Based on the work of Van Eekelen, et al. (2005), we collected digital logs to examine the activities of the teachers. The teachers were asked to write down and e-mail their learning experiences, which boiled down to the provision of a description of what was learned and how it was learned. Owing to the reform context in which this study took place, the teachers were asked to report on only those experiences that related to the topic of 'active and self-regulated student learning.' In order to attain a comprehensive overview of the teachers' activities, we asked them to present their learning experiences in a story-like manner. The teachers were asked to write a log every six weeks, which resulted in six digital logs for each teacher. Using digital logs gives teachers the opportunity to think carefully about meaningful learning experiences, as they have time to consider relevant aspects of their learning experiences. In interviews, teachers have to respond immediately to questions, which might impede their recollection of learning experiences. In order to support teachers in recalling their learning experiences in detail, we gave them a card illustrating the relevant aspects related to learning experiences at the start of the study (cf. Appendix 2.1). When a teacher was unclear about one of more of the aspects of the card, we asked clarifying questions in replies to the e-mails. In order to emphasize that all sorts of learning experiences could be reported, a variety of examples of teacher learning experiences was provided as part of the instructions on how to write a digital log. This was done to emphasize that, although the

teachers were participating in a professional development program (i.e., a collaborative project), learning experiences that did not specifically relate to their collaboration in these teams could also be reported. An unexpected situation that occurred during teaching practice, and concerning a different topic from that discussed in the interdisciplinary team, might be reported as a learning experience as well, for example (Zwart, Wubbels, Bergen, & Bolhuis, 2007). The aim was to gather data on the activities that the teachers themselves considered relevant to their learning; 204 digital logs were obtained for this purpose.

3.3 Analysis

For each teacher and for each of the seven scales separately, we examined whether the scores on the second measurement occasion differed significantly ($p<.05$) from those on the first measurement occasion. Significantly different scores were labelled 'changes in beliefs congruent with' or 'changes in beliefs incongruent with' the underlying aims and principles of the educational reform in Dutch upper secondary education. Significantly lower scores (closer to 1 on a five-point Likert scale) on one or more of the four student-oriented beliefs scales were labelled 'incongruent with the aims of the reform', and significantly higher scores (closer to 5 on a five-point Likert scale) on one or more of these four scales were labelled 'congruent' (cf. Table 3.1). For example, a teacher with significantly lower scores on the items of the scale 'collaborative learning', such as '*It's important that the teacher stimulates students to learn from each other*', has changed his beliefs in a way that is not in line with the reform. Conversely, a teacher who scored significantly higher on the items of this scale was considered to have come closer to the aims of the reform in his beliefs.

Significantly lower scores on one or more of the three subject-matter-oriented beliefs were labelled 'congruent with the aims and principles of the reform', and significantly higher scores on one or more of these three scales were considered 'incongruent with the reform'. For example, a teacher with scores significantly lower on the items of the scale 'individual learning', such as '*Students learn better when they work individually on tasks*', has changed his beliefs in a way that is in line with the reform. Conversely, a teacher who scored significantly higher on these items has moved further from the aims of the reform.

For the analysis of the digital logs and teacher activities, a four-phase procedure was adopted. The first step consisted of randomly selecting the logs of ten teachers. These logs were then summarized by identifying sequences of activities reported by the teachers to result in a particular learning outcome or a so-called 'configuration' of activities and learning outcomes (see also Chapter 2). An example of such a configuration is presented in Figure 3.1.

This configuration shows a sequence of activities consisting of noticing student behavior, asking students for an explanation, and listening to their responses during an extensive discussion. The three activities resulted in a positive feeling and an intention to think up new assignments. Since we regard teacher cognition as consisting of knowledge, beliefs, and orientations (personal goals, emotions, expectations, and attitudes) (Fenstermacher, 1994; Putnam & Borko, 1997; Korthagen, 2001), we consider feelings and intentions to be part of teacher cognition and, therefore, view new feelings and intentions as cognitive change.

Actual reported learning experience in digital log	**Configuration of sequences of activities and learning outcome**
During one of my lessons students were not paying attention, and I asked them for an explanation of their behavior. I indicated that I got the impression that they did not like the lesson, and asked what I could do to make it more interesting for them.	Notices that students are not paying attention during lesson ↓ Asks students why they are not paying attention
This resulted in a serious conversation about what they considered fun and interesting lessons, and what students and teachers can do to accomplish that.	↓ Undertakes extensive discussion of education with students +
We discussed several topics in that conversation: - Students do not want to discuss questions during whole class teaching. - Students would like to collaborative with peers in small projects.	Listens to request for more assignments on which they can collaborate with each other ↓
Based on this conversation I have learned to: - Plan future lessons in which different methods and collaborative assignments are used. Students enjoy this, and I think it can be very informative. - Pay extra attention to preparing such methods and assignments.	Intention to create more assignments for students to collaborate on with each other +
My feelings about this experience are positive; it is nice to confer with students in this way. I am pleased that we can be honest to each other and think collaboratively about the causes and solutions of a problem.	Positive feeling about the possibility of conferring with students in such a manner

Figure 3.1 Example of a configuration of teacher activities plus outcome

In the second analytic step, the configurations identified for the 10 selected teachers were searched for more general patterns. For example, one of the teachers reported the following learning experience:

> **Ann, digital log number 3**
> My first learning experience started off during our first team meeting. Just before the meeting I had marked a test of one of my classes who had got really low grades. [...] Something had to change in that class. My first thought was: the students don't learn, they underestimate the subject matter. [...] My goal was to control students' homework very strictly in future and to confront them with the fact that they did not study well since I could point out in their textbooks and assignments exactly where they could have found the corrects answers to the test questions. [...] During the meeting I realized that it would be worthwhile to examine first why students caught on to the subject matter so badly, because it is a rather quick conclusion to say that they just do not work hard enough. [...] In this meeting, colleagues often mentioned motivation and positive feedback as the key to activate students' learning. I realized that this was the problem in my own teaching practice. I formed the intention to be strict about homework but mainly to compliment students in order to improve the atmosphere and work climate. So far, I do not have new grades to prove that this approach is working, but the atmosphere has improved and I notice that students are indeed more motivated when they receive a compliment. Actually, I knew this for years, but the consultation with colleagues has opened my eyes and stimulated me to use this knowledge in my teaching practice.

In this example the teacher reports having learned in a team meeting by listening to colleagues' experiences with teaching methods that foster active and self-regulated learning. After listening to these colleagues, the teacher decides to experiment with the same method in her own practice, and evaluates her experimentation. This experimentation and evaluation result in a rediscovered idea of how to motivate students. Another teacher reported the following in one of her digital logs:

> **Susan, digital log number 1**
> [...] This year I wasn't very pleased with my own method of controlling students' homework. I want students to do their homework as asked, but I don't want to use punishment exercises. I would rather motivate them to do their homework in a different manner. In the second term of this school year, I started off with a different method. I got the idea by visiting schools in France and observing a teacher at one school. This teacher pulled out a number out of

> a bag at the start of each lesson and asked the student whose number on the student list corresponded to this number, to write his or her homework on the blackboard. [...] I don't control students' homework anymore, but I let chance decide which student has to write down his or her answer to a homework assignment on the blackboard. [...] Students think it is important to have their homework in order when it is their turn to present it, and I can give them a compliment for their efforts. Students appear to be more motivated when I use this 'chance method' than when I checked their homework. This surprises me, but it is a pleasant surprise.

In this example, the teacher reports having learned by observing a colleague during an assignment for an in-service training course. As a result of this observation she decides to try the colleague's method in her own classes, and evaluates the positive and negative aspects of the method. Based on the experimentation and evaluation, the teacher reports having acquired a new idea of student learning.

In both examples the general pattern of activities can be characterized as follows: acquaintance with colleagues' methods in a professional development context, experimentation in own teaching practice, and evaluation of experimentation. This sequence in learning activities, however, resulted in different learning outcomes: a rediscovered idea and a new idea of how students can be motivated to work in a more active and self-regulated way.

In the third analytic step, we examined the reported learning experiences by separating sequences of activities from learning outcomes. In the 60 digital logs of the ten selected teachers, we found 12 similar sequences of activities.

In the final analytic step, the 12 initial sequences of activities were used to analyze the remaining 144 digital logs of the other twenty-four teachers in our study. Digital logs with a sequence of activities similar to one of the 12 original sequences were coded using the corresponding number. A total of 18 digital logs could not be coded using one of the 12 original sequences. These 18 logs contained 3 sequences that resembled each other across logs; these sequences were, therefore, added to the 12 original sequences of activities. Seven sequences of activities appeared to be specific to only one teacher and were, therefore, not included in the remainder of the analysis. In the end, this procedure resulted in a list of 15 sequences of activities.

Three researchers were involved in the interpretation and classification of the learning experiences reported in the digital logs. In addition, a research assistant was involved in the coding of the digital logs; this was to see if a person who was not familiar with the data could reliably apply the same codes as the first

researcher. A total of 50 digital logs were coded by the research assistant, which resulted in an interrater reliability of .77 (Cohen's kappa).

3.4 Results

We first present the questionnaire results for the teachers' beliefs about teaching and learning, followed by the results of the analysis of the digital logs. Finally, we present our interpretation of explain the observed relations between changed teacher beliefs about teaching and learning and learning activities.

3.4.1 Changes in teacher beliefs about teaching and learning

Factor analyses were conducted to determine if teacher beliefs about teaching could be distinguished from teacher beliefs about learning. In line with the results of previous research by Boulton-Lewis, et al. (2001), the different teacher beliefs did not load on separate factors and were, therefore, not distinguished in the remainder of the analysis. Of the thirty-four teachers participating in the study, twenty-one were found to produce significantly different scores on one or more of the teacher beliefs about teaching and learning scales after a period of one year. In Table 3.2, information on the direction of the changes in the student-oriented and subject-matter-oriented teacher beliefs about teaching and learning is presented.

As can be seen, the largest group (13) consists of teachers who did not have significantly different subject-matter- or student-oriented beliefs after one year and participation in an interdisciplinary team. Changes that were congruent with the aims of the relevant reform occurred more frequently than changes that were not congruent with the aims of the reform. For the student-oriented teacher beliefs about teaching and learning, the frequencies of changes that were congruent and those of changes that were incongruent with the aims of the reform were almost equal. For the subject-matter-oriented teacher beliefs about teaching and learning, however, changes that were congruent with the aims of the reform were found to occur more often than changes that were not congruent with the aims of the reform.

Table 3.2 Numbers of teachers with congruent, incongruent, or no changes in beliefs about teaching and learning

		Student-oriented beliefs			
		Number of teachers with changes congruent with the aims of the reform	Number of teachers with no changes	Number of teachers with changes incongruent with the aims of the reform	*Total*
Subject-matter-oriented beliefs	Number of teachers with changes congruent with the aims of the reform	5	5	1	11
	Number of teachers with no changes	3	13	6	22
	Number of teachers with changes incongruent with the aims of the reform	1	0	0	1
	Total	9	18	7	34

3.4.2 Teacher activities

The procedure used to analyze the digital logs resulted in a list of 15 sequences of activities, which are described in Table 3.3. In sequences 1, 2, 3, 5, and 6, colleagues are explicitly involved in the learning activities of the teachers. Sequences 7 through 14 represent various individual learning experiences during actual teaching practice. Sequences 4 and 15 can be characterized as learning through awareness of one's own learning process.

Table 3.3 List of learning activity sequences

Sequence code	Description of general learning activity sequence	Frequency
1	Acquaintance with teaching methods or ideas of colleagues in the context of a professional development program (e.g., observation, discussion) → Experimentation with teaching methods of colleagues → Evaluation of alternative teaching methods	24
2	Acquaintance with teaching methods or ideas of colleagues during spontaneous interaction with colleagues (e.g., observation, discussion) → Experimentation with methods of colleagues → Evaluation of alternative methods	11
3	Dissatisfaction with current methods → Request for feedback from colleagues → Experimentation with an adjusted form of one's own teaching methods → Evaluation of adjusted teaching methods	12
4	Encountering difficulties with own learning process → Relating difficulties to student learning difficulties → Consideration of explanations and solutions for own learning difficulties and student learning difficulties	9
5	Acquaintance with the beliefs of colleagues via reading or listening → Reflection on and evaluation of explanations for these (negative) beliefs	6
6	Collective dissatisfaction with level of knowledge, skills, or attitudes of students → Collective or individual formulation and experimentation with alternative teaching methods → Evaluation of alternative methods	10
7	Individual dissatisfaction with level of knowledge, skills, or attitudes of students and the effects of current teaching methods → Individual formulation and experimentation with alternative teaching methods → Evaluation of alternative teaching methods	43
8	Formulation of alternative teaching methods due to illness or time constraints → Experimentation with alternative teaching methods → Evaluation of alternative teaching methods	5
9	Selection of standard assignment for students → Observation and evaluation of students doing the assignment → Evaluation of the assignment	37
10	Inquiry into student desires regarding lesson content → Experimentation with an alternative teaching method → Evaluation of the alternative teaching method	13
11	Observation of students → Surprise at a particular student attitude	5
12	Confrontation with an unexpected situation (e.g., students making fun of the teacher or a student crying in class) → Reaction to the situation → Evaluation of own reaction (either reflexive or conscious) to the situation	12
13	Grading of tests and detection of disappointing results → Search for explanations for the disappointing results → Consideration of whether the teacher, the students, or perhaps both may be responsible for disappointing results	3
14	Reflection on own teaching methods and behaviors at the end of the school year → Experimentation with new teaching behaviors → Evaluation of new teaching behaviors	3
15	Writing and re-reading of own digital logs → Detection of own special points of interest for improved teaching practice → Consideration of ways to adjust own teaching practices	4

3.4.3 Exploration of changed beliefs in relation to learning activities

In order to explore the relations between the learning activities reported by the teachers and changes in their beliefs about teaching and learning, the following calculations for the student- and subject-matter-oriented beliefs of the teachers were performed separately. The frequencies of the 15 sequences of learning activities reported in the digital logs of those teachers with 1) a change of beliefs congruent with the aims of the reform, 2) no change of beliefs, or 3) a change of beliefs incongruent with the aims of the reform were calculated. Given the initially unequal frequencies of changes in the student- and subject-matter-oriented beliefs of the teachers, the relative frequencies of the fifteen sequences for the different categories of teachers were calculated. For example, for the nine teachers with a change of student-oriented beliefs congruent with the aims of the reform, the number of reported learning experiences that could be characterized with sequence number 1 (n=11) was divided by the total number of reported learning experiences of that group of teachers (n=47) and presented in percentages (11/47=0.234= 23.4%). The eighteen teachers who did not change their student-oriented beliefs reported 8 learning experiences that were labelled with sequence number 1. When this number of learning experiences was divided by the total number of reported learning experiences of this group (8/110=0.073), a lower relative percentage of 7.3% resulted. Finally, the seven teachers with a change in student-oriented beliefs incongruent with the aims of the reform reported 5 learning experiences with label sequence number 1, which resulted in a relative percentage of 12.5% (5/40=0.125).

The relative frequencies were then compared to determine which types of activity sequences were most noteworthy (i.e., had a high frequency) for a particular group of teachers (i.e., teachers showing congruent changes, incongruent changes, or no change in their beliefs about teaching and learning). A difference of more than 5% between the relative frequencies for the different groups of teachers was considered noteworthy. Since we measured both student-oriented and subject-matter-oriented beliefs, the relative frequencies were compared for each set of beliefs separately. An incongruent change in the subject-matter-oriented beliefs about teaching and learning was found to occur for only one teacher, which made comparison of the relative frequencies with a group of such teachers impossible.

Inspection of the relative frequencies of the different activity sequences showed that those sequences with a frequency that was less than 19 were not specific to a particular group of teachers. The relative frequencies of those three activity sequences with the highest frequencies of occurrence are presented in Table 3.4.

Table 3.4 Relative frequencies of activity sequences 1, 7, and 9 according to changes in student- and subject-matter-oriented beliefs about teaching and learning.

Beliefs about teaching and learning	Changes (frequency)	Sequence of activities code		
		1 (n=24)	7 (n=43)	9 (n=37)
Student-oriented beliefs	Teachers with changes congruent with the aims of the reform (9)	23.4%	12.8%	14.9%
	Teacher with no changes (18)	7.3%	20.9%	22.7%
	Teachers with changes incongruent with the aims of the reform (7)	12.5%	35.0%	12.5%
Subject-matter-oriented beliefs	Teachers with changes congruent with the aims of the reform (11)	12.3%	24.6%	15.8%
	Teachers with no changes (22)	12.1%	20.7%	20.0%

As can be seen from Table 3.4, noteworthy differences in the relative frequencies of activity sequences 1, 7, and 9 were detected for differences in changes in student-oriented beliefs. Sequence 1 reflects learning experiences in which teachers reported experimentation (or an intention to experiment) with alternative teaching methods that they discovered through interaction with colleagues in a professional development setting (cf. Table 3.3). This sequence of learning activities was found to occur relatively more often in the digital logs of teachers who produced a higher score for student-oriented beliefs about teaching and learning in October 2005 than in October 2004. Activity sequence 7 reflects learning experiences in which teachers experimented with alternative teaching methods owing to dissatisfaction with the students' level of knowledge, skills, or attitudes, or the effectiveness of the methods otherwise used. This activity sequence was found to occur relatively more

often for those teachers who produced lower student-oriented belief scores in 2005 than in 2004. Activity sequence 9 reflects teachers learning through observation of students during an assignment that was part of the standard curriculum, and showed the highest relative frequency for teachers who did not change their student-oriented beliefs after a period of one year and participation in an interdisciplinary team. No noteworthy differences in the relative frequencies of activity sequences 1, 7, and 9 were found to occur for the different groups of teachers when their subject-matter-oriented beliefs about teaching and learning were examined over time. That is, the relative frequencies of the activity sequences did not differ to a noteworthy extent for those teachers with beliefs that changed in a manner that was congruent with the aims of the reform or those teachers who showed no changes in their subject-matter-oriented beliefs after a period of one year.

In sum, it can be argued that activity sequences 1, 7, and 9 related differently to the changes (or lack of change), particularly in the student-oriented beliefs of the teachers. The question remains to be answered why activity sequence 7 occurred more often for teachers showing a change of student-oriented beliefs incongruent with the aims of the educational reform, while activity sequence 1 occurred more often for teachers showing a change congruent with the aims of the educational reform. Similarly, it is unclear why some teachers did not change their beliefs about teaching and learning despite collaboration in an interdisciplinary team and the report of activity sequences 9. These questions are addressed in the following sections, where we report examination of the nature and topics of the reported learning activities in greater detail and closer examination of the initial teacher belief scores.

3.4.4 Differences in the nature and topics of the learning activities

Closer inspection of the teachers' learning experiences showed the reported activities to differ sometimes with regard to whether or not they were undertaken with the intention of learning from the activities. For example, learning through experimentation with a new teaching method, the observation of students during such a lesson, and subsequent evaluation of the new method is very different from learning through observation of students working on a standard assignment. The former learning experience includes the explicit intention to change one's teaching practices whereas the latter learning experience can be characterized as largely spontaneous.

Darling-Hammond, Hammerness, Grossman, Rust, and Shulman (2005) have further observed that "although much research has focused on the processes of teacher learning, evidence suggests that *what* teachers learn matters at least as

much as *how* they learn" (p.395). For example, teachers can experiment with a new method that gives students greater responsibility for their own learning, or with a new method that involves taking greater control of student learning. While the nature of the activity itself is basically the same, the focus or topic of the activity is very different.

In Table 3.4, it can be seen that activity sequence 1 occurred relatively more often for teachers who changed their student-oriented beliefs in a direction that was congruent with the aims of the educational reform than for teachers who did not change their student-oriented beliefs or who changed them in a direction that was not congruent with the aims of the educational reform. Experimentation with the methods of a colleague is a typical sequence 1 activity, and was usually preceded by familiarization with the teaching methods and ideas of colleagues (e.g., through observation, discussion, or brainstorming) and reflection upon one's own teaching methods. The latter two activities took place either in the teams or in interaction with colleagues outside the team. In both cases, however, the sequence of activities was undertaken with the intention of changing teaching practices. The topic of the activities also always concerned the fostering of more active and self-regulated student learning, which is clearly congruent with the aims of the relevant educational reform.

The results in Table 3.4 further showed activity sequence 7 to relate to teacher beliefs that changed in a direction that was *not* congruent with the aims of the educational reform. Activity sequence 7 starts with individual dissatisfaction, which can be seen to prompt experimentation with alternative teaching methods and confirmation of one's initial assumptions (see Table 3.3).

Comparison of activity sequences 1 and 7 shows the impetus for learning in sequence 1 to be interaction with colleagues, while the impetus for learning in sequence 7 is individual consideration (i.e., dissatisfaction). The two activity sequences are, however, very similar in nature: they both include intentional experimentation with an alternative teaching method. However, the topic of the learning experiences represented by activity sequence 7 clearly differs from the topic of the learning experiences represented by activity sequence 1. In the case of activity sequence 7, for example, the teachers see that students cannot (yet) be held responsible for their own learning and, therefore, decide to take greater control of the student learning process and experiment with teaching methods along these lines. In the case of activity sequence 1, alternatively, the teachers see that the methods of colleagues produce more active and self-regulated student learning and they, therefore, experiment with these methods.

Finally, the results presented in Table 3.4 show that activity sequence 9 occurred most often for teachers who did not change their student-oriented beliefs

about teaching and learning. Inspection of the activities constituting this sequence in Table 3.3 shows that the relevant activities clearly differ in nature from the activities constituting sequences 1 and 7. In sequence 9, the teachers learned from spontaneous observation of students during standard assignments. In other words, there was no explicit a priori intention to learn, as there was in activity sequences 1 and 7.

In sum, teachers can engage in activities of a similar nature but show different patterns of change in their student-oriented beliefs. This outcome can better be understood when the topics of the learning activities are examined. Teachers showing changes in beliefs that are largely congruent with the aims of the educational reform can be seen to have experimented with teaching methods that give students greater responsibility for their own learning. Conversely, teachers showing changes in beliefs incongruent with the aims of the educational reform can be seen to have experimented with teaching methods that more strongly regulate student learning. The differences between teachers who changed their student-oriented beliefs and those who did not change their beliefs can conceivably be explained by the fact that the former group of teachers specifically intended to learn from the reported activities while the latter group did not.

3.4.5 Differences in initial teacher beliefs about teaching and learning

In order to better understand the differences between the teachers with respect to the changes in their beliefs about teaching and learning, their initial scores on the questionnaire 'Beliefs about teaching and learning' were examined in greater detail. In Table 3.5, the initial means, standard deviations, minimum scores, and maximum scores along a five-point scale are displayed in relation to the different patterns of change in the student- and subject-matter- oriented beliefs of the teachers.

As can be seen, the initial mean and maximum scores for teachers who later changed their student-oriented beliefs in a manner that was congruent with the aims of the reform were lower than the initial mean and maximum scores for teachers who later changed their student-oriented beliefs in a manner that was incongruent with the aims of the reform. This means that to some extent ceiling effects may have occurred for the second group of teachers. The results presented in Table 3.5 further show that the mean and maximum scores for teachers with subject-oriented beliefs that changed in a manner congruent with the educational reform were higher at the start of the study than the scores for teachers showing no such changes. The scores of the first group are, therefore, more likely to decline after a year than the scores of the second group.

Table 3.5 Initial means, standard deviations, minimum scores, and maximum scores for different patterns of change in student- and subject-matter-oriented beliefs about teaching and learning (October 2004)

Changes in beliefs about teaching and learning		Mean	Std. Deviation	Minimum	Maximum
Student-oriented beliefs	Teachers with change congruent with the aims of the reform	3.83	0.26	3.42	4.28
	Teachers with no change	4.26	0.41	3.56	4.98
	Teachers with change incongruent with the aims of the reform	4.27	0.34	3.85	4.74
Subject-matter-oriented beliefs	Teachers with change congruent with the aims of the reform	3.11	0.75	2.32	4.54
	Teachers with no change	2.86	0.32	2.19	3.53

In Table 3.6, a schematic overview is given of the results presented above with regard to the differences in the changes in teacher beliefs in conjunction with the nature and topics of the reported learning experiences and initial teacher beliefs.

Table 3.6 Characterization of activity sequences and belief changes in terms of nature and topic of learning experiences and initial belief scores

	Activity sequences in relation to pattern of change in student-oriented beliefs		
	Activity sequence 1 & congruent belief changes	Activity sequence 7 & incongruent belief changes	Activity sequence 9 & no belief changes
Nature of the learning experience			
Intentional	✓	✓	
Unintentional			✓
Topic of the learning experience			
Teacher regulation		✓	
Student regulation	✓		✓
Initial teacher belief scores			
Average	✓		
High		✓	✓

3.5 Conclusions and discussion

In this study the relations between teacher learning activities and the patterns of change in teacher beliefs with respect to the topic 'active and self-regulated learning' were explored. Below, the most important results are first summarized; the implications of the results are then discussed. We conclude with some comments on the data collection methods employed and some suggestions for future research on teacher learning.

The present results show that sixteen teachers clearly changed their student-oriented beliefs and twelve teachers clearly changed their subject-matter-oriented

beliefs. The changes in teachers' student- and subject-oriented beliefs could be divided into 1) changes that were congruent with the aims of the reform and 2) changes that were not congruent with the aims of the reform. This finding is in line with the findings of Tillema and Knol (1997), who also found that student teachers changed their beliefs as a result of two different teacher education programs, but not consistently in one direction. Changes incongruent with the aims of the reforms are particularly remarkable in light of the context in which the teachers in this study were examined: all of the teachers participated in a project that involved participation in an interdisciplinary team with the objective of fostering more active and self-regulated student learning.

How can the finding be explained that some teachers changed their beliefs in a manner congruent with the idea of fostering more active and self-regulated student learning, while other teachers did not? What learning activities were undertaken by some of the teachers but not by others? And in what way do teachers whose beliefs changed in a manner congruent with the educational reform differ from teachers whose beliefs did not change in a manner congruent with the aims of the reform? In order to answer these questions, we first analyzed the learning activities reported by the teachers in their digital logs. We described teachers' learning experiences in sequences of activities instead of separate activities; as a result, a more detailed view of how teachers learn in the workplace was attained. For future studies on teacher learning, therefore, we suggest focusing on sequences of activities rather than on separate activities

As depicted in Table 3.4, the relative frequencies of the activity sequences with the highest frequency of occurrence clearly differed for the different patterns of change in beliefs. For the subject-matter-oriented beliefs of the teachers, no noteworthy differences in the relative frequencies of the activity sequences were detected. For the student-oriented beliefs of the teachers, however, some noteworthy differences in the relative frequencies of activity sequences 1, 7, and 9 were found. Activity sequence 1 occurred relatively more often for teachers with student-oriented beliefs that changed in a manner congruent with the aims of the reform. Activity sequence 7 occurred relatively more often for teachers with student-oriented beliefs that changed in a manner incongruent with the aims of the reform. Finally, activity sequence 9 occurred relatively more often for teachers who showed no changes in their student-oriented beliefs about teaching and learning.

The exact nature and topics of the learning experiences reported by the teachers were examined in greater detail in order to further interpret the observed differences in the relations between teacher learning activities and patterns of change in the teacher beliefs about teaching and learning. In addition, possible differences in their initial belief scores were now taken into consideration.

Activity sequence 1 was found to have the highest relative frequency of occurrence for teachers with student-oriented beliefs that changed in a manner congruent with the aims of the educational reform. Through exposure to the teaching methods of colleagues, and methods that could be seen to foster more active and self-regulated student learning in particular, these teachers were prompted to experiment with the methods on their own. In general, the teachers greatly valued the opportunity to experiment with new methods, became more positive about efforts to promote more active and self-regulated student learning, and changed their student-oriented beliefs about teaching and learning accordingly. Although beliefs are often found to be difficult to change (Pajares, 1992), we found that collaboration with colleagues led to such changes: the exchange of experiences and methods clearly promoted experimentation with the methods of colleagues. Positive experiences of the adoption of new methods to foster more active and self-regulated student learning then led to changes in the beliefs about teaching and learning held by the teachers or — in other words — to the changes required for successful implementation of an educational reform. This finding confirms the results of previous research showing collaboration between teachers to constitute a powerful learning environment (Butler, et al., 2004; Grossman, et al., 2001; Putnam & Borko, 2000; Shank, 2006). This finding contributes to a more comprehensive understanding of how exactly teacher learning takes place in collaboration. In many studies on teacher collaboration, it was assumed that the exchange of ideas, experiences, teaching methods, and feedback fosters learning. Based on the findings of this study it might be argued that merely exchanging teaching methods may not be sufficient to result in belief changes. We found that teachers learn by exchanging ideas, experiences, and teaching methods with colleagues in combination with experimentation in their own practice with alternative methods, and deliberate evaluation of this experimentation.

Activity sequence 7 was found to have a relatively high frequency of occurrence for teachers with student-oriented beliefs that changed in a manner that was not congruent with the aims of the relevant educational reform. The information presented in Table 3.4 also shows that the teacher learning activities in sequence 7 related differently to the changes in the student-oriented beliefs of the teachers than the activities in sequence 1. Closer examination of the specific topics addressed in activity sequence 7 showed that these teachers experimented mostly with methods aimed at strong regulation of the student learning process, and that such experiments were highly valued. As a result of negative experiences of allowing students greater autonomy, these teachers considered students (so far) incapable of taking responsibility for their own learning, and had lower student-oriented belief scores in October 2005 than in October 2004.

The results in Table 3.4 also show that teachers with student-oriented beliefs that changed in a manner congruent with the aims of the reform also reported learning experiences involving activity sequence 7, but to a far lesser extent than did teachers with student-oriented beliefs that changed in a manner incongruent with the aims of the reform. The question, then, is what prompted these teachers to change their student-oriented beliefs about teaching and learning in a manner nevertheless congruent with the aims of the reform? More detailed examination of the topics in the learning experiences reported by the teachers showed that these teachers in particular experimented with teaching methods that nevertheless gave students greater responsibility for their own learning. On the basis of their negative experiences of allowing students greater autonomy, these teachers reasoned that the students simply did not have enough experience of working and learning in a more active and independent manner, and, therefore, experimented with new methods and assignments specifically intended to give students greater responsibility for their own learning.

Finally, the results in Table 3.6 show that, in contrast to the results for activity sequences 1 and 7, activity sequence 9 involves no explicit intention to learn. The absence of such an a priori intention to learn may explain, in turn, the lack of changes in the student-oriented beliefs of the teachers.

Our final conclusion on the basis of the results of this study is that patterns of change in the beliefs of teachers should always be considered with respect to their initial beliefs. The lack of change in the beliefs of some teachers was explained by teachers' pre-existing beliefs. We demonstrated that these teachers possessed strong student-oriented beliefs which may have impeded belief change (Pintrich, et al., 1993). Also, changes congruent and incongruent with the aims of the reform were detected, but a value judgment was not assigned to these two types of change. Viewed from the perspective of policymakers, however, changes that are not in agreement with the aims of a reform may be valued negatively. By taking the initial scores of the teachers in the present study into account, we hope to have made it clear that incongruent changes need not necessarily be interpreted negatively, and thereby to have made the nature of the incongruent changes more comprehensible.

We referred in the introduction to the work of Sfard (1998) and Hodkinson and Hodkinson (2005), who have argued that (teacher) learning should be approached in terms of combinations of the acquisition, construction, and participation perspective. To understand teacher learning, information should be called upon from 1) an acquisition perspective, where learning is described in terms of individual learning outcomes (changes in cognition), 2) a construction perspective, where learning is regarded as an ongoing process of constructing knowledge, and 3) a participation perspective, where learning is understood in

terms of participation in (workplace) activities. In the present study, we aimed to meet this requirement with the inclusion of information on changes in teacher beliefs about teaching and learning, and on teachers' engagement in learning activities in their working environment, and by examining just how belief changes relate to teachers' work-related learning activities over time. Two instruments that differ with regard to the level of information measured were used for this purpose. Whereas the teacher learning activities were measured at a situation-specific level, the changes in the teachers' beliefs about teaching and learning were measured at a more general level. The relations between the reported learning activities and observed changes in the teacher beliefs were computed as the relative frequencies of occurrence for different sequences of activities according to the different types of observed change in beliefs. The results of such an analysis do not reveal causal relations, even though the teachers were asked to report on learning experiences which they considered most relevant to their own learning regarding the topic of active and self-regulated learning. Information about teacher learning activities was collected using the reports of six learning experiences of each teacher. Given that teachers may learn every day from their teaching experiences, changes in their beliefs about teaching and learning may also be better understood and more fully explained when their daily activities are also examined in greater detail.

Based on the findings of previous studies of conceptual change, it can be argued that motivational factors such as goal orientation, interest, and efficacy beliefs are intermediate factors in the process of conceptual change (Patrick & Pintrich, 2001). It would be interesting to examine teachers' goal orientation in relation to changes in beliefs. This orientation can be divided into a mastery orientation and a performance orientation (Patrick & Pintrich, 2001). Teachers with a mastery orientation towards learning are likely to think deeply about new ideas or situations they have been confronted with, in order to attain a comprehensive understanding. On the contrary, teachers with a performance orientation are likely to be extrinsically motivated. For the experienced teachers in this study, such an orientation might imply that they change their teaching practices in order to meet the expectations of others, such as school management teams. Applied to beliefs changes found in this study, teachers who did not change their beliefs might be mainly performance oriented, whereas teachers who did change their beliefs might have been mastery oriented. However, the majority of reported learning experiences included evaluations of experiences in which the teachers, for example, reflected on their experiments with alternative methods and sought possible underlying principles and explanations of why a method did or did not work. Such deliberate evaluation of situations and experiences may be interpreted as mastery oriented rather than performance oriented. For future

research on experienced teachers' belief changes, we suggest examining the influence of motivational factors on learning activities in more detail.

In addition to including motivational factors in future research on teacher learning, it would also be useful to include school organization factors, such as (teachers' perceptions of) the support provided by principals and school management teams to teachers in implementing educational reforms and in teachers' professional development (Geijsel, Sleegers, van den Berg, & Kelchtermans, 2001). Teachers who feel supported in their professional development may be more inclined to look for opportunities and situations which are helpful in their own development than teachers who do not feel supported. For this study we had only general information on school organizational factors; for example, all five schools were secondary schools for senior general secondary education or pre-university education, or both, and in all five schools the teachers were facilitated in their participation in the teams. Also, the participating teachers who changed their beliefs worked in different schools. Consequently, it is difficult to relate teacher learning to school organizational factors. Teachers working in the same school can have different views on their school organizations, and it would, therefore, be interesting to include data on teachers' individual perceptions on school organizational factors in future studies. This might provide insight into differences in individual teacher learning within a school organization.

Finally, the digital logs contain information not only on the learning-related activities of the teachers but also on the learning-related outcomes of such activities. It is, therefore, possible that a new or confirmed idea about student learning or the decision to use a particular method more frequently, for example, may also relate differently and significantly to the observed changes in teacher beliefs. Teachers who report mainly intentions to change their teaching methods or confirmation of their ideas regarding student learning in their digital logs, for instance, are not likely to change their more general beliefs about teaching and learning. Teachers who report new insights regarding student learning in their digital logs, in contrast, may be predisposed to change their general beliefs about teaching and learning as well. Examination of such situation-specific changes in cognition, therefore, constitutes a promising direction for future studies on teacher learning.

Chapter 4

Ann, digital log number 1

My first learning experience started off during our first team meeting. Just before the meeting I had marked a test of one of my classes who had got really low grades. [...] Something had to change in that class. My first thought was: the students don't learn, they underestimate the subject matter. [...] My goal was to control students' homework very strictly in future and to confront them with the fact that they did not study well since I could point out in their textbooks and assignments exactly where they could have found the corrects answers to the test questions. [...] During the meeting I realized that it would be worthwhile to examine first why students caught on to the subject matter so badly, because it is a rather quick conclusion to say that they just do not work hard enough. [...] In this meeting, colleagues often mentioned motivation and positive feedback as the key to activate students' learning. I realized that this was the problem in my own teaching practice. I formed the intention to control homework but mainly to compliment students in order to improve the atmosphere and work climate. So far, I do not have new grades to prove that this approach is working, but the atmosphere has improved and I notice that students are indeed more motivated when they receive a compliment. Actually, I knew this for years, but the consultation with colleagues has opened my eyes and stimulated me to use this knowledge in my teaching practice.

Iris, digital log number 3

I went to Eric in his class as I had a question. It was so much fun that I decided to stay (just by coincidence, I had a free hour). [...] The students had to individually show Eric what they had done for the drawing teacher. When a student had not done the work, it was immediately agreed that it had to be done by the next class. This was done with a joke, but thereafter order and clarity and he wants immediate explanation from the students. The students who did do the work were asked to explain what the assignment entailed and how they interpreted it. The rest of the class watches and discusses as well. [...] Good atmosphere, involvement, and clarity. I left the classroom with the idea that I should have attention for every student, good or bad but in a positive manner, because then you can do almost anything. My learning experience is that you can confront students with their failures and also compliment them with their product as long as you do that with humor and clarity. And the students learn from each other: how things should be done and what is expected of them.

Jeff, digital log number 6

Three weeks ago, we were in an Education Group meeting to prepare the first study afternoon. [...] One of my colleagues introduced the concept 'visible learning' that requires a high level of action for both the teacher and the students during a lesson. [...] In a short enumeration of possible teaching methods for 'visible learning,' my colleague mentioned the 'half-time conversation'. The teacher asks small groups of students to briefly talk with him or her about what has been done during the past few lessons. The students can learn from each other in such a manner and are, of course, forced to put aspects of the subject matter into words. [...] In the two weeks following this preparatory meeting, I used the half-time conversations in four lessons and they really worked! Of course, you have to ask the right questions. [...] A pleasant side effect is that you can pay more personal attention to the students in a serious environment.

Susan, digital log number 1

This year I wasn't very pleased with my own method of controlling students' homework. I want students to do their homework as asked, but I don't want to use punishment exercises. I would rather motivate them to do their homework in a different manner. In the second term of this school year, I started off with a different method. I got the idea by visiting schools in France and observing a teacher at one school. This teacher pulled out a number out of a bag at the start of each lesson and asked the student whose number on the student list corresponded to this number, to write his or her homework on the blackboard. [...] I don't control students' homework anymore, but I let chance decide which student has to write down his or her answer to a homework assignment on the blackboard. [...] Students think it is important to have their homework in order when it

Chapter 4
The relations of teacher learning activities to changes in preferences for learning activities[4]

In this study teacher learning is explored via an examination of changes in teachers' preferences for particular learning activities and the connection of changes in these preferences to actual learning activities undertaken. Thirty-four teachers were asked to complete a questionnaire to assess their preferences for learning activities on two occasions. During the intermediate period of one year, the teachers collaborated with colleagues in teams and were asked to report their learning activities in digital logs. Comparison of the questionnaire scores showed some of the teachers' preferences for learning activities to change and particularly their preference for the activity 'trying different things.' Those teachers with a higher preference for this learning activity often reported learning experiences in which they, based upon their interactions with colleagues, experimented with different teaching methods. The digital logs also showed the learning activity of 'trying different things' to always be a part of a more general sequence of learning activities and never occurs as a separate activity. Preferences for the learning activity 'asking colleagues for advice' did not change, despite collaboration in small teams and the report of frequent learning experiences involving colleagues. Comparison of the formulations of the learning activities for the questionnaire and in the digital logs showed the learning experiences reported in the digital logs to be characterized by 'listening to the experiences of colleagues,' which is clearly different from the questionnaire item 'asking colleagues for advice.'

[4] This chapter has been submitted in adapted form as:
Meirink, J.A., Meijer, P.C., Verloop, N., & Bergen, T.C.M. *How do experienced teachers learn in the workplace? Changes in teacher preferences for learning activities related to teacher learning experiences.*

4.1 Introduction

In recent years, numerous educational reforms have been implemented on several different levels of the educational system. In Dutch secondary education, a reform aimed at — among other things — the fostering of active and self-regulated student learning has recently been implemented. The stimulation of students to take responsibility for their learning has nevertheless proved difficult for many teachers. In addition to the task of imparting subject matter, teachers must also now stimulate students to manage their own learning processes. As Sykes (1996) has observed, teachers are now continuously confronted with the "low-lying swamp of messy problems and persistent dilemmas of practice for which no evident technical knowledge exists" (p. 465). However, dilemmas at one's work can prompt critical reflection, experimentation, and subsequent professional development (Smylie, 1995). In order to help teachers with these dilemmas and changes in education, several professional development programs have been introduced into secondary education during the past few years.

Most of the teacher professional development programs are situated in the actual workplace as this is assumed to provide teachers with numerous and instant opportunities to experiment with newly acquired knowledge and skills. Stated differently, teachers need to gain insight into the underlying ideas and objectives of educational reforms, how to change their behavior, and what approaches may work best to adjust their teaching practices accordingly. But descriptions of just *how* teachers learn in the workplace are still largely lacking (Hashweh, 2003).

4.1.1 Preferences for learning activities

Previous research on the professional development of teachers has shown teachers to learn from — among other things — experience (Jarvis, 1987), deliberate practice (Dunn & Shriner, 1999), and collaboration with colleagues (Little, 2002; Schwarz McCotter, 2001). The descriptions of teacher learning are still rather general, however.

In studies of student learning, considerable attention has been paid to precise descriptions of how they learn and how they may differ from each other in terms of learning activities, learning strategies, and learning styles (cf. Entwistle, 1991; Schmeck, 1988; Vermetten, Lodewijks, & Vermunt, 1999). Vermetten, et al. examined student learning in terms of *learning activities* (i.e., such thinking activities as memorization and analysis) and defined *learning* as the "application of learning activities in such a way that an individual's knowledge base or his/her repertory of skills changes" (p. 1). Students were found to consistently adopt the same learning activities across different situations. Along these lines, the concepts of *learning strategies* and *learning styles* suggest that learners may *prefer* a

particular manner of learning (Entwistle, 1991). In studies by Vermunt (1998) and Vermunt and Vermetten (2004), the stability of student learning styles was found to be high but not sufficiently high to treat learning style as an unchangeable trait. This finding is important in light of the recently implemented educational reforms that require students to learn in a more active and self-regulated manner.

The question that now arises is what learning preferences do teachers show and how their preferences for particular learning activities can change as a result of involvement in recent educational reforms. To understand how *teachers* learn in the workplace, that is, their preferences for learning activities and changes in these preferences should be explored across time.

4.1.2 Teacher learning activities

The results of recent research show teachers to learn from self-initiated activities in the workplace which allows teachers to construct meaning (Lohman, 2005). In contrast to the many studies of student learning in terms of thinking activities, teacher learning is often conceptualized in terms of their workplace activities. In section 2.2.2, we described five general categories of learning activities: 1) doing, 2) experimentation, 3) reflection on experiences, 4) learning from others without interaction, and 5) learning from others with interaction. *Doing* refers to the activities of teachers undertaken without an explicit intention to learn. For example, a teacher may use an old assignment, notice that the assignment is not working, and adjust the assignment on-the-spot. *Experimentation* includes activities explicitly undertaken to evaluate alternative methods and possibly change one's own methods as a result. *Reflection on experiences* refers to the activities that teachers explicitly undertake following experiences with a particular teaching method such as consideration of alternatives for use in future lessons. *Learning from others without interaction* includes such activities as reading books or listening to lectures, which can give teachers new ideas without two-sided interaction. *Learning from others with interaction*, in contrast, involves engagement in such activities as brainstorming, discussions with colleagues, and discussions with students.

Most current professional development programs for teachers are situated in the school and thus provide ample opportunities for different types of learning activities. One such professional development program involves teacher collaboration in teams, which is generally assumed to constitute a very powerful learning environment for teachers (Schwarz McCotter, 2001; Little, 2002). In collaborative learning teams, teachers can exchange their own experiences and ideas, develop and discuss new materials, and receive feedback from colleagues (Putnam & Borko, 2000; Butler, et al., 2004).

4.1.3 The present study

The aim of the present study is to gain a more comprehensive understanding of the workplace learning of experienced teachers in the context of an educational reform. A more comprehensive understanding of workplace learning is needed for the design and optimization of future professional development programs. Drawing upon findings from the study of student learning, we will first explore the *preferences* of teachers for particular types of learning activities and any *changes* in these preferences across a period of a year. Second, we will examine how the observed changes in the preferences of the teachers relate to actual engagement in learning activities related to a specific aim of the secondary education reform, namely the promotion of more active and self-regulated learning on the part of students. The following research question will thus be addressed:

- How are learning activities that teachers undertake in a context of collaboration in interdisciplinary teams related to changes in their preferences for learning activities during a period of one year?

4.2 Method

4.2.1 Participants

Thirty-four experienced teachers were examined across a period of one year. Their teaching experience ranged from three to thirty-four years, and they collaborated in five teams involving four to nine teachers from different subject departments, as the topic of active and self-regulated learning is assumed to be not subject-specific. The five teams were located at five different secondary schools in the western part of the Netherlands, and the aim of the collaboration in teams was to collectively think of ways to foster more active and self-regulated student learning. The teams were free to develop their own manner of working to achieve this. For example, one team chose to discuss the topic of student motivation and experimented with different teaching methods to increase student motivation in their own classes. Another team opted to exchange ideas and experiences regarding alternative methods to discuss the results of tests and thereby stimulate self-regulated learning on the part of students. All five teams began their collaboration at the start of this study. More detailed information on the composition of the teams is presented in Table 4.1.

Table 4.1 Composition of the five teams

	Team A	**Team B**	**Team C**	**Team D**	**Team E**
Number of teachers	7 (4 females, 3 males)	8 (5 females, 3 males)	4 (3 females, 1 male)	8 (3 females, 5 males)	7 (3 females, 4 males)
Subjects	Economics History Geography Science Physics Mathematics Chemistry	Geography Science Dutch language English (3x) Economics Physical education	Mathematics Economics Latin Culture and arts education	Biology English Culture and arts education Mathematics Economics (2x) Dutch language (2x)	Science Economics Physics English German Culture and arts education History
Years of experience	Mean 15.4 SD 9.98	Mean 20.8 SD 9.96	Mean 10.5 SD 8.5	Mean 15.0 SD 4.6	Mean 19.6 SD 9.83

4.2.2 Data collection

To examine the preferences of the teachers for different types of learning activities, we developed a questionnaire consisting of eight descriptions of particularly challenging or problematic tasks and situations that are likely to occur in the workplace and could result in teacher learning (see Appendix 4.1). The situations were formulated in collaboration with four educational researchers and in such a manner that the following situations were covered: everyday learning situations, situations specific to actual teaching practice and beyond, and situations involving a variety of individuals (e.g., students, colleagues, parents).

For all eight situations, the participating teachers had to indicate what they would do in that particular situation using a set of response options derived from the five general categories of learning activities as described earlier in section 2.2.2. For each of five categories of learning activities, the teachers had to rate the likelihood of choosing that option in connection with the described situation along a five-point scale ranging from *I would never do that* to *I would always do that*. Table 4.2 shows both the categories of learning activities used in the present questionnaire and the categories of learning activities identified in previous research.

Table 4.2 Categories of learning activities identified in the literature and used in the questionnaire

Categories in questionnaire	**Categories in literature (cf. section 2.2.2)**
Asking colleagues for advice.	Learn from others with interaction.
Critical individual reflection in order to think up an appropriate approach.	Reflect upon experiences.
Trusting own intuitions and feelings.	Doing.
Gathering information from the internet, books, et cetera.	Learn from others without interaction.
Trying different things and see where they go.	Experiment.

The validity of the questionnaire was established via discussion of the eight situations and five response options with both teacher educators and teachers to check that the situations and response options were recognizable for secondary school teachers and formulated accurately. In Table 4.3, a sample situation from the questionnaire is presented.

Table 4.3 Example situation of the questionnaire 'Preferences for learning activities'

When I am having trouble with a class and want to do something about this, then I will	I never do that	I rarely do that	I sometimes do that	I often do that	I always do that
a ask a colleague for advice.	○	○	○	○	○
b critically reflect individually in order to think up an appropriate approach.	○	○	○	○	○
c trust my intuitions and feelings.	○	○	○	○	○
d gather information from the internet, books, etc.	○	○	○	○	○
e try out different things and see where they go.	○	○	○	○	○

In order to attain information on the *changes* in the teachers' preferences for learning activities, the teachers completed the 'Preferences for learning activities' questionnaire at both the beginning and the end of the study with an intermediate period of one year.

To examine the actual learning activities of the teachers in the context of the educational reform, the teachers were asked to record their learning experiences in digital logs and e-mail at least one learning experience to the researchers every six weeks. This occurred across a period of one school year, which meant that a total of six digital logs could be submitted. The teachers were asked to describe their learning experiences in a story-like manner: what and how they had learned and the manner in which the learning experience related to the specific topic of active and self-regulated student learning. The teachers were asked to do this in order to gain greater insight into those learning activities that they, themselves, considered relevant and important for their learning. Examples of various learning experiences were provided as part of the instructions on how to write a digital log. Also, it was stressed that all types of learning experiences could be reported and not just learning experiences directly related to the teams in which they participated.

4.3 Analysis

For the 'Preferences for learning activities' questionnaire, we initially computed the mean scores and standard deviations for the five types of learning activities across the eight situations for the two measurement occasions separately. Whether or not the mean preference scores for the different learning activities *changed* significantly (p <.05) from the first to the second measurement occasion was then determined. As we were interested in individual changes of preference, the Reliable Change Index (RCI) was used to identify significant differences between the scores for each teacher separately (Jacobson & Truax, 1991).

The digital logs were next analyzed in several steps. First, the digital logs from ten teachers were scanned for the specific types of learning activities reported. The teachers were found to frequently report more than one learning activity in connection with a particular learning outcome. The learning experiences reported by the teachers were therefore next described in terms of *a sequence of specific learning activities* (for further details, see section 2.4 and Appendix 2.2). The sequences of learning activities identified for the 60 digital logs from the ten teachers were next searched for more general patterns, which resulted in a list of 12 general sequences of learning activities that were subsequently used to analyze the digital logs from the remaining twenty-four teachers. Eighteen logs could not be classified using this initial list of sequences and new general patterns of learning

activities were therefore sought, which resulted in 3 new sequences in addition to the original 12 or a total of 15 general sequences of learning activities. Seven of the reported learning experiences in digital logs appeared to be specific to a single teacher and were and were therefore not included in the remainder of the analysis. A research assistant coded 50 randomly selected digital logs using the list of 15 sequences of learning activities to assess the reliability of the coding process, and an interrater reliability of .77 (Cohen's kappa) was found.

Following the analyses of the 'Preferences for learning activities' questionnaire and the sequences of learning activities reported in the digital logs, the *changes* in the teachers' preferences for the five learning activities were next compared to the specific learning activities sequences reported in their digital logs.

4.4 Results

4.4.1 Preferences for learning activities

In Table 4.4, the means and standard deviations for the 'Preferences for learning activities' questionnaire are presented for the two measurement occasions separately.

Table 4.4 Means and standard deviations for the questionnaire

	Occasion 1		**Occasion 2**	
	Mean	Std. deviation	Mean	Std. deviation
Asking colleagues for advice	3.75	.79	3.63	.68
Critical individual reflection	4.42	.43	4.37	.48
Trusting intuitions and feelings	3.96	.56	3.85	.58
Gathering information from the internet, books, etc.	2.78	.97	2.75	.70
Trying different things	2.30	.93	2.30	.91

As can be seen from Table 4.4, the teachers generally prefer to critically reflect individually when confronted with challenging or problematic tasks and situations. They also indicate that in challenging or problematic situations they often trust their own intuitions and feelings or ask colleagues for advice. On both measurement occasions teachers indicate to use the other two types of learning

activities — namely, gather information from the internet, books, et cetera and try out different things — only sometimes.

4.4.2 Changes in preferences for learning activities

The mean preference scores for the teachers on the different types of learning activities were next compared for significant ($p<.05$) differences between the first and second measurement occasion. Inspection of the results in Table 4.5 shows only one teacher to have an increased preference for 'asking colleagues for advice'; eleven teachers showed changed preferences for 'critical individual reflection'; eight teachers showed significantly different preference scores for 'trusting own intuitions and feelings'; seven teachers showed significant changes in preference scores for 'gathering information from internet, books et cetera.'; and sixteen teachers scored significantly different for 'trying out different things.' In general, however, the results in Table 4.5 show the preferences of the majority of the teachers to not have changed.

Table 4.5 Number of teachers with significant changes in their preferences for learning activities after one year (N=34)

	Number of teachers with *significantly lower scores*	Number of teachers with *unchanged scores*	Number of teachers with *significantly higher scores*
Asking colleagues for advice	0	33	1
Critical individual reflection	7	23	4
Trusting own intuitions and feelings	5	26	3
Gathering information from the internet, books, etc.	3	27	4
Trying different things	6	18	10

4.4.3 Reported sequences of learning activities in digital logs

The thirty-four teachers in this study reported a total of 204 learning experiences in their digital logs, which comes down to an average of six learning experiences per teacher (with a range of three to nine logs submitted per teacher). As already mentioned, the analysis of the learning experiences reported in the digital logs produced a list of 15 general sequences of learning activities. Seven reported learning experiences appeared to be specific for only one teacher, and were

therefore not included in the list of general sequences of learning activities (cf. Table 3.3).

As can be seen from Table 3.3, sequences 1, 2, 3, 5 and 6 involve colleagues in the learning experiences of the teachers in different ways. Sequences 7 through 14 represent individual learning experiences that occurred during actual teaching practice. Finally, sequences 4 and 15 differ somewhat from the other sequences in that it can be characterized as learning from becoming aware of one's own learning process.

Comparison of the fifteen general sequences of learning activities to the five types of general learning activities (cf. section 2.2.2) shows the five types of learning activities to be clearly reflected in the fifteen sequences but in different ways. The category of 'doing' resembles sequence 9 in which teachers learn from the observation of students during a standard assignment. The category 'experimentation' is reflected in many of the sequences. In sequences 1 and 2, for example, the teachers experiment with alternative methods as a result of exposure to the methods of colleagues. The category 'reflect upon experiences' is also present in many of the general sequences. In sequence 7, for example, the teachers reflect upon their experimentation with alternative methods. The category 'learning from others without interaction' was not reported very often (cf. sequence 5). The category 'learning from others with interaction,' however, was clearly reflected in sequence 6, for example, where teachers report a collective dissatisfaction with the level of knowledge, skills, or attitudes of students and therefore collectively think up alternative methods to increase the student level of knowledge, skills, or attitudes.

Finally, inspection of Table 3.3 shows each of the general sequences of learning activities to involve more than one type of learning activity. In sequence 2, for example, the teachers experiment with alternative methods as a result of exposure to the methods of colleagues and subsequently reflect upon this experimentation; the following types of learning activities are thus included: 'learning from others with interaction,' 'experimentation,' and 'reflect upon experiences.'

4.4.4 Associations between changed preferences for learning activities and specific learning activities reported in the digital logs

When the changes in the teachers' preferences for learning activities were examined in connection with the general sequences of learning activities actually reported in their digital logs, three rather surprising findings were encountered.

Finding 1
While a high frequency of sequences of learning activities involving colleagues occurred in the digital logs (cf. sequences 1, 2, 3, 5, and 6, N=63), only one teacher showed an increased preference for the 'asking colleagues for advice' type of learning activity.

Finding 2
a) The teachers preferred the activity 'trying different things' *least* on both measurement occasions, but 'experimentation' was part of many of the general sequences of learning activities, as can be seen from Table 3.3.
b) Also, sixteen of the thirty-four teachers nevertheless showed significant changes in their preferences for the learning activity 'trying different things'. Ten of the teachers scored significantly higher and six of the teachers scored significantly lower, which could be explained by different antecedent activities.

Finding 3
Eleven teachers showed significant changes in their preferences for 'critical individual reflection' but in different directions. The preferences of the teachers for this type of learning activity related inversely to the reporting of learning experiences involving colleagues.

In the following, we will further elaborate upon these findings and illustrate them with fragments from the digital logs.

Finding 1: Only one increase in preference for 'ask colleagues for advice' despite reports of many such learning experiences in digital logs
Inspection of Table 3.3 shows the teachers to often report learning experiences that involved their colleagues. Particularly learning experiences in which the teachers report learning from experimentation with colleagues' methods after observation or discussion of the methods with colleagues (sequence 1) was often reported. Colleagues were also involved in sequences 2, 3, 5, and 6. The reporting of the teachers with regard to their learning experiences involving colleagues was generally positive (with the exception of sequence 5). Given these positive experiences and the fact that the teachers collaborated with colleagues in teams for a year, one would expect an increased preference for learning activities involving colleagues. However, only one teacher scored significantly higher on the learning activity 'asking colleagues for advice' when the 'Preferences for learning activities' questionnaire was again administered on the second measurement occasion.

In our search for an explanation for this result, we closely examined the exact reporting of the teachers with regard to the involvement of colleagues in their learning experiences and found this to differ markedly from the formulation of the relevant information in the questionnaire. For the questionnaire, the teachers were confronted with eight challenging or problematic situations and asked to indicate just how often they would ask colleagues for advice. In their digital logs, in contrast, the teachers report learning from *listening* to colleagues' experiences with (new) teaching methods or *observation* of colleagues using these methods. They were subsequently inspired by these experiences and experimented with the methods, but they initially listened and observed as evident in the following segment from Jeff, an economics teacher.

> **Jeff[5], digital log number 6[6]**
> Three weeks ago, we were in an Education Group meeting to prepare the first study afternoon. [...] One of my colleagues introduced the concept 'visible learning' that requires a high level of action for both the teacher and the students during a lesson. [...] In a short enumeration of possible teaching methods for 'visible learning,' my colleague mentioned the 'half-time conversation'. The teacher asks small groups of students to briefly talk with him or her about what has been done during the past few lessons. The students can learn from each other in such a manner and are, of course, forced to put aspects of the subject matter into words. [...] In the two weeks following this preparatory meeting, I used the half-time conversations in four lessons and they really worked! Of course, you have to ask the right questions. [...] A pleasant side effect is that you can pay more personal attention to the students in a serious environment.

In the above example, Jeff was inspired by the description of a new teaching method by a colleague and subsequently experimented with the new method. Other teachers similarly report experimentation with new teaching methods, more or less immediately following an interaction with colleagues as evident in the following segment from Iris, an English language teacher.

[5] For privacy reasons, we have adopted fictional names.
[6] Cf. sequence number 1.

> **Iris, digital log number 3**[7]
> I went to Eric in his class as I had a question. It was so much fun that I decided to stay (just by coincidence, I had a free hour). […] The students had to individually show Eric what they had done for the drawing teacher. When a student had not done the work, it was immediately agreed that it had to be done by the next class. This was done with a joke, but thereafter order and clarity and he wants immediate explanation from the students. The students who did do the work were asked to explain what the assignment entailed and how they interpreted it. The rest of the class watches and discusses as well. […] Good atmosphere, involvement, and clarity. I left the classroom with the idea that I should have attention for every student, good or bad but in a positive manner, because then you can do almost anything. My learning experience is that you can confront students with their failures and also compliment them with their product as long as you do that with humor and clarity. And the students learn from each other: how things should be done and what is expected of them.

In the examples above, the teachers expanded their teaching repertoires by listening to a colleague or observing a colleague. In fact, this was the essence of most of the reported learning experiences involving colleagues. In sequence number 3, in contrast, the teachers encountered a problem and explicitly asked their colleagues for feedback in order to deal with the problem and improve their teaching practice.

In sum, a discrepancy between the activity descriptions presented in the 'Preferences for learning activities' questionnaire and the teacher descriptions of their learning experiences in the digital logs was found. This may explain the absence of an increased preference for 'asking colleagues for advice' despite the frequent report of learning activities involving colleagues.

Finding 2a: Low preference for 'trying different things' despite high frequency of reported learning experiences involving 'experimentation'

From Table 3.3, it can be seen that eight of the fifteen general learning sequences involved 'experimentation with alternative or new teaching methods' (sequences 1, 2, 3, 6, 7, 8, 10, and 14). Although this specific learning activity resembles the learning activity 'trying different things' from the questionnaire, the results in Table 4.4 nevertheless show the learning activity 'trying different things' to be *least* preferred on both measurement occasions. Once again, a discrepancy between the reported preferences of the teachers and their reported learning activities appears to exist and the question is just how this discrepancy should be explained.

[7] Cf. sequence number 2.

The digital logs submitted by the teachers were carefully reviewed to determine if the questionnaire item 'trying different things' differed from the teacher descriptions of learning activities involving 'experimentation.' The segments below from the digital logs of Mark, Isabel, and Mary are illustrative.

Mark, digital log number 3[8]

Whole-class discussion of test results is often difficult. Students with high scores find it boring, and students with low scores often have so many questions that it is impossible to answer them all in 45 minutes. In order to develop a better method for this, we decided to think up a new method of test analysis and experiment with this in our classes.

Last week, I analyzed the results of a test in such a manner. I assigned two boys and two girls to a group with two good students and two less good students in each group. I opted for this particular composition because I assumed that such a varied composition would allow the groups to solve most of the problems.

The students were told that they had to discuss the 25 test questions and that they could only go to the next question when each student in the group understood the current question. They were also told that they could only ask for my help when all of the students in the group were stuck and could not find the answer. [...]

I quickly noticed that the students were all very busy discussing the questions. It also quickly became apparent that I had time to walk around and help students as needed.

I am very enthusiastic about the attained results. Of course there are some students who do not attach much value to this manner of test analysis, but the majority by far was very satisfied. They repeatedly mention that they learn a lot from hearing how other students interpret the questions and can clarify the material. For some of the students, just where they make the same mistakes and those skills that need considerably more practice also became abundantly clear. [...] I am very satisfied with the results and had not expected such positive results. I am certainly going to keep using this method even though it may cost somewhat more preparation time. In the end, it saves a lot of work!

Isabel, digital log number 2[9]

[...] I have learned that it is really important to teach in a varied manner using different instructional techniques. One of my classes indicated right at the beginning of the school year that they wanted to do fun things in Arts and Culture. They did not want to have just lectures as that was boring. I agreed as

[8] Cf. sequence number 6.
[9] Cf. sequence number 10.

I like to do fun things as well. They conducted a project in the second period of the year [...]. And for the period that just ended, I had them prepare a lesson, which boiled down to a type of presentation. Some of the students did a really nice job while others made a complete mess of things. The question that I am now asking myself is whether the fun things were very educational. If you want things to go really well, then you have to invest a lot of time in the guidance of things. I should probably have a kind of manual for students with points to pay attention to during a presentation. [...]
What did I learn? I suggested that regular lessons would be taught in the upcoming periods of the year with different instructional techniques in them, of course. The students also now felt like this as well. Too many fun things without structure doesn't, thus. You simply have to alternate between all kinds of lessons and instructional techniques.

Mary, digital log number 4[10]
My learning experience concerns examination training. As a result of the meeting on March 17th, I applied the same approach as my colleague Hans during the final lesson for one of my classes. [...] My colleague came up with the idea of having the students take part of correcting a test, distributing the answer sheet, and having them then grade their own work. I thought this was a good idea. The students can immediately see and be made aware of (as a result of grading) what they should pay attention to.
While we were talking about this, I thought to myself that it might be even more interesting to have the students grade the work of a fellow student instead. I hoped to achieve a stronger learning effect in such a manner. The student is now in the same position that I am in when it comes to grading. And sees how important it is to provide clear answers. [...] I was really enthusiastic about this arrangement and tried it out. [...] What happened thereafter (and I naturally could have foreseen)? The one student finished much quicker than the other. The one who finished earlier had no one to exchange exams with. It's too bad, this part of my plan could not be done. And I thus decided that everyone would check his or her own work. [...]
What I learned is that you should not, with your enthusiasm, try to achieve too many things at once because the one objective can sometimes exclude another. I felt that I had thought of everything [...]. But this appeared to not be the case. I have learned that it is better to survey where the pitfalls in my approach may lie ahead of time: wanting too much at the same time (qua *objectives* but also the *amount of work*). [...] This will certainly increase the effectiveness.

[10] Cf. sequence number 1.

The above three examples show 'experimentation' to indeed occupy a central position in the learning experiences reported by the teachers, but the teachers can also be seen to always *start* their reports of learning experiences with learning activities other than experimentation. Mark starts the description of his learning experience with the collective dissatisfaction that is apparent for whole-class discussion of test results with students. This results in an agreement to individually think up a solution to this problem and experiment with new methods in order to then exchange experiences with colleagues. Isabel first hears students say that they want to do something fun in art class and thus experiments with a new approach. Mary first hears a colleague describe a technique for helping students prepare for exams and, after this meeting, decides to experiment with the new method and even elaborate upon it. In other words, teachers may have shown a low preference for 'trying different things' on the questionnaire as they never really *start* with such experimentation. Other activities, such as brainstorming about solutions to a problem, often precede experimentation with new methods in one's own practice.

Finding 2b: High number of changed preferences for 'trying different things' explained by different antecedent activities.

Given that numerous learning experiences with experimentation activities were reported by the teachers in their digital logs, one might expect to see a shift of preference in the direction of this learning activity at some point. The results in Table 4.5 show ten of the thirty-four teachers to indeed show such a significant shift, but six other teachers showed a significant shift *away* from such a preference when they again completed the questionnaire (p <.05). Stated differently, almost 50% of the teachers who participated in this study showed a change of preference with regard to the learning activity of 'trying different things' but not all in the same direction.

To gain greater insight into the different shifts of preference, the frequencies of reported learning experiences involving 'experimentation' were next examined for the different groups of teachers. Given the unequal numbers of teachers with preference scores that had decreased significantly (n=6) versus increased significantly (n=10), relative frequencies for the learning experiences involving 'experimentation' were calculated and compared for these two groups of teachers. These relative frequencies were derived from dividing the number of experiences involving 'experimentation' in a group of teachers by the total number of reported learning experiences of that group and put into percentages (Table 4.6).

Table 4.6 Relative frequencies of learning experiences involving 'experimentation'[11] for teachers with changed preference scores for 'trying different things'[12]

	Sequence code						
	1	2	3	6	7	8	10
Teachers with *lower* preference scores (N=6)	3.0%	3.0%	9.1%	3.0%	36.4%	0%	12.1%
Teachers with *higher* preference scores (N=10)	11.3%	1.9%	5.7%	11.3%	26.4%	3.8%	3.8%

Inspection of the results in Table 4.6 shows those teachers with significantly *lower* preferences for the activity 'trying different things' upon second measurement to often report learning experiences involving sequence 7. In 36.4% of the total number of digital logs for these six teachers, *individual dissatisfaction* with the level of knowledge, skills, or attitudes of students and the effects of current teaching methods was reported to prompt their experimentation with alternative teaching methods. For those teachers with significantly *higher* preferences for learning activity 'trying different things,' his percentage was 26.4%. This latter group reported relatively more learning experiences involving interaction with *colleagues* across a variety of settings and subsequent experimentation with alternative teaching methods (e.g., sequences 1, 2, 3 and 6). In contrast to the group of teachers with significantly lower preference scores upon second measurement, moreover, this group reported a variety of causes for experimentation with alternative teaching methods. It appears, thus, that experimentation with alternative teaching methods as a result of *multiple causes* can produce a higher preference for the learning activity of 'trying different things' in the long run.

Finding 3: Changes in preference for 'critical individual reflection' with different associations to the involvement of colleagues in learning experiences

'Critical individual reflection' was found to be the most preferred learning activity for almost all of the teachers on both measurement occasions. Nevertheless, seven

[11] Cf. Table 3.3

[12] Sequence 14 did not occur in any of the digital logs for these two groups of teachers.

teachers scored significantly lower and four teachers scored significantly higher upon second measurement. Closer inspection of the reported learning experiences for these two groups of teachers showed more than 50% of the learning experiences for the teachers with significantly *lower* scores to involve colleagues while about 33% of the learning experiences for the teachers with significantly *higher* scores involved colleagues. More specifically, teachers with significantly lower scores for 'critical individual reflection' upon second measurement reported six learning experiences in which they were, together with colleagues, dissatisfied with the students' level of knowledge, skills, and attitudes or the effects of a previous method on student learning and therefore collectively brainstormed about possible solutions. Teachers with significantly higher scores for 'critical individual reflection' upon second measurement did not report this type of learning experience at all. Also teachers with significantly lower scores more often than teachers with significantly higher scores, reported learning experiences in which they based on acquaintance with colleagues' ideas and methods, experimented with alternative methods in their practices. Apparently, teachers who have had positive experiences with working with colleagues in different ways may develop lower preferences for critical consulting themselves as a means to change their practices.

4.5 Conclusions and discussion

The aim of this study was to contribute to a better understanding of the workplace learning of experienced teachers. We formulated the following research question: How are learning activities that teachers undertake in a context of collaboration in interdisciplinary teams related to changes in their preferences for learning activities during a period of one year? First, we examined the general preferences of the thirty-four teachers for five types of learning activities. Second, we examined if and how the learning preferences of the teachers changed across a period of one year. Finally, we examined just how the sequences of learning activities reported by the teachers in digital logs related to the changes in their preferences for different types of learning activities.

Examination of the mean scores on the 'Preferences for learning activities' questionnaire showed a general preference for 'critical individual reflection', when confronted with particularly challenging or problematic situations. The teachers also showed a preference for two other learning activities; namely, 'asking colleagues for advice' and 'trusting own intuitions and feelings.' The remaining two learning activities of 'gathering information from the internet, books etc.' and 'trying different things' were least preferred. The majority of the teachers did not show a change of preferences, although some of the teachers did show a change of preference for one or more of the five learning activities. Taken together, these

results are in line with the results of studies of student learning in which the learning styles of students appear to be relatively stable across time but not absolutely unchangeable (Vermunt, 1998). The learning activities probed in the present study can be assumed to be a part of learning styles, and this has important implications for the professional development of teachers. Teacher preferences for particular types of learning can change, which suggests that in professional development programs it would be worthwhile to pay attention to such changes in addition to increasing or adjusting teachers' subject matter or pedagogical knowledge and skills.

In order to gain greater insight into why certain teachers scored differently on the second measurement, we examined the specific learning activities reported by the teachers in the period between first and second measurement in their digital logs. The analysis of the learning experiences reported by the teachers in their digital logs produced a list of fifteen general sequences of learning activities. The frequencies of changed preferences for the five types of learning activities addressed in the questionnaire were next compared to the frequencies of similar learning activities reported by the teachers in their digital logs. To start with, colleagues often played a part in the learning experiences reported by the teachers but this finding did not relate to a general preference for 'asking colleagues for advice.' Instead, the teachers reported mostly learning from the observation of colleagues or listening to colleagues and their experiences with alternative teaching methods. This finding is in line with the results of a recent study by Shank (2006) in which it is argued that 'storytelling' with colleagues is an effective means for teacher professional development. Teachers also indicate in other studies that they can learn a lot from watching others or the exchange of ideas with others (e.g., Briscoe & Peters, 1997; Butler, et al., 2004). However, in most of these studies, the 'sharing of ideas' refers to situations in which the teacher learns by telling his or her problem or experiences to colleagues and by collectively reflecting upon the experience and by directly receiving feedback from colleagues. In the present study, the teachers frequently reported learning from just *listening* to the ideas and experiences of colleagues and subsequent experimentation with alternative ideas or methods in their own teaching practice. Future studies of teacher learning preferences, types of learning activities, and the questionnaire used here should therefore take the listening and observation forms of learning from colleagues more explicitly into account. In other words, it appears that teachers in this study do not learn so much from solving individual problems with colleagues but more often from just listening to the experiences and ideas of other teachers.

A second finding is that the learning activity of 'experimentation' played a role in eight of the fifteen general sequences of learning activities identified for the

digital logs provided by the teachers. Once again, however, the 'Preferences for learning activities' questionnaire did not show a similar preference for the comparable learning activity of 'trying different things.' In fact, this activity was preferred *least* by the majority of the teachers. At first sight, these results appear to contradict each other. However, closer examination of the descriptions of the learning experiences provided by the teachers in their digital logs showed other activities, such as individually or collectively thinking up alternatives or solutions, to *precede* 'experimentation.' In future research on teacher learning, the learning activity 'trying different things' should therefore be explicitly referred to as possibly part of a *sequence* of activities. Despite the fact that the teachers displayed the least preference for 'trying different things' on both measurement occasions, six teachers scored significantly lower and ten teachers scored significantly higher on the second measurement occasion. Teachers who showed a significantly *lower* preference for 'trying different things' reported learning experiences in which experimentation was the result of an individual dissatisfaction with the level of knowledge, skills, and attitudes of students or the effects of current teaching methods relatively more often. Teachers who showed a significantly higher preference for 'trying different things' reported a variety of causes or antecedent activities to precede their experimentation with alternative or new teaching methods, and this may explain their increased preference for 'trying different things' in the long run. It is also possible that the teachers interpreted the questionnaire formulation of this particular learning activity differently. Some teachers may interpret 'trying different things' as 'non-purposeful' or as 'trial and error' (Lohman, 2005). Other teachers may interpret 'trying different things' as more purposeful and thus as a conscious and explicit means of evaluation. In their digital logs, the teachers we examined mainly reported on their experiments with alternative or new teaching methods in terms of 'deliberate practice.' Dunn and Shriner (1999, p. 633 & 635) observed that "teachers' development of expertise is supported by engagement in specific activities that provide optimal opportunity for learning and skill acquisition." "Deliberate practice is distinct from actual job performance." Deliberate experimentation with alternative teaching methods implies that teachers consciously choose a specific alternative because they have an idea of why and how the approach may work (cf. Mark's digital log number 3). In future research on teacher learning it should also be made sufficiently clear that the activity of 'trying different things' concerns experimentation with the deliberate selection of one or more specific alternatives or new methods for consideration.

The third finding concerned the changed preferences of some teachers for the learning activity of 'critical individual reflection'. We found those teachers with a significantly lower preference for 'critical individual reflection' upon second

measurement to report relatively more learning experiences in which colleagues played part in changing their teaching practices. Conversely, those teachers with a significantly higher preference for 'critical individual reflection' upon second measurement reported relatively fewer learning experiences involving colleagues. We suspect that positive experiences with involvement of colleagues in teachers' professional development can thus produce a lower preference for reliance on one's own knowledge and skills. Initiatives aimed at teacher professional development may stimulate such experiences as for teachers it is important to realize that their needs, experiences and problems when changing their teaching practices are not unique, which makes it easier to collaborate with colleagues in future. Teacher collaboration is supposed to stimulate professional learning and consequently the implementation of educational innovations.

In future research on teacher preferences for learning activities and possible changes in these preferences, sequences of learning activities and not just single learning activities should probably be considered. In the questionnaire used in the present study, the teachers had to indicate the likelihood of choosing a single specific activity when confronted with a challenging or particularly problematic situation. However, the analysis of the actual learning experiences reported in the teachers' digital logs showed teachers to often learn from *sequences* of activities. Similarly, in the literature on student learning, it has been shown that students often undertake more than one learning activity (Snowman, 1986; Vermetten, et al., 1999). A focus on separate learning activities may not do sufficient justice to the complexity of teacher learning in the workplace.

In future studies of how teachers learn but also in professional development programs, attention should be paid to not only learning as a result of dealing with challenging situations but also 'spontaneous' learning. The learning experiences reported by the teachers in the present research showed them to often — and freely — acquaint themselves with other teaching methods without actually experiencing problems with their own methods. This was done via the observation of students during standard assignments, via listening to colleagues' experiences with particular methods, or perhaps during unexpected situations.

To conclude, the results of this study can be applied to help optimize professional development programs for teachers. Teachers should be stimulated to not only increase and possibly adjust their subject matter or instructional knowledge and skills but also consider their preferences for a particular form of learning. For example, in interdisciplinary teams teachers can be stimulated to learn from not only solving individual problematic situations with colleagues but also from listening to colleagues' ideas and experiences or from the observation of students during regular assignments. Stimulating teachers to become more aware

of their own ways of learning and how to regulate their learning may also help them in think up novel ways to foster more active and self-regulated student learning.

Appendix 4.1 Situations in the questionnaire 'Preferences for learning activities'

	Description of situation
Situation 1	"When I notice didactical problems during the preparation of my lessons and want to do something about this, then I will…"
Situation 2	"When I have problems in a certain class and want to do something about this, then I will…"
Situation 3	"When I see that assignments are not working very well for my students and I want to do something about this, then I will…"
Situation 4	"When I have problems with a colleague and want to change this, then I will…"
Situation 5	"When I have problems in the contact with the parents of a student and want to solve these, then I will…"
Situation 6	"When I have to start working with new, just purchased teaching materials, then I will…"
Situation 7	"When I notice that a particular teaching method is not working very well and I want to elaborate on it, then I will…"
Situation 8	"When I have to develop a test for use by all of the teachers in my department, then I will…"

Chapter 5

Chapter 5
Characterizing collaboration in interdisciplinary teams and its relation to teacher learning[13]

In this study the relation between teacher learning and collaboration in interdisciplinary teams was explored. Firstly, we elaborated extensively on the conceptual framework underlying this study, especially on the concepts of interdependency, alignment, group and organizational characteristics, and belief changes. Secondly, we conducted a comparative case study. Five interdisciplinary teams were examined for a period of one year. The collaboration in these teams focused on a topic related to 'fostering active and self-regulated learning'. Several complementary data collection methods were used to examine collaboration and teacher learning, such as observations of team meetings, digital logs, and questionnaires on (1) beliefs about teaching and learning, (2) group characteristics, and (3) organizational characteristics. The results of cross-case analysis showed that patterns could be identified in teacher learning and type of collaboration. The collaboration in all interdisciplinary teams could be characterized as 'sharing'. Sharing was further specified with regard to the content of sharing and the aim for sharing. Sharing in teams that focused on exchanging both *ideas and experiences with experimentation* with alternative methods, and that was aimed at *shared* instructional problem-solving, was effective in terms of teacher learning. Sharing that focused on *exchanging ideas* and that was aimed at *individual* problem-solving was less effective in terms of teacher learning.

[13] This chapter has been submitted in adapted form as:
Meirink, J.A., Imants, J., Meijer, P.C., & Verloop, N. *Teacher learning and collaboration in interdisciplinary teams.*

5.1 Introduction

Teacher collaboration and teaming generally are regarded as positive conditions for teacher learning in schools. Teachers' reports stress collaboration with colleagues as a powerful learning environment (Dunn & Shriner, 1999; Kwakman, 1999; Lohman, 2005). While collaborating, teachers can exchange ideas or experiences, develop and discuss new materials, get feedback from colleagues, and give each other moral support (Butler, et al., 2004; Johnson, 2003; Meirink, Meijer, & Verloop, 2007). In this study, teacher teams were regarded as the contexts in which teacher collaboration and learning emerge.

Secondary education has a tradition of teacher collaboration in the context of subject departments (Little, 1999; Van Wessum, 1997; Witziers, et al., 1999). Departments have been found to be relevant contexts from which teachers have collective engagement and collaboration. However, departments can also create barriers to professional communication and interaction within the department as well as in the larger school community. Organization of teachers into departments is not sufficient in itself to ensure that these teachers will collaborate on topics or will do this in a way conducive to innovative teacher learning.

As an alternative to departments as disciplinary teams, the development of interdisciplinary teams has gained attention in the last 10 years (Crow & Pounder, 2000; Imants, Sleegers, & Witziers, 2001; Pounder, 1999; Witziers, et al., 1999). Interdisciplinary teams are assumed to be a favorable condition in the implementation of innovations in the curriculum aimed at integration of school subjects, and thus requiring an interdisciplinary approach. Moreover, it is assumed that collaboration between teachers with different discipline backgrounds can foster their professional development as they can get acquainted with more new knowledge and skills (e.g., Johnson, 2003; Putnam & Borko, 2000). Finally, semi-autonomous interdisciplinary teams are assumed to create work interdependence and increased responsibilities for the group's performance and outcomes (Crow & Pounder, 2000). The results of the scarce research aimed at exploring these interdisciplinary teams in schools do not, however, meet the initial high expectations. For example, Crow and Pounder (2000) showed that teacher teams that initially aimed at interdisciplinary curriculum planning mainly focused on dealing cooperatively with daily problems with student behavior and learning. At this point, however, the knowledge base on how these teams can foster teacher collaboration and learning is too limited to conclude that interdisciplinary teams do not fit in innovative secondary schools (Imants, et al., 2001).

Interdisciplinary teams generally served as alternatives to the traditional department structures in school organizations. Starting from specific innovative and professional development aims, another type of interdisciplinary team might

be introduced into schools. These interdisciplinary teams would not replace subject departments but would function separately from the existing department structure on a temporary basis. In most cases, only a limited number of the teaching staff would participate in such teams, often on a voluntary basis, and the teams would serve specific innovative goals. The focus in this study was on this type of interdisciplinary team. The assumption was that the interdisciplinary teacher collaboration in such teams might foster teacher learning with regard to specific instructional innovations. However, as the review of research on subject department teacher teams shows, the fact that teachers can be regarded as members of a team does not automatically imply that these teachers collaborate in ways that foster professional development in innovative topics. For example, defensive behaviors of team members can prevent them from participating in and contributing to the learning activities undertaken in collaboration (Bakkenes, De Brabander, & Imants, 1999; Senge, 1990).

The interdisciplinary teams examined in this study had recently been set up in their schools. It was assumed that the quality and topics of teacher collaboration in the interdisciplinary teams were related to how these teachers enacted emerging group characteristics and organizational characteristics. We examined five interdisciplinary teams in order to gain an understanding of how teachers start up and develop collaboration in such teams, and how this collaboration is related to group and organizational characteristics. In addition, we examined how collaboration in such teams contributes to teacher learning with respect to an educational reform. The following research question was addressed:

- How do teachers collaborate in interdisciplinary teams and how does this relate to teacher learning with respect to the topic 'active and self-regulated student learning'?

5.2 Conceptual framework

In this section we further elaborate on the conceptual background of the variables used in the study. We start with an elaboration of the reform context in which the study took place. We then discuss the conceptual background of how teacher learning in collaboration was examined. Following this, we elaborate on two important elements of teacher collaboration: interdependency and alignment. We close this section with a brief description of the group and organizational characteristics which were taken into account in the study.

The rationale underlying this study is depicted in Figure 5.1. We examined how collaboration in interdisciplinary teams was started up and developed. The collaboration was aimed at contributing to teacher learning for specific instructional innovation. The analysis of collaboration was focused on

interdependency and alignment. Group characteristics and organizational characteristics were regarded as contextual factors that affected the starting up and development of collaboration in these interdisciplinary teams.

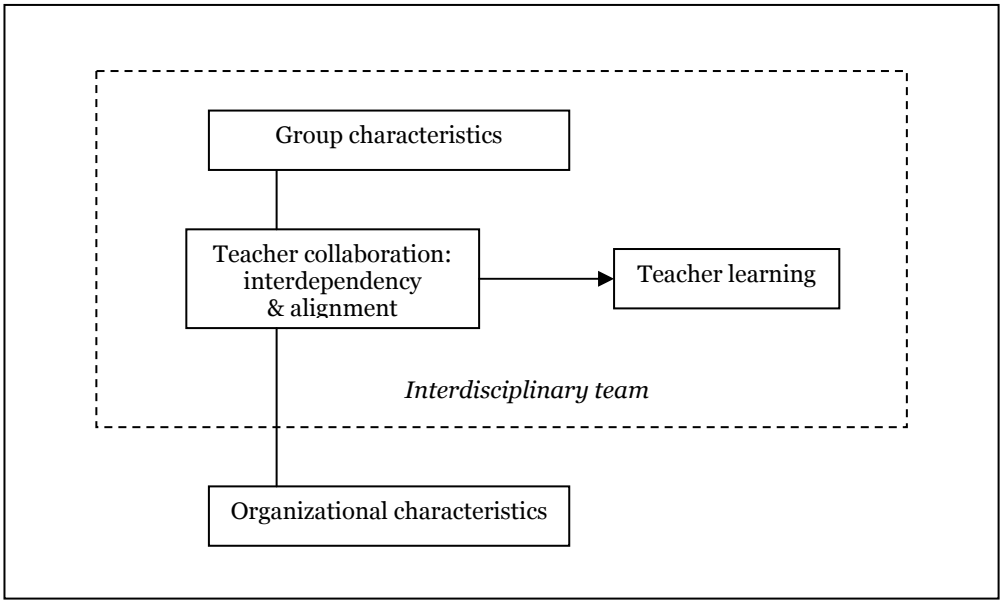


Figure 5.1 Teacher collaboration and learning in interdisciplinary teams within the school organization

5.2.1 The educational reform as a context for collaboration and learning in interdisciplinary teams

A recent educational reform in Dutch secondary education is aimed at changing the curriculum in upper secondary education, and at stimulating a new pedagogical approach: fostering active and self-regulated student learning. Fostering 'active and self-regulated student learning' is often regarded as a cross-curricular topic in which teachers can support and stimulate one another in practicing this pedagogy.

In addition to fostering active and self-regulated learning, teachers are stimulated to collaboratively develop assignments and projects that encourage students to integrate related subjects. In this study, fostering active and self-regulated student learning by teachers was selected as the context to invite teachers to participate in interdisciplinary teams. This part of the reform suited the research aim well for several reasons. Firstly, to successfully implement this educational reform, it is important that teachers support the underlying principles and teach their students accordingly (e.g., Oolbekkink-Marchand, et al., 2006b). For many

teachers the reform implies a way of thinking about student learning they are not used to. In other words, many teachers need to change their beliefs about teaching and learning. This makes it an appropriate context to examine teacher learning. Secondly, schools are not obligated to use the new pedagogical approach aimed at fostering active and self-regulated learning. The non-obligatory character of this part of the reform creates opportunities for teachers to determine their own preferred working conditions in the teams. In this way, teachers might be less tempted to show the defensive behavior that is often associated with mandated large-scale educational reforms.

5.2.2 Teacher learning in collaboration

The teachers in this study were assumed to collaborate in innovative interdisciplinary teams and the question was how and what they learned while participating in these teams. A common assumption is that the exchange of ideas, beliefs, opinions, knowledge, and experiences enhances learning. In collaboration, new knowledge can be created or existing knowledge can be extended. The learning process in contexts of collaboration is particularly enhanced when people with different ideas, beliefs, and opinions are in interaction (Putnam & Borko, 2000).

Learning in collaboration can be examined on either an individual level or team level (Dechant, Marsick, & Kasl, 1993). We examined individual teacher learning in collaboration in interdisciplinary teams; more specifically, we examined *what* individual teachers learn and *how* they learn individually. It is assumed that teacher learning in collaboration can take place along two dimensions: an efficiency dimension and an innovative dimension (Hammerness, et al., 2005; see also Chapter 1). In this first dimension, collaboration aims at making teachers' existing teaching routines more efficient and elaborate. With regard to the second dimension, collaboration aims at innovative teacher learning and requires that teachers give up old routines and change prior beliefs. Beliefs generally refer to suppositions, commitments, and ideologies (Calderhead, 1996). They are based on evaluation and judgement, and are often assumed to be difficult to change (Pajares, 1992). We argued above, however, that it is important for a successful implementation of educational reforms that teachers support the underlying ideas of these reforms. For many experienced secondary school teachers this requires changes in their beliefs about teaching and learning, as they are expected to gradually endorse a more student-oriented approach to teaching and learning. With regard to *what* teachers learn, therefore, we focused on *changes* in individual teachers' *beliefs about teaching and learning* (cf. Bolhuis & Voeten, 2004; Boulton-Lewis, et al., 2001; Van Driel, et al., 2007).

To examine *how* teachers learn, we explored teachers' *learning experiences* with regard to implementing a pedagogical approach in their own teaching practice aimed at fostering active and self-regulated student learning. Implementing a new or different pedagogical approach requires experimentation with alternative methods and critical reflection on current practices which form teacher learning experiences. In this study, we considered it important to examine to what extent collaboration with colleagues with different subject matter backgrounds was part of teachers' learning experiences.

5.2.3 Teacher collaboration

Teacher collaboration is a widely used, but problematic concept. To provide a better understanding of what collaboration means, an illuminating distinction between cooperation and collaboration is made by Hord (1986). Cooperation assumes two or more teachers, each with separate and autonomous practices, who agree to work together to make their private practices more successful. Collaboration implies that the teachers involved share responsibility and authority for making decisions about their common practices. In many schools teachers make efforts to cooperate, but teachers are actually collaborating in far fewer schools. In daily practice, teachers and researchers often use the word collaboration while they actually practice cooperation. Imants (2003) argues that the primary goal of cooperation is the efficient division of tasks, while improvement and professional development are central aims of collaboration.

Research on subject departments in Dutch secondary schools has shown that department members frequently meet both formally and informally (Witziers, et al., 1999). However, serious limitations occur concerning the nature of department members' interaction and communication. The focus is on the effective organization of teaching: formalization of content, pace of instruction, and testing within grades (what topics should be taught, what knowledge should be tested, and when). Instructional problems encountered in the classroom, and school improvement and teacher development items, are hardly discussed. Teachers show ambiguous views on coordination and improvement by preferring shared decision-making and low engagement. Decisions on the application of methods of instruction and pedagogies remain the domain of individual teachers. It may be concluded that in so far as Dutch secondary school teachers take coordinated action in their subject departments, cooperation to formalize instruction is dominant while collaboration for improvement hardly occurs (Imants, et al, 2001; Witziers, et al;. 1999). Scarce studies on interdisciplinary teams in other countries have not yielded fundamentally different results. Some aspects of communication may improve (communication between subjects within grade levels), but new problems

occur, such as the problem of professional interdependence versus norms of professional autonomy (Crow & Pounder, 2000; Kruse & Louis, 1997; Pounder, 1999). As a result of an intensification of collaboration aimed at shared decision-making, teachers can feel limited in their own professional autonomy. These findings do not suggest that innovation of instruction does not occur in secondary schools; individual teachers' discretion and autonomy in making decisions regarding instruction, methods, and pedagogies is generally high (Archbald & Porter, 1994). As a consequence, it can be expected that defensive behaviors might play a strong role when teachers are invited to change their methods of instruction while collaborating in interdisciplinary teams, even when they participate in the team on a voluntary basis.

We considered two central aspects of collaboration to be relevant in examining collaboration in interdisciplinary teams: *interdependency* and *alignment*.

5.2.3.1 Interdependency

The first aspect of collaboration explored in this study was *interdependency*. In the case of interdependence, two or more actors have indirect control over outcomes, depending on their actions and the actions of other team members (Weick, 1979). An example in education is an interdisciplinary team in which teachers are dependent on each other, as they share responsibility for a joint integrated curriculum. In normal daily classroom practices, however, interdependence between work elements and work processes is low, corresponding to high teacher autonomy in instructional and pedagogic topics, and the loosely coupled character of schools. Potential advantages of high interdependence are mutual empowerment, effective improvement, and rich professional learning. A potential advantage of low interdependence is undisturbed continuation of instruction and learning in situations of a turbulent school environment and problematic relations between teachers and school management (Weick, 1976). Applied to the discussion of cooperation and collaboration, the level of interdependence is higher in collaboration than in cooperation (Imants, 2003).

Little (1990) and Rosenholtz (1989) distinguish various types of collegiality and collaboration among teachers, based on the level of interdependence in interaction between teachers in everyday school practice. These various types are assumed to have different contributions to the professional development of individual teachers. The hypothesis underlying these classifications is that in a group with a high level of interdependence, the teachers learn more than do teachers in a group with a low level of interdependence. Collegial interaction with a low level of interdependence is labelled 'storytelling and scanning'. This type of

collaboration, in which teachers learn about each others' teaching practice, often occurs in staff rooms or in hallways, and can be characterized best as moment-by-moment exchanges. Rosenholtz (1989) describes 'experience swapping' as a specific type of storytelling in which teachers, for example, confirm that they are not responsible for problems in student learning. Experience swapping often results in the emotional sympathy and support of colleagues. The second type of collaboration with an intermediate level of interdependence is labelled 'aid and assistance'. The level of interdependence is higher than in 'storytelling and scanning' as it allows colleagues to critically look at one's teaching practice. The third type of collaboration is labeled 'sharing', or 'exchanging instructional materials and ideas'. In this type of collaboration teachers routinely share materials, methods, ideas, and opinions which allow them to make their daily teaching routines accessible to other teachers, and it can stimulate productive discussions of the curriculum. Finally, the type of collaboration with the highest level of interdependence, and which consequently holds a rich learning potential, is labeled 'joint work' or 'instructional problem-solving and planning'. In this type of collaboration teachers feel a collective responsibility for the work of teaching. They may either agree to act in a similar way in their own practice or agree on general principles that guide their individual actions in teaching practice.

In this study, interdependency was explored in order to characterize collaboration in interdisciplinary teams. We used Little's and Rosenholtz's classifications of types of collaboration. Note that Little's classification is based on how interaction takes place in everyday school practice, and not on how interaction takes place in more formal settings, such as the teams examined in this study. We considered the types of collaboration to be four positions on a dimension of interdependence. On this dimension, the types of collaboration were not fixed points but rather parts of the dimension. Thus, potentially diverse subtypes might be identified in each type of collaboration.

5.2.3.2 Alignment

According to Senge (1990), *alignment* in the team is essential to team learning. When a team becomes more aligned, a commonality in direction emerges, and individuals' energies harmonize. Team learning can be regarded as the process of alignment and developing the capacity of a team to produce the results its members truly desire. Following this conceptualization, alignment is an entity that emerged in the interdisciplinary teacher teams during the one year of the present study. This notion of alignment corresponds to Weick's vision on the formation of collective structure. According to Weick (1979), collective structures develop from diverse ends, along common means, to common ends and diverse means. Applied to the

interdisciplinary teams in this study, it might be expected that initially these teams were regarded by the participating teachers as common means to reach diverse individual ends, and that gradually these teachers would (or would not) develop common ends.

We explored alignment by analyzing two aspects of collaboration. Firstly, we analyzed the extent to which the goals of the teachers were shared in the interdisciplinary teams in the year that these teams were followed by the researcher. Shared goals reflect a harmony in interests which can provide a clear focus and direction for collaboration. This focus and direction are conducive to learning in collaboration (Rosenholtz, 1989). Secondly, we looked for images of collaboration. Most people have prior experiences with collaboration in teams or groups. These experiences determine their images of working in teams, and consequently their expectations of collaboration in a new team (Homan, 2001). These initial images of different team members should get in line with each other for effective collaboration to occur. If discrepancies between teachers' initial images of collaboration and actual collaboration occur, this may point to an unsuccessful alignment of images which might have negative consequences for learning from collaboration.

5.2.4 Group and organizational characteristics affecting collaboration in teams

As stated in the introduction, the assumption in this study was that the quality and topics of teacher collaboration in the interdisciplinary teams would be related to how teachers enacted emerging group characteristics and organizational characteristics (Dechant, et al., 1993). At the group level, group cohesion is assumed to affect effective collaboration (Evans & Jarvis, 1986; Mebane & Galassi, 2003; Pennington, 2002). At the organizational level, the school's capacity for change, and more specifically shared vision, influence on decision-making, and support for teacher professional development of the school management are assumed to be important variables (Borko, et al., 1997; Geijsel, et al., 2001; Rosenholtz, 1989).

Group characteristic

In the literature on group dynamics, *group cohesion* or *attraction to group* is considered to be related to the effectiveness of collaboration. Group cohesion can be defined as the 'glue' that holds a small group of people together or the extent to which members of the group are attracted to each other, accept and agree with the priorities and goals of the group, and contribute to achieving the goals. Cohesion is necessary for a group to be able to function (Pennington, 2002). High cohesive groups are generally more effective in achieving goals and solving problems than

low cohesive groups (Shaw, 1981). At the same time, high cohesive groups provide a positive experience for individual group members. However, the cohesion in a group can also become too high, which may lead to groupthink (group members are no longer critical; they agree too much with other group members) (Little, 2003). Cohesion is usually measured at the level of the individual group member. Measurement of this concept generally involves the levels of attraction to the group as a whole, or attraction to one another. The underlying assumption is that cohesiveness can be measured by taking the sum of individual members' levels of attraction to the group or to one another. Attraction to the group is defined as the individual members' feelings of belonging to the group, or more specifically, an individual desire to identify with and be an accepted member of the group (Evans and Jarvis, 1980).

Organizational characteristics

Effective implementation of educational innovations is assumed to be influenced by several organizational characteristics, such as teachers' participation in decision-making (Geijsel, et al., 2001). In the study by Geijsel, et al., effective implementation of educational innovations was conceptualized as the level at which teachers agree with the principles underlying the innovations and the extent to which teachers themselves indicate that their teaching practice is oriented towards the principles of the innovation. From their study it appeared that vision, participation in decision-making, and intellectual stimulation had indirect or direct impact on the implementation of educational innovations. An explicitly formulated educational *vision* can inspire teachers to implement educational innovations in their own teaching practice. It is important that teachers be involved in the creation and maintenance of a school's vision as this can stimulate teachers to develop congruently. By *participating in decision-making,* teachers can explicate their own needs and problems. Finally, teachers' perceptions and experiences of being able to rely on the *support for their professional development* has positive influence on how teachers learn and develop professionally. Summarizing, Table 5.1 provides an overview of the variables that were used in this study and how they were specified.

Table 5.1 Overview of variables

Variables		
Teacher collaboration in interdisciplinary teams	- type of collaboration	- interdependency four levels: • storytelling and scanning • aid and assistance • sharing • joint work - alignment • shared goals • images of collaboration
	- group characteristic	- group cohesion
	- organizational characteristics	- vision - influence in decision-making - support for professional development
Teacher learning in a context of collaboration in interdisciplinary teams	- what do teachers learn?	- changes in beliefs about teaching and learning
	- how do teachers learn?	- teacher workplace learning experiences

5.3 Method

5.3.1 Design

We examined collaboration and teacher learning in five interdisciplinary teams. As collaboration and teacher learning can not be considered separately from the contexts in which they take place, we adopted a comparative case study methodology (Yin, 2003). "A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and context are not clearly evident" (Yin, 2003, p. 13). In our study, collaboration and teacher learning in interdisciplinary teams took place in the context of a national educational reform; these can take on different forms in different school contexts. Several complementary data collection methods were used, both quantitative and qualitative. The various variables and corresponding instruments were analysed in the five teams. To search for patterns in variables, we additionally conducted cross-case analysis of the five teams (Miles

& Huberman, 1994). Since research on how collaboration in interdisciplinary teams fosters teacher learning is scarce, this study had an exploratory character.

5.3.2 Participants

Over a period of one school year, we examined five interdisciplinary teams, in five different schools. School principals in the western part of the Netherlands were enlisted to participate in a study on teacher learning in interdisciplinary teams aimed at collectively thinking of ways to foster active and self-regulated student learning. A total of thirty-four teachers participated in the five teams. In order to take account of the specific needs and concerns of teachers in each school, the teams were free to further specify the central topic of their collaboration. They were also free to design their collaboration, and an experienced coach assisted the teachers in establishing their collaboration in the interdisciplinary team. All five teams met at least five times during the school year that they participated in this study. Table 4.1 provides more information on the team compositions.

5.3.3 Data collection methods

In order to better understand collaboration and teacher learning in interdisciplinary teams, we used several complementary data collection methods. Below, we describe how we measured the various variables.

Teacher collaboration in interdisciplinary teams: Type of collaboration

Observations and written reports of team meetings were used to obtain information about how the teachers started up and developed the collaboration in the five interdisciplinary teams. In describing the collaboration, we focussed on two concepts: interdependency and alignment. We explored *interdependency* using the classification in types of collaboration of Little (1990) and Rosenholtz (1989), as described earlier. We examined the team meetings by looking at activities that the teams undertook, such as brainstorming, discussing, and giving feedback. We also examined the topics of the interaction, such as brainstorming about ideas for alternative teaching methods or brainstorming about explanations for a problem. For each team, we examined the activities and topics of interaction over a period of one school year in order to determine reoccurring activities and topics.

For information on *alignment,* we examined teachers' perceptions of shared goals and teachers' images of collaboration. Teachers' perceptions of both aspects were collected using open-ended questions in a questionnaire addressing their perceptions and evaluations of the collaboration in their team after a period of one school year. This questionnaire was completed by all teachers in the final meetings of all five interdisciplinary teams. Among other things, the teachers were

asked to write down their initial *images of the collaboration* in their team and to state whether the collaboration met these initial images. Also, the teachers had to indicate what in their views the *shared goals* for the collaboration in their teams were.

Teacher collaboration in interdisciplinary teams: Group characteristic
Information on *group cohesion* was collected using a Dutch translation of the Group Attitude Scale (Evans & Jarvis, 1986). The teachers responded to 20 items on a five-point Likert scale (1=disagree to 5= agree). Sample items are the following: I look forward to coming to group meetings; In spite of individual differences, a feeling of unity exists in my group; and I want to remain a member of this group.

Teacher collaboration in interdisciplinary teams: Organizational characteristics
A questionnaire on teachers' perceptions of organizational characteristics was administered at the end of the year in which we examined these teachers. The questionnaire consisted of twenty-three items which were divided over three scales. All items were to be responded to on a five-point Likert scale (1=disagree to 5= agree), and were derived from a study by Geijsel, et al., (2001) which was aimed at examining conditions that foster effective implementation of educational innovations. Table 5.2 provides a sample item from each of the three scales.

Table 5.2 Sample items from 'Organizational characteristics' questionnaire

	Sample item
Vision	*At our school we regularly discuss what we want to achieve with our teaching.*
Influence on decision-making	*At our school teachers' experiences play a part in making plans for the approach of educational innovations.*
Support for professional development	*At our school we are motivated to continuously and critically examine our teaching practice.*

Teacher learning in a context of collaboration in interdisciplinary teams
In order to obtain information on *what* teachers learned, we asked them to complete the questionnaire 'Beliefs about teaching and learning', both at the beginning and at the end of the year that they were examined. Because teachers

completed the questionnaire twice, it was possible to determine changes in their beliefs. A detailed description of the development and characteristics of the questionnaire can be found in section 3.2.2 (Table 3.1).

Teachers with strong subject-matter-oriented beliefs considered strong teacher regulation of students' learning processes to be important. They scored high on items such as 'It's important that the teacher makes sure that students know exactly how to work best on an assignment'. In contrast, teachers with strong student-oriented beliefs considered it important that students learn to regulate their own learning, and scored high on items such as 'Students learn better when they have to check learning progress themselves'. Teachers scored all 69 items of this questionnaire on a five-point scale (1= I totally disagree to 5= I totally agree).

We were also interested in *how* teachers learn when participating in interdisciplinary teams. For this purpose, the teachers were asked to report learning experiences in digital logs every six weeks. In these digital logs, the teachers reported on learning experiences they had been engaged in with respect to fostering active and self-regulated student learning. In an instruction meeting for the teachers it was explained that all learning experiences that teachers themselves consider relevant could be reported in their digital logs. For the purpose of this study, we were particularly interested in how often the teachers reported collaboration in their interdisciplinary team as the context for their learning experiences.

A pictorial representation of the total data collection for this study can be found in section 1.4 (below the research question of study 4).

5.4 Analysis

Within-case analyses

In order to examine collaboration and teacher learning in interdisciplinary teams, we first conducted within-case analyses of the data of the five teams for the various variables and corresponding data collection instruments separately. Below, we discuss how each of the instruments was analysed for the within-case analyses.

**Teacher collaboration in interdisciplinary teams*

Firstly, all team meetings were characterized by the level of *interdependency* using the classification into types of collegiality and collaboration. The first one or two meetings of all five teams were analyzed to determine how the teams explored the focus for their collaboration during the year. For example, did they reflect on current practices or their problems with fostering active and self-regulated student learning, or did they explore interdisciplinary projects for the coming school year? The findings of this part of the analysis would enable us to differentiate between

teams that succeeded in finding a shared problem or thinking up a shared project for their collaboration and teams that decided to focus their collaborative meetings on teachers' individual problems. The remainder of the meetings were analyzed to determine how teachers brainstormed or discussed new or alternative teaching methods that foster active and self-regulated student learning. For example, did they discuss ideas for alternative methods; did they provide feedback to colleagues? To assess the validity of our observations of the meetings, we used 'peer debriefing': the descriptions of the team meetings were presented to one teacher from each team in order to make sure that these descriptions were adequate. All teachers agreed with the descriptions of their team meetings. Next, for each team, we determined which type of activities occurred most often in the team meetings, and which combination of activities characterized the collaboration of each team in general.

Secondly, the collaboration in teams was further characterized with regard to *alignment* in goals and images of collaboration. In the questionnaire 'Evaluation of collaboration', all teachers had to indicate if the collaboration met their initial *images* of the collaboration. Analysis of these responses made it possible to indicate how often friction between initial images of the collaboration and the actual collaboration occurred in all five teams. Regarding *shared goals,* we examined whether the reported collective goals were similar in each team.

Thirdly, concerning group and organizational characteristics, mean scores and standard deviations on the Group Attitude Scale and the three scales of the questionnaire 'Organizational characteristics' (vision, support for professional development, and influence on decision-making) were computed for each team.

**Teacher learning in a context of collaboration in interdisciplinary teams*

To determine whether teachers changed their *beliefs about teaching and learning*, we examined whether their mean scores on the scales the second time they completed the questionnaire 'Beliefs about teaching and learning' differed significantly (p <.05) from the first time. As we were interested in individual changes in beliefs about teaching and learning, the Reliable Change Index (RCI) was used to determine significantly different scores on the eight scales for each teacher separately (Jacobson & Truax, 1991). Significantly different scores on one of the eight scales were labelled as congruent or incongruent with the underlying aims and principles of the educational reform in Dutch upper secondary education. Significantly lower scores on subject-matter-oriented beliefs, such as strong *teacher* regulation of students' learning processes, were labelled 'congruent with reform' as the reform aims at stronger *student* regulation of learning processes. Significantly higher scores on these subject matter beliefs were labelled

'incongruent with reform'. Significantly lower scores on student-oriented beliefs, such as the importance of constructing own knowledge, were considered changes in beliefs 'incongruent with the aims of the reform', as the reform aims to foster construction of knowledge by students. Significantly higher scores on the student-oriented beliefs were labelled changes in beliefs 'congruent with the aims of the reform' (cf. section 3.3).

The *learning experiences* in the digital logs were analyzed to determine their connection with the collaboration in the interdisciplinary teams. We expected that teachers who participated in effective interdisciplinary teams would more often refer to the collaboration in their teams as the context in which their learning experiences occurred compared to teachers who participated in less effective interdisciplinary teams. Based on this assumption, we coded the reported learning experiences in the digital logs according to four categories. The first category consisted of learning experiences in which teachers explicitly referred to the collaboration in the interdisciplinary team as the context in which their learning experience took place. The second category represented learning experiences in which the theme of a learning experience corresponded with the theme of collaboration in the interdisciplinary team in which a teacher participated, such as increasing student motivation. The third category included learning experiences in which teachers reported learning as a result of collaboration with colleagues outside the interdisciplinary team. Reported learning experiences that did not meet any of the aforementioned criteria formed the fourth category.

Cross-case analysis

As a first step in the cross-case analysis we combined and summarized the results of the five interdisciplinary teams on the various data collection instruments in one overview matrix (Miles & Huberman, 1994). Next, in this overview matrix we examined cross-case patterns in the scores on the various variables (type of collaboration, group and organizational characteristics, and what and how teachers learned) for the five teams (Yin, 2003). Irregularities were interpreted as caused by the specific characteristics of the teams and the schools in which the teams were situated.

5.5 Results

In the middle column of Table 5.3 we provide a brief description of the aims, themes, and activities of the meetings of the five teams. In the right column we indicate how the collaboration in the five teams was labelled according to the classification in types of collegiality in terms of the level of interdependence (Little, 1990). We distinguished between the intended type of collaboration and the actual type of

Table 5.3 Description and classification of the collaboration in the five teams

	Description of aims, themes, and activities in team meetings	**Intended and actual type of collaboration**
Team A (N=7)	The seven teachers in this team all experienced problems with fostering self-regulated learning and were particularly concerned with how to stimulate student autonomy without losing depth in students' subject-matter mastery. After one of the teachers introduced his idea for discussing test results with students in an alternative way, all other teachers agreed that this was a good method for stimulating self-regulated learning which also provided an opportunity for all teachers to approach students in a more positive way. Consequently, in the remaining team meetings, the time was spent exchanging and reflecting on alternative ways for discussing test results with students. By experimenting with different methods, the team aimed to develop a broad variety of methods that would be useful for colleagues outside this team as well.	*Intended collaboration* Joint work *Actual collaboration* Sharing: exchanging ideas and experiences aimed at shared instructional problem-solving
Team B (N=8)	The collaboration in this team of eight teachers was aimed at collectively thinking up ways to deal with the whole-school problem of the high rate of students who had to repeat the fourth grade of senior general secondary education. The team discussed ways of motivating students in tutor lessons by making them more conscious of their own learning styles and by adapting their own teaching styles to students' learning styles. Also, teachers were stimulated to experiment in their own teaching practice with teaching methods that foster active student learning. However, only two of the eight teachers in this team shared their experiences with or ideas for stimulating active student learning with the other team members.	*Intended collaboration* Joint work *Actual collaboration* Sharing: exchanging ideas and some experiences
Team C (N=4)	The teachers in this team aimed to design interdisciplinary projects for students in the second stage of secondary education. The teachers were unable to think up one general interdisciplinary project in which all subjects could participate, and decided to split up into two dyads. For one dyad it remained difficult to think up a topic for an interdisciplinary project. This dyad therefore decided to exchange individual experiences with alternative methods they had experimented with in their teaching practice. In the team meetings the teachers shared their experiences and the team collectively reflected on these experiences.	*Intended collaboration* Joint work *Actual collaboration* Sharing: exchanging ideas and experiences aimed at individual instructional problem-solving
Team D (N=8)	The teachers in this team all experienced problems with student motivation and active student learning. In the first meeting the eight teachers decided to split up into four dyads in order to make reciprocal classroom observation possible. In addition to these classroom observations the teachers shared their experiences in the central team meetings and informed the other colleagues about the relevant literature with regard to their experiences.	*Intended collaboration* Joint work *Actual collaboration* Sharing: exchanging ideas and experiences aimed at shared instructional problem solving
Team E (N=7)	In the first meeting the teachers exchanged ideas for experimentation with teaching methods aimed at stimulated active and self-regulated learning in the fourth grade of pre-university education. Each teacher was free to think up a method he/she considered relevant to his/her own teaching practice. They agreed to carry out their experiments and share their experiences in the following meetings. In two meetings the team was divided into two small teams in which the experiences of one teacher with his/her experiment were discussed in detail. The teachers used a specific method for collaborative reflection in which the other teachers first had to ask clarifying questions in order to understand what really happened during the experiment; they could then advise the teacher on what to do in future lessons.	*Intended collaboration* Joint work *Actual collaboration* Sharing: exchanging ideas and experiences aimed at shared instructional problem solving

collaboration. The intended types of collaboration were derived from the first team meetings in which the teachers explored the focus and goals of their collaboration. We further elaborate on the classifications in the within-case analyses for the five teams.

5.5.1 Within-case analyses: Collaboration and teacher learning in the five teams[14]

Team A

From Table 5.3 it can be seen that the seven teachers in this team mainly exchanged ideas for alternative teaching methods and discussed their experiences of experimentation with these alternative teaching methods. The exchange of ideas and experiences with experimentation was aimed at shared instructional problem-solving, namely, developing alternative methods for discussing test results with students. The level of interdependency in this team can be considered high, as the teachers in this team all had to contribute to the development of alternative methods for discussing test results with students in order to achieve their collective goal. The teachers evaluated their collaboration in this team in a positive manner; only one teacher in this team reported friction between his/her initial images of the collaboration and the actual collaboration in the team. The teachers in this team were, therefore, successful in aligning their images of collaboration. Additionally, the majority of the teachers reported similar goals as regards the content of their collaboration. The positive evaluation of the collaboration is also clearly reflected in the high mean score on the Group Attitude Scale (a score of 4.15 on a five-point scale), and a low variability in scores between the teachers. From the high mean score for the organizational characteristic 'support for professional development' and the above-average scores for 'vision' and 'influence on decision-making', it can be inferred that the teachers were also positive about the school in which they worked. In line with the high level of interdependency, successful alignment of goals and images of collaboration, and high positive evaluation of both the team and organizational contexts, many changes in beliefs about teaching and learning occurred in this team after the period of one year. Changes in beliefs both congruent and incongruent with the underlying ideas and principles of the reform were identified. Finally, in their reported learning experiences, the teachers in this team often referred to the collaboration in their team as the context for their experiences, either with an explicit reference (20% of the total number of learning experiences) or with a corresponding theme, such as discussing test results with students (22%).

[14] The results presented in the within-case analyses are summarized in Appendix 5.1

Team B

In the majority of meetings of team B, the eight teachers exchanged ideas aimed at shared instructional problem-solving, namely, thinking up ways to motivate students and foster active and self-regulated student learning. Only two teachers actually experimented with alternative methods aimed at increasing active student learning in their own practices and discussed their experiences with these alternative methods in the team meetings. The actual collaboration in this team can be characterized as having a low level of interdependency within the category sharing, as the teachers merely exchanged ideas for changing current teaching practices. This did not result in actual experimentation with alternative teaching methods, which was required to achieve the collective goal. The collaboration in this team was not evaluated positively by all teachers; four of the eight teachers in this team reported friction between their initial images of the collaboration and the actual collaboration. One of the teachers reported that the discussions about changing teaching practices were often too theoretical, and that she had expected to discuss and exchange ideas that would be easily implemented in daily teaching practice. The majority of the teachers reported a similar goal for the collaboration as regards the content or theme of their collaboration. The differences between teachers in their evaluations of the collaboration in the team are also clearly reflected in the high mean standard deviation on the Group Attraction Scale. Furthermore, the teachers in this team differed in their perceptions of organizational characteristics. The mean scores on these characteristics were just above average.

In line with previous results, the number of changes in beliefs about teaching and learning was rather low. Only two of the eight teachers changed their beliefs in a way that was congruent with the aims of the reform. Changes in beliefs incongruent with the aims of the reform did not occur. Finally, the teachers in this team scarcely explicitly referred to the collaboration in the team as the context for their own learning experiences with respect to 'fostering active and self-regulated learning'.

Team C

The teachers in team C mostly exchanged ideas for alternative teaching methods and discussed experiences of experimentation with alternative methods in team meetings. These exchanges of ideas and reflections on experimentation with alternative methods were mostly aimed at solving teachers' individual instructional problems. Since the sharing of ideas and experiences was aimed at individual problem-solving for the teachers in this team, the level of interdependence in this type of sharing can be regarded as low. Teachers in this team helped each other by

providing feedback on their ideas and experiences, but their teaching practice was not dependent on the actions of the other team members. For three of the four teachers participating in this team, the actual collaboration did not meet their initial expectations, and only two of the teachers reported similar goals with regard to the content of their collaboration. The teachers indicated that they had expected to work together with all teachers participating in the team, but in the end they only worked together with one other colleague. The relatively low mean score on the Group Attraction Scale appears to be in line with the unsuccessful alignment in images of collaboration and goals. A noteworthy result for this team is the relatively high scores on the questionnaire used to measure teachers' perceptions of school characteristics, and especially the high mean score on 'influence on decision-making'. This relatively high score may be explained by the type of school in which this team functioned. The school provides one type of education (college preparatory school) and is relatively small. Most teachers in this type of education were educated at a research university and consider both autonomy and shared decision-making to be important.

Despite the somewhat negative evaluations of the actual collaboration in this team, two of the four participating teachers did change their beliefs about teaching and learning congruent with the aims of the reform. From the observations of the interactions in the team meetings it became clear that during the year in which this study took place a large educational innovation project was built up, which may have resulted in the changes in the teachers' beliefs. The results for the reported learning experiences are, nevertheless, more in line with the negative evaluations of the collaboration in this team. Only 8% of the reported learning experiences referred to the collaboration with colleagues in this team.

Team D

The collaboration in team D can be described on two levels: the collaboration with the dyad partner and the collaboration with the whole interdisciplinary team. In the dyads, the teachers exchanged ideas and discussed experiences of experimentation with alternative teaching methods. They also observed each other and collectively reflected on their ideas and experiences. The collaboration in both the whole team and in the dyads was aimed at shared instructional problem-solving, namely, thinking up ways to increase student motivation. Regarding the collaboration in the whole team, the teachers discussed their experiences of experimentation with teaching methods aimed at increasing student motivation developed in the dyads. The level of interdependency in the meetings of the whole team can be considered lower than the level of interdependency in the collaboration in the dyads. In the dyads, teachers agreed to observe experiments in

the dyad partner's teaching practice and give immediate feedback. In the team meetings, experiences were merely exchanged and discussed. The teachers' contributions in the dyads can be regarded as more important than the contributions made in the whole team meetings to achieve the goal of thinking up ways to increase student motivation. The actual collaboration in the whole team was evaluated negatively. Almost all teachers reported (partial) friction between their initial images of collaboration and actual collaboration. Teachers' evaluations of the collaboration in the dyads were positive. As the teachers in this team did not plan in advance to work together in dyads, it was not possible to determine friction between initial images of collaboration in dyads and actual collaboration in dyads. The alignment in goals for the whole team can be regarded as more successful. The majority of the teachers in the team reported similar goals as regards the content of their collaboration. In addition, five of the eight teachers reported 'learning from colleagues' as a collective goal for the collaboration in their team. The high number of reported frictions between initial images of collaboration and actual collaboration is also reflected in a relatively low mean score on the Group Attraction Scale. Similar to their evaluation of the collaboration in the whole team, the teachers evaluated organizational characteristics of the school in which they worked quite negatively. Their mean scores on all three scales, 'vision', 'influence in decision-making', and 'support for professional development', were just above average.

Despite the negative evaluation of the actual collaboration in the whole team, five of the eight participating teachers in this team changed their beliefs in a way congruent with the aims of the reform. This result can be related to the positive evaluations of the actual collaboration with the dyad partners. Finally, in their digital logs, the teachers of this team often referred to the collaboration, either making an explicit reference or mentioning a corresponding theme, as the context for their learning experiences. Also, they often referred to collaboration with colleagues outside their team as a context for their learning experiences.

Team E

The collaboration in this team was characterized by the exchange of ideas and discussion of experiences of trying different teaching methods aimed at fostering active and self-regulated student learning in teachers' individual teaching practices. Additionally, in two meetings, the teachers in this team used a specific method for collaborative reflection on and discussion of their ideas and experiences of experimentation with alternative teaching methods. The collaboration in this team can be classified as having a high level of interdependency as the teachers in this team were all equally responsible for successfully fostering active and self-regulated

learning within a specific grade of pre-university education. Teachers from this team did not report any friction between their initial images of the collaboration and the actual collaboration in their team, and the majority of the teachers in the team reported similar goals with regard to the content of their collaboration. The high level of interdependency and the successful alignment can be seen in the relatively high mean score on the Group Attraction Scale (4.22 on a five-point scale). Also, the teachers in this team perceived the school organization in which they worked positively.

In addition to these positive evaluations of both the collaboration in the team and the school organization, many changes in the teachers' beliefs about teaching and learning were congruent with the aims of the reform after a period of one year. Also, teachers often explicitly referred to the collaboration in the team they participated in as the context for their learning experiences.

5.5.2 Cross-case analysis: Patterns in collaboration and teacher learning in the five teams

Appendix 5.1 corresponds to the overview matrix that was created to examine cross-case patterns in the results of the five interdisciplinary teams for the various variables.

From part I of this overview matrix it can be seen that in all five teams the actual collaboration could be labelled as 'sharing', but we found differences in what exactly took place during the collaboration labelled 'sharing'. To differentiate the collaboration in the five teams, we divided this category into two subcategories. The teams differed with respect to the content and aim of sharing. In some teams, the content sharing was limited to *communicating ideas* for alternative methods. In other teams, *experiences* of experimenting with these alternative teaching methods *were discussed*, in connection with communicating these ideas. Moreover, in some teams, the aim was to solve the *problems of individual teachers*. In other teams, the aim was to solve instructional problems that were identified as *shared problems*.

When this differentiation in types of sharing was combined with the results of the other data collection instruments presented in Appendix 5.1, two patterns in the scores on the variables collaboration and teacher learning in interdisciplinary teams were discerned. Table 5.4 summarizes these two patterns.

Table 5.4 Patterns in scores on the variables collaboration and teacher learning in interdisciplinary teams

Variables	Pattern 1	Pattern 2
* Interdependency:		
Content of sharing		
- communicating ideas	+	+
- discussing experiences of experimentation	+	+/-
Aim of sharing		
- individual problem-solving	-	+
- collective problem-solving	+	+/-
* Alignment in:		
- goals	+	+/-
- images of collaboration	+	-
* Group cohesion	+	+/-
* Organizational characteristics	+	+/-
* Changes in beliefs	+	+/-
* Learning experiences related to collaboration	+	-

The first pattern in scores on the variables collaboration and teacher learning in interdisciplinary teams was found in team A and team E. In both teams, the collaboration could be characterized as sharing ideas and discussing experiences of experimentation with alternative teaching methods. The collaboration was aimed at shared instructional problem-solving: developing alternative methods aimed at discussing test results with students and fostering active and self-regulated student learning. In general, teachers from both teams evaluated this way of collaboration in their interdisciplinary team positively. With the exception of one teacher, nobody reported friction between initial images of collaboration and actual collaboration. Also, the mean Group Attraction Scale scores were high compared to those of the other three teams, and the teachers reported similar goals for the collaboration as regards the content. In line with this positive evaluation of the collaboration in their teams, teachers from both teams were also positive about their school organization. In view of what and how teachers learned in these two teams, it is clear that in both teams the frequency of changed beliefs about teaching

and learning congruent with the aims of the reform was relatively high. In both teams also, however, more than one teacher changed his or her beliefs in a way incongruent with the aims of the educational reform. Finally, in both teams, the teachers often referred in their digital logs to the collaboration in their teams as the context for their learning experiences.

A second pattern in scores on the variables collaboration and teacher learning in interdisciplinary teams was found in teams B and C. In these teams, the collaboration did not, like in the other three teams, consist of exchanging ideas and experiences with experimentation aimed at shared instructional problem-solving. In team B, the collaboration could be characterized as exchanging ideas for alternative methods aimed at shared instructional problem-solving. The collaboration in team C was aimed at individual problem-solving. Teachers from both teams often reported friction between their initial images of collaboration and the actual collaboration in their team. Also, their scores on the Group Attraction Scale were relatively low (team C) or showed great variety between teachers in the team (team B). Compared to the other three teams, teachers from teams B and C reported fewer similar collective goals. Teachers from teams B and C differed in their perceptions of their school organization; teachers from team B were relatively negative about their school organization and were also quite diverse in their perceptions. Teachers from team C did not evaluate the collaboration in their team positively, but were in fact positive about their participation in school decision-making. This result can be explained by the type of school in which this team functioned, a college preparatory school. In the Netherlands, this type of school is often much smaller than the combined schools in which the other four teams functioned. It is to be expected that in small schools for secondary education teaching staff are more involved in school-based decision-making. With respect to teacher learning in both teams, it appears that teachers from neither team referred to the collaboration in their teams as a context for their learning experiences in their digital logs as much as did teachers from the other three teams. The two teams, however, differ in the number of changed beliefs about teaching and learning. In team B, only two of the eight participating teachers changed their beliefs, whereas in team C two of the four participating teachers changed their beliefs in a way congruent with the aims of the reform.

The results for the various variables measured for team D demonstrate a somewhat inconsistent pattern. In line with the characterization of the collaboration in teams A and E, the collaboration in team D also consisted of sharing ideas and discussing experiences of experimentation with alternative methods aimed at shared instructional problem-solving. They also often reported similar goals with regard to the content of collaboration: increasing student

motivation. However, like the teachers in teams B and C, much friction between initial images of collaboration and actual collaboration was reported. Unequal input of participants and too much discussion instead of brainstorming were reported as reasons for this friction. Also, their perceptions of the school organization were negative. The teachers in this team were positive about the collaboration with their dyad partners during the school year. Brainstorming about ideas for alternative teaching methods and receiving feedback after lessons observed by the dyad partner were perceived as motivating and inspiring. Regarding teacher learning in this team, the results are again in line with the results of teams A and E. The teachers often referred to the collaboration in their digital logs. However, these references to the collaboration were more based on corresponding themes rather than on explicit references. In addition they often referred to collaboration with other colleagues in their digital logs. Also, many changes in beliefs about teaching and learning congruent with the aims of the reform occurred in team D.

5.6 Conclusions and discussion

In this study, we aimed to examine collaboration and teacher learning in interdisciplinary teams. We formulated the following research question: How do teachers collaborate in interdisciplinary teams and how does this relate to teacher learning with respect to the topic 'active and self-regulated student learning'?

The conclusion drawn with regard to the first part of the research question is that the collaboration in all five teams was aimed at joint work in optimizing the implementation of one of the aims of the educational reform in Dutch upper secondary education: fostering active and self-regulated student learning. Secondly, although all teams aimed at joint work at the start of their collaboration, the actual collaboration in the teams could be characterized using the category 'sharing', more specifically, sharing instructional materials and ideas (Rosenholtz, 1989). In order to differentiate between the collaboration in the five teams, refinements were made in this category. Based on the results, we concluded that the category 'sharing' could be specified with regard to two aspects, each containing two subcategories: 1) sharing in the content of exchanges (*exchanging ideas* for alternative teaching methods and *exchanging and discussing experiences of experimentation* with alternative teaching methods, and 2) sharing in the problems that were identified (identifying and solving *shared* or *individual* instructional problems). Collaboration in teams that consisted of exchanging both ideas and experiences of experimentation, and which was aimed at shared problem-solving, had a higher level of interdependency than collaboration that consisted of exchanging ideas for alternative methods or which was aimed at individual

problem-solving. Alignment in images of collaboration and goals for collaboration, and the level of group cohesion, could be related to the level of interdependency. Teams with a high level of interdependency often met teachers' initial expectations of the collaboration; teachers in these teams often reported a similar goal for the collaboration; and the level of group cohesion was high. Collaboration in teams with a lower level of interdependency did not meet teachers' initial images; the teachers in these teams reported dissimilar goals for the collaboration; and these teams had an average level of group cohesion. The organizational characteristics were not related to the level of interdependency, alignment, and level of group cohesion of the five teams. Teams with a high level of interdependency, successful alignment in goals and images, and a high level of group cohesion did not always evaluate their school organizations in a positive manner. Teams with a lower level of interdependency and in which teachers evaluated the collaboration in a more negative manner did not necessarily evaluate characteristics of their schools negatively. This finding may be explained by differences in the type of education provided in the schools.

The first conclusion with regard to the second part of the research question, how collaboration is related to teacher learning, is that the teams differed considerably in learning effects. In three of the five teams, many changes in beliefs about teaching and learning congruent with the underlying ideas and principles of the reform were found. Also, the teachers in these three teams often referred to the collaboration in their teams as a context for their learning experiences. In the other two teams, the teachers referred less frequently to collaboration in their team as the context for their learning experiences. In one of these two teams, the number of changes in beliefs was also low, whereas in the other teams two of the four teachers changed their beliefs.

The second conclusion with regard to the second question is that in the relationship between collaboration and teacher learning, the distinctions between subcategories of sharing appeared to be particularly important. Teams appeared to be effective in which teachers exchanged ideas for alternative teaching methods and discussed experimentation on these alternative methods, and in which teachers started from shared problem identification. In these teams the teachers succeeded in aligning their goals for the collaboration, and the number of teachers who changed their beliefs about teaching and learning in a way congruent with the aims of the reform was relatively high. Teachers' involvement in the collaboration in these teams could be regarded as high as they exchanged reports of their problems in practice and experimentation on alternative methods with their colleagues and were open to discuss these problems and experiences with colleagues. Teams that merely exchanged experiences of experimenting or instructional methods, and that

started from problems only identified by individual teachers did not succeed in aligning their goals for collaboration, and appeared to be less effective in terms of changes in beliefs about teaching and learning.

We argued above that for a successful implementation of educational reforms it is important that teachers endorse the underlying ideas and principles of these reforms. The conclusions of this study are in line with the assumption that interdisciplinary teams are a favorable condition in the implementation of educational innovations. Collaboration in terms of sharing allows teachers to make their teaching practices accessible to other teachers, and it can stimulate discussions of the curriculum. Acquaintance with the knowledge and skills of teachers with different discipline backgrounds is assumed to foster teachers' professional development (e.g., Johnson, 2003; Putnam & Borko, 2000) and may result in changes in teachers' beliefs about teaching and learning. In this study it was found that after the period of one year in which the teachers participated in interdisciplinary teams some teachers changed their beliefs in a way congruent with the aims of the reform.

The relation between collaboration and teacher learning became clearer following differentiation of types of sharing. This differentiation in the category 'sharing' was in line with our earlier-mentioned idea that the four types of collaboration should be viewed as parts of the dimension of interdependency and not as fixed points. Sharing was, therefore, considered part of the dimension for which subtypes could be discerned. This distinction in types of sharing can to some extent be compared with the distinction between cooperation and collaboration discussed in the conceptual background section of this article (Hord, 1986; Imants, 2003). In all five teams, teacher learning was supposed to take place along the innovative dimension (Hammerness, et al., 2005). The central aim was improvement and teacher professional development, which can be characterized as collaboration (Imants, 2003). Efficient division of tasks did not apply to the interdisciplinary teams in this study. This distinction between cooperation and collaboration of Hord (1986) corresponds well to the division in subcategories of sharing made in this study. The teams in which teachers exchanged ideas for and experiences of experimentation with alternative methods, and aimed at shared instructional problem-solving, which implies a high level of interdependency, correspond mostly to the description of collaboration. Note, however, that although the teachers had a shared problem, they were still free to decide whether to implement a new or alternative method, which limited their interdependency. The teams in which teachers mostly shared ideas and experiences aimed at individual problem-solving can be characterized as cooperative teams.

The central focus of the interdisciplinary teams in this study also partly corresponds to the findings of Crow and Pounder (2000), who concluded that interdisciplinary teacher teams mainly focus on dealing cooperatively with daily problems with student behavior and learning. Although all teams in our study discussed problems with students' behavior and learning, these teams could be divided into teams that used shared means to reach individual ends, and teams that developed shared ends. Some of the teams went one step further in choosing a specific topic or theme to deal with by exchanging ideas for and experiences with experimentation for a period of one year. This type of collaboration stimulated teachers to be open and less defensive about their own individual teaching practices, and consequently to learn from colleagues' feedback, and additionally also to learn by becoming acquainted with colleagues' experiences and difficulties with certain teaching methods. Most teachers in secondary education, however, work together with colleagues in the same subject matter department. In subject-matter departments, instructional problems and teacher development items are hardly discussed (Witziers, et al., 1999). Collaboration in interdisciplinary teams that consists of exchanging both ideas and experiences of experimentation, and which is aimed at collective problem-solving, may therefore be regarded as a promising direction for initiatives aimed at teacher professional development with respect to educational innovations.

In closing, we discuss some limitations of this study and make some suggestions for future research on collaboration and teacher learning in interdisciplinary teams. In this study, the five teams were followed for a period of one year, which can be considered a rather short period for teachers to start up and develop effective collaboration, especially with regard to the alignment of goals and initial images of collaboration. Only two of the five teams succeeded in aligning their goals and images of collaboration. Therefore, it would be worthwhile to investigate such teams over a longer period of time in order to explore the effects on teacher learning on the long term. Investigation of teacher collaboration in teams over a longer period of time would also make it possible to examine perceived goals and images of collaboration several times during a period. This would provide information on the process of aligning goals and images of collaboration, which can be regarded as a type of team learning. In this study, however, we focussed on individual teacher learning in a context of collaboration by examining changes in individual teachers' beliefs about teaching and learning. Teachers' beliefs about teaching and learning were measured at a general level in order to compare the results found for the teachers of the five teams. For future research it would be interesting to focus not only on changes in teachers' general beliefs, but also on teachers' beliefs about more specific themes, such as student

motivation. Furthermore, with regard to examining team learning, it would also be interesting to examine if and how teachers develop a shared view on how to foster active and self-regulated student learning during a period in which they collaborate in interdisciplinary teams. Exploring what teachers learn as a team constitutes a promising direction for future research on teacher learning in interdisciplinary teams.

Appendix 5.1 Matrix of results for type of collaboration, group and organizational characteristics, and teacher learning

VARIABLES	Team A (N=7)	Team B (N=8)	Team C (N=4)	Team D (N=8)	Team E (N=7)
Part I Collaboration					
Level of interdependency	*Intended type of collaboration:* Joint work	*Intended type of collaboration:* Joint work	*Intended type of collaboration:* Joint work	*Intended type of collaboration:* Joint work	*Intended type of collaboration:* Joint work
	Actual type of collaboration: Sharing: exchanging ideas and experiences aimed at shared instructional problem-solving	*Actual type of collaboration:* Sharing: exchanging ideas and some experiences	*Actual type of collaboration:* Sharing: exchanging ideas and experiences aimed at individual instructional problem-solving	*Actual type of collaboration:* Sharing: exchanging ideas and experiences aimed at shared instructional problem-solving	*Actual type of collaboration:* Sharing: exchanging ideas and experiences aimed at shared instructional problem-solving
Alignment: Number of teachers with shared goals with regard to	- Content 6 - Learning from colleagues 2	- Content 6 - Learning from colleagues 0	- Content 2 - Learning from colleagues 0	- Content 7 - Learning from colleagues 5	- Content 5 - Learning from colleagues 2
Alignment: Friction between initial images of collaboration and actual collaboration	Yes → 0 teachers No → 6 teachers Partially → 1 teacher	Yes → 4 teachers No → 5 teachers Partially → 0 teachers	Yes → 3 teachers No → 1 teacher Partially →0 teachers	Yes → 4 teachers No → 0 teachers Partially → 4 teachers	Yes → 0 teachers No → 7 teachers Partially →0 teachers
Part II Group characteristic					
Group cohesion	Mean score 4.15 Std. deviation 0.22	Mean score 4.07 Std. deviation 0.64	Mean score 3.88 Std. deviation 0.43	Mean score 3.63 Std. deviation 0.53	Mean score 4.24 Std. deviation 0.33
Part III Organizational characteristics					
Shared vision	Mean score 3.71 Std. Deviation 0.46	Mean score 3.30 Std. deviation 1.04	Mean score 3.83 Std. deviation 0.84	Mean score 3.29 Std. deviation 0.48	Mean score 3.81 Std. deviation 0.57
Influence on decision-making	Mean score 3.61 Std. deviation 0.21	Mean score 3.39 Std. deviation 0.91	Mean score 4.06 Std. deviation 0.26	Mean score 3.11 Std. deviation 0.75	Mean score 3.50 Std. deviation 0.66
Support for professional development	Mean score 4.41 Std. deviation 0.63	Mean score 3.04 Std. deviation 1.23	Mean score 3.92 Std. deviation 0.71	Mean score 3.13 Std. deviation 0.54	Mean score 3.94 Std. deviation 0.57

Appendix 5.1 *(continued)*

	Team A (N=7)	**Team B** (N=8)	**Team C** (N=4)	**Team D** (N=8)	**Team E** (N=7)
Part IV Teacher learning					
Changed beliefs about teaching and learning	- Frequency of changed beliefs *congruent* with aims of reform: 4 - Frequency of changed beliefs *incongruent* with aims of reform: 3	- Frequency of changed beliefs *congruent* with aims of reform: 2 - Frequency of changed beliefs *incongruent* with aims of reform: 1	- Frequency of changed beliefs *congruent* with aims of reform: 2 - Frequency of changed beliefs *incongruent* with aims of reform: 1	- Frequency of changed beliefs *congruent* with aims of reform: 5 - Frequency of changed beliefs *incongruent* with aims of reform: 1	- Frequency of changed beliefs *congruent* with aims of reform: 7 - Frequency of changed beliefs *incongruent* with aims of reform: 2
Reported learning experiences in digital logs	Total number of reported learning experiences: 41	Total number of reported learning experiences: 51	Total number of reported learning experiences: 24	Total number of reported learning experiences: 43	Total number of reported learning experiences: 33
	Percentage of reported learning experiences in: - category 1*: 20% - category 2: 22% - category 3: 24% - category 4: 34%	Percentage of reported learning experiences in: - category 1: 10% - category 2: 16% - category 3: 24% - category 4: 51%	Percentage of reported learning experiences in: - category 1: 8% - category 2: 0% - category 3: 24% - category 4: 68%	Percentage of reported learning experiences in: - category 1: 14% - category 2: 19% - category 3: 33% - category 4: 34%	Percentage of reported learning experiences in: - category 1: 45% - category 2: 9% - category 3: 12% - category 4: 33%

*) Category 1= learning experiences with explicit reference to collaborative group; Category 2= learning experiences in which the theme corresponded with theme of collaborative group; Category 3= learning experiences as a result of collaboration with colleagues outside the group; Category 4= remaining learning experiences

Chapter 6

Ann, digital log number 1

My first learning experience started off during our first team meeting. Just before the meeting I had marked a test of one of my classes who had got really low grades. [...] Something had to change in that class. My first thought was: the students don't learn, they underestimate the subject matter. [...] My goal was to control students' homework very strictly in future and to confront them with the fact that they did not study well since I could point out in their textbooks and assignments exactly where they could have found the corrects answers to the test questions. [...] During the meeting I realized that it would be worthwhile to examine first why students caught on to the subject matter so badly, because it is a rather quick conclusion to say that they just do not work hard enough. [...] In this meeting, colleagues often mentioned motivation and positive feedback as the key to activate students' learning. I realized that this was the problem in my own teaching practice. I formed the intention to control homework but mainly to compliment students in order to improve the atmosphere and work climate. So far, I do not have new grades to prove that this approach is working, but the atmosphere has improved and I notice that students are indeed more motivated when they receive a compliment. Actually, I knew this for years, but the consultation with colleagues has opened my eyes and stimulated me to use this knowledge in my teaching practice.

Iris, digital log number 3

I went to Eric in his class as I had a question. It was so much fun that I decided to stay (just by coincidence, I had a free hour). [...] The students had to individually show Eric what they had done for the drawing teacher. When a student had not done the work, it was immediately agreed that it had to be done by the next class. This was done with a joke, but thereafter order and clarity and he wants immediate explanation from the students. The students who did do the work were asked to explain what the assignment entailed and how they interpreted it. The rest of the class watches and discusses as well. [...] Good atmosphere, involvement, and clarity. I left the classroom with the idea that I should have attention for every student, good or bad but in a positive manner, because then you can do almost anything. My learning experience is that you can confront students with their failures and also compliment them with their product as long as you do that with humor and clarity. And the students learn from each other: how things should be done and what is expected of them.

Jeff, digital log number 6

Three weeks ago, we were in an Education Group meeting to prepare the first study afternoon. [...] One of my colleagues introduced the concept 'visible learning' that requires a high level of action for both the teacher and the students during a lesson. [...] In a short enumeration of possible teaching methods for 'visible learning,' my colleague mentioned the 'half-time conversation'. The teacher asks small groups of students to briefly talk with him or her about what has been done during the past few lessons. The students can learn from each other in such a manner and are, of course, forced to put aspects of the subject matter into words. [...] In the two weeks following this preparatory meeting, I used the half-time conversations in four lessons and they really worked! Of course, you have to ask the right questions. [...] A pleasant side effect is that you can pay more personal attention to the students in a serious environment.

Susan, digital log number 1

This year I wasn't very pleased with my own method of controlling students' homework. I want students to do their homework as asked, but I don't want to use punishment exercises. I would rather motivate them to do their homework in a different manner. In the second term of this school year, I started off with a different method. I got the idea by visiting schools in France and observing a teacher at one school. This teacher pulled out a number out of a bag at the start of each lesson and asked the student whose number on the student list corresponded to this number, to write his or her homework on the blackboard. [...] I don't control students' homework anymore, but I let chance decide which student has to write down his or her answer to a homework assignment on the blackboard. [...] Students think it is important to have their homework in order when it

Chapter 6
General conclusions and discussion

6.1 Short overview of the research project

In this research project we aimed to examine teacher learning in a context of collaboration in interdisciplinary teams. In recent years, teachers in Dutch secondary education have been confronted with the implementation of an educational reform which, among other things, aims at fostering active and self-regulated student learning. For most experienced teachers, this reform requires changes in their ways of thinking about teaching and student learning and in their teaching behavior. On a more general note, present knowledge-based society requires professionals to pay constant attention to self-improvement. As a result of these developments, teacher professional development has become an important topic in research and the literature on teaching and teacher education.

Initiatives both in and outside teachers' work context have been organized to support teacher professional development. An example of an initiative aiming at stimulating professional development in teachers' daily practice is teacher collaboration in teams. Teachers themselves mention collaboration with colleagues as a powerful way of learning (Kwakman, 1999; Lohman, 2005). Several authors suggest drawing a distinction between cooperation, which is aimed at the efficient division of tasks, and collaboration, which is a type of working together mainly focused on improvement and professional development (Hord, 1986; Imants, 2003). Teachers in Dutch secondary education often work together with colleagues in their subject-matter departments, which often can be characterized as cooperation, as it consists of the efficient division of tasks. Interdisciplinary collaboration of Dutch secondary school teachers does not occur often (Van Wessum, 1997; Witziers, et al., 1999). As a result of the implemented educational reforms, however, teachers are stimulated to collaborate more often with colleagues from different subject-matter departments. It is assumed that teachers can support and stimulate one another when implementing a new pedagogical approach in their practice. Also, they can become acquainted with more ideas and teaching methods than when collaborating with colleagues with a similar subject-matter background. Another aim of the implemented reform is to stimulate students to make connections between the knowledge and skills they have learned in different subjects. Consequently, teachers who teach different subjects are stimulated to collaboratively develop assignments and projects which motivate students to make these connections.

Although interdisciplinary collaboration is emphasized in Dutch secondary education, little is known about the ways in which teachers start up and develop collaboration in interdisciplinary teams, and what and how teachers learn in such a context. In this thesis, four studies were described which were all aimed at gaining a more comprehensive understanding of how teachers learn in a context of collaboration in interdisciplinary teams. Five interdisciplinary teams in five different schools were examined for a period of one year. In total, thirty-four teachers participated in this study. The five interdisciplinary teams worked together on a topic related to 'fostering active and self-regulated student learning'.

Firstly, we collected data on *what* the teachers learned, mainly by examining changes in beliefs about teaching and learning. Secondly, we examined *how* teachers learned by asking the teachers to map learning activities they had been engaged in with respect to the topic 'fostering active and self-regulated learning'. We also examined teachers' preferences concerning their own ways of learning, if and how these preferences changed in a period of one year, and how this related to teachers' actual learning experiences. Finally, we examined how teachers' changes in beliefs about teaching and learning and their learning experiences related to the team environment, and more specifically how teacher learning was related to the type of collaboration in the team.

In the remainder of this chapter we first summarize the main findings drawn for the four research questions described in the first chapter (section 1.2). Next, the limitations of this study are discussed. In closing, we discuss the implications of this study for future research on teacher learning in the workplace in general, and more specifically for research on teacher learning in a context of collaboration in interdisciplinary teams.

6.2 Main findings with regard to the research questions

6.2.1 Research question 1: What learning activities do teachers undertake in collaboration in interdisciplinary teams and what do they report to learn from it during a period of one year?

To answer this research question we analyzed the in-depth interviews held with one or two teachers from each team after each team meeting. In addition, the teachers' digital logs in which they explicitly referred to the collaboration in the team were analyzed.

From the qualitative analysis of the data it was firstly concluded that the general classification of learning activities we used in this study needed to be specified in more detail for teacher learning activities in a context of collaboration in interdisciplinary teams. This general classification of teacher learning activities

initially consisted of five categories: doing, experimenting, reflecting on experiences, learning from others without interaction, and learning from others in interaction (Bakkenes, et al., 2004). Learning activities belonging to the category 'doing' were not found in the data. The category 'experimenting' was further divided into four sorts of experimenting. These four sorts differed with respect to the amount of a teacher's own contribution to a teaching method. Experimenting with a copied method was placed at the one extreme and experimenting with a self-invented method at the other. The category 'reflecting' was specified as reflecting on exchanged teaching methods, reflecting on or becoming aware of own teaching practice, and reflecting on processes that take place during the team meetings. Three types of activities were found that fitted the general category 'learning from others without interaction': 1) observing, 2) listening, and 3) reading. The general category 'learning from others in interaction' was further specified as brainstorming, discussing, exchanging (experiences with) teaching methods, asking questions, and receiving feedback.

Secondly, from the analysis of the reported learning activities in both the interviews and the digital logs, it was concluded that learning outcomes mainly resulted from *sequences* of learning activities teachers had been engaged in. In previous studies, teacher learning was often described in terms of single learning activities. A closer examination of the reported sequences of learning activities in connection with reported learning outcomes resulted in a list of seven configurations. The label 'configuration' was used to indicate that sequences of activities and changes in cognition or behavior, or both, are related, and to show how they are related. In six out of the seven configurations, the learning activity 'getting acquainted with alternative teaching methods' was reported as the starting activity for the learning experience. In only one of these six configurations did acquaintance with alternative methods result in experimenting with these methods in one's own teaching practice. In the other five configurations it resulted in an intention to use a method in one's own practice, or in a new idea about student learning or teaching. Also, many teachers reported that by listening to colleagues' experiences with alternative methods they could validate or confirm the use of their own newly acquired teaching methods (cf. Shank, 2006).

Based on these seven configurations, we firstly concluded that changes in cognition were reported much more often than changes in behavior. Several possible explanations for this finding were discussed. We argued that teachers did not experiment with alternative methods they had become acquainted with as a result of the year plans they have to follow. Some teachers formulated a wish to postpone experimenting with an alternative method as they had just finished work on a subject for which the method would be most appropriate. Another explanation

for the low frequency of changes in behavior might be found in the methodology used in this study. We relied on *reported* changes in cognition or behavior, or both, and did not use, for example, observations in classrooms. It is possible that the teachers were not aware of the changes they had put into practice. On the other hand, it is also possible that the teachers reported changes in behavior which did not take place in practice, as differences can exist between what teachers say they do and what they actually do (cf. Mathijsen, 2006). Another explanation is that the period in which we examined these teachers might have been too short for changes in behavior to occur (Guskey, 2002). A second conclusion to be drawn from the seven configurations is that teachers often reported that as a result of becoming acquainted with alternative methods they were able to validate or confirm their own newly acquired teaching methods. We explained the high frequency in which this learning outcome was reported in the interviews or digital logs by the reform context in which the teachers worked. In a reform context teachers are expected to change their teaching practices and use new or alternative teaching methods, which might result in feelings of insecurity and uncertainty (Hammerness, et al., 2005). In this light, teachers' searching for confirmation or validation for newly acquired methods is not surprising. It can be considered useful as confirmation might provide teachers with the confidence to try new teaching methods and assignments in their teaching practices in the future.

6.2.2 Research question 2: How are learning activities that teachers undertake in a context of collaboration in interdisciplinary teams related to changes in their beliefs with respect to the topic 'active and self-regulated student learning' during a period of one year?

All thirty-four teachers completed a questionnaire on their subject-matter-oriented and student-oriented beliefs about teaching and learning twice with an intermediate period of one year. In the intermediate period, the teachers reported on learning activities they had been engaged in, which did not necessarily have to be related to the collaboration in the interdisciplinary teams.

For each teacher separately we determined whether their scores on the subject-matter-oriented or student-oriented belief scales between the first and second measurement occasions differed significantly. Next, significantly different scores were labeled as congruent or incongruent with the underlying aims and principles of the educational reform in Dutch upper secondary education. From the results of analysis of the teachers' scores on the questionnaire addressing their beliefs, it was firstly concluded that twenty-one teachers in this study changed their beliefs, as they were found to produce significantly different scores on one or more of the subject-matter-oriented or student-oriented belief scales the second time

they filled in the questionnaire. Changes both congruent and incongruent with the underlying principles and aims of the educational reform were found. Thirteen teachers did not change their subject-matter-oriented and student-oriented beliefs about teaching and learning after a period of one year.

To contribute to our knowledge of why the beliefs about teaching and learning of some teachers change but not those of other teachers, we analyzed the teachers' reported learning activities in their digital logs. We analyzed the reported learning experiences in the digital logs qualitatively by searching for general patterns in the reported learning activities. The analysis of the total of 204 reported learning experiences resulted in a list of fifteen general sequences of learning activities. In five of these sequences, colleagues were involved in the reported learning activities. Colleagues' involvement often consisted of exchanging (experiences with) teaching methods, which resulted in the teacher becoming acquainted with alternative methods. Asking colleagues for feedback on own (difficulties with) teaching methods and collectively thinking up new teaching methods were also reported as meaningful learning activities, but less frequently. The other ten sequences were characterized as individual learning experiences, mostly occurring during actual teaching practice. These experiences were broadly divided into experiences in which teachers intentionally experimented with alternative teaching methods and experiences in which teachers learned in a more spontaneous, unintentional way, for example, by being confronted with unexpected student behavior.

We explored relations between learning activities and changes of beliefs by calculating and comparing the relative frequencies of the fifteen sequences of learning activities reported in the digital logs of those teachers with 1) a change of student-oriented beliefs congruent with the aims of the reform, 2) no change of student-oriented beliefs, or 3) a change of student-oriented beliefs incongruent with the aims of the reform.

From the comparison of the relative frequencies of reported sequences of activities for the three groups of teachers (changes of student-oriented beliefs congruent with the aims of the reform, changes of student-oriented beliefs incongruent with the reform, or no change of student oriented beliefs), three conclusions were drawn. *Firstly*, changes of student-oriented beliefs congruent with the aims of the reform appeared to be related to learning experiences that involved experimentation (or an intention to experiment) with alternative teaching methods which teachers discovered through interaction with colleagues in a professional development setting. *Secondly*, changes of student-oriented beliefs incongruent with the aims of the reform were found to be related to reported learning experiences in which teachers experimented with alternative teaching

methods owing to individual dissatisfaction with the students' level of knowledge, skills, or attitudes, or the effectiveness of the methods otherwise used. *Thirdly*, unchanged student-oriented beliefs after a period of one year were found to be related to learning experiences in which teachers reported having learned through observation of students during an assignment that was part of the standard curriculum.

These three conclusions were further specified through a closer examination of the nature and topics of the reported learning experiences and teachers' initial subject-matter-oriented and student-oriented beliefs (see Chapter 3 for a detailed description of these specifications).

6.2.3 Research question 3: How are learning activities that teachers undertake in a context of collaboration in interdisciplinary teams related to changes in their preferences for learning activities during a period of one year?

All thirty-four teachers completed a questionnaire on their preferences for learning activities twice with an intermediate period of one year. In this questionnaire, the teachers were confronted with eight descriptions of particularly challenging or problematic tasks or situations that are likely to occur in the workplace and might result in teacher learning. For each task or situation, the teachers had to indicate the likelihood of their choosing one of the five response options: a) asking colleagues for advice, b) critical individual reflection, c) trusting own intuition and feelings, d) gathering information from the internet, books, et cetera, and e) trying different things and seeing where they go.

Following inspection of the teachers' mean scores at both measurement occasions it was firstly concluded that, on both occasions, teachers prefer to critically reflect individually in order to think up an appropriate approach (i.e., they almost always do this). Teachers also indicated that in challenging or problematic situations they often trust their own intuition and feelings, or ask colleagues for advice. On both measurement occasions, the teachers indicated that they would choose the activities 'gathering information from the internet, books, et cetera' and 'trying different things' only sometimes.

Secondly, for each teacher separately, we determined whether their scores on the five learning activities between the first and second measurement occasions differed significantly. It was found that eleven teachers significantly changed their scores for the learning activity 'critical individual reflection', and sixteen teachers changed their scores for the learning activity 'trying different things and seeing where they go'. Only one teacher was found to increase his preference for the learning activity 'asking colleagues for advice'. Overall, the majority of the teachers did not change their preferences for learning activities. However, as some teachers

did have significantly different scores for one of the five learning activities after a period of one year, we concluded that preferences for learning activities should not be considered an unchangeable trait of teachers. This conclusion is in line with the literature on students' preferences for ways of learning, in which learning styles are assumed to be relatively stable across time but not absolutely unchangeable (Vermunt, 1998).

In order to contribute to our understanding of why some teachers changed their preferences after a period of one year while others maintained their preferences, we examined teachers' actual learning experiences as reported by the teachers in their digital logs in the period between first and second measurements of teachers' preferences for learning activities. From the analysis of the digital logs it appeared that the ways in which teachers reported in their digital logs about learning activities differed markedly at some points from the formulation of learning activities used in the questionnaire 'Preferences for learning activities'. *Firstly*, teachers often reported learning experiences in which colleagues had been involved. However, this was not related to an increased preference for the activity 'asking colleagues for advice' at the end of the one-year period. A closer look at the reported learning experiences in which colleagues played a part showed this often concerned learning from observing colleagues or from listening to colleagues and their experiences with alternative teaching methods. This type of involvement of colleagues in learning experiences is different from 'asking colleagues for advice' which was used in the questionnaire. We concluded that the teachers in this study did not learn much from collaborating with colleagues to solve particular individual problems; they learned more from simply listening to the experiences and ideas of other teachers. Consequently, we suggested that in future studies of teacher learning in the workplace, the activities of listening to colleagues' ideas and experiences and observing colleagues' practices should be more explicitly taken into account. *Secondly,* the activity 'experimenting with alternative teaching methods' was also often reported in teachers' learning experiences. At first sight, this result appeared to be incongruent with the low preference for a comparable activity in the questionnaire: 'trying different things'. We argued, however, that that it is possible that the teachers interpreted the formulation used in the questionnaire as 'trial and error' and 'non-purposeful', which is different from the more deliberate ways of trying different things reported in the learning experiences in the digital logs. We concluded that in future studies it should be made clear that the activity 'trying different things' entails experimenting with a deliberate selection of alternative methods. We also argued that the incongruence between the low preference for 'trying different things' and the high number of reported learning experiences involving 'experimentation' could be explained by the finding

that 'experimentation' was often preceded by other activities, such as individually or collectively thinking up alternatives or solutions for a particular problem. We concluded that the learning activity 'trying different things' should be considered part of a sequence of activities instead of a single learning activity, and suggested that in future research on teacher learning in the workplace it should be referred to as such.

In addition to explaining teachers' changes in preferences by a discrepancy in formulation of learning activities in the questionnaire and in the reported learning experiences in the digital logs, we also concluded that the higher and lower preferences for the activities 'trying different things' and 'critical individual reflection' could be explained by the nature of the reported learning experiences of these teachers. Regarding teachers' preferences for 'trying different things', six teachers scored significantly lower the second time, and ten teachers scored significantly higher. We found that teachers with significantly lower scores on the second measurement occasion often reported learning experiences in which they tried out alternative methods in their practice as a result of individual dissatisfaction with the level of knowledge, skills, and attitudes of students or the effects of current teaching methods. On the contrary, teachers with significantly higher scores on the second occasion more often reported learning experiences in which they tried out different teaching methods as a result of a variety of causes or antecedent activities, such as getting acquainted with colleagues' methods. With regard to teachers' preferences for 'critical individual reflection', seven teachers showed significantly lower preferences for this activity, and four teachers scored significantly higher on the second measurement occasion. This difference in changes was related to the frequency with which teachers reported learning experiences in which colleagues were involved in different ways. Teachers with a significantly lower preference for 'critical individual reflection' reported relatively more such experiences than did teachers with a significantly higher preference. We supposed that positive experiences with the involvement of colleagues in teachers' professional development might cause a lower preference for reliance on one's own knowledge and skills.

In conclusion, we argued that in future studies on teacher learning in the workplace, sequences of learning activities should be considered instead of single learning activities. Also, attention should be paid to 'spontaneous' learning in addition to learning as a result of dealing with challenging situations. The participating teachers often reported learning experiences in which they acquainted themselves with other teaching methods without actually having experienced problems with their own methods, for example, by listening to experiences of colleagues or by observing students performing a standard assignment.

6.2.4 Research question 4: How do teachers collaborate in interdisciplinary teams and how does this relate to teacher learning with respect to the topic 'active and self-regulated student learning'?

To answer this question we conducted a comparative case study. Various complementary data collection instruments, both qualitative and quantitative, such as observations and written reports of team meetings, questionnaires, and digital logs, were used to conduct case studies.

The first conclusion drawn with regard to the first part of the research question is that the collaboration in the interdisciplinary teams aimed at 'joint work' in implementing a new pedagogical approach: fostering active and self-regulated student learning, in teachers' daily teaching practices. The actual collaboration in the five teams could be characterized as the category 'sharing', and more specifically as exchanging ideas and experiences with teaching methods aimed at fostering active and self-regulated learning. The high level of interdependency in this type of collaboration is assumed to stimulate teacher learning. We also concluded that the category 'sharing' needed to be further divided into subcategories. The category was specified with respect to the *content* of sharing and the *aim* of sharing. With regard to the content of sharing, differences were noticed in teams that exchanged ideas for alternative teaching methods, and teams that in addition to exchanging ideas also exchanged experiences of experimentation with alternative teaching methods. With regard to the aim of sharing, teams differed in whether they identified and focused on individual or on shared problem-solving. Furthermore, it was concluded that alignment in goals and images of collaboration was related to this specification in types of sharing. Teams that exchanged both ideas and experiences of experimentation with alternative methods aimed at shared instructional problem-solving were successful in the alignment of both goals and images of collaboration. Teams that merely exchanged ideas for alternative methods or aimed at individual problem-solving did not succeed in the alignment of goals and images of collaboration.

Distinguishing subcategories of sharing also appeared to be important for answering the second research question, which addressed the relation between teacher learning and collaboration in interdisciplinary teams. We concluded that collaboration that consisted of exchanging both ideas and experiences of experimentation, and which aimed at shared instructional problem-solving, was related positively to teacher learning. In such teams, many changes in beliefs about teaching and learning congruent with the new pedagogical approach 'fostering active and self-regulated student learning' were identified. Additionally, teachers who collaborated with colleagues in this way often referred to the teams as a context for their learning experiences with respect to the topic 'active and self-

regulated student learning'. In contrast, teams in which teachers only exchanged ideas for alternative methods, or exchanged ideas and experiences with experimentation but aimed at individual problem-solving, were less successful with regard to teacher learning effects. In these teams, few changes in beliefs congruent with the aims of the reform were identified, or the frequency with which teachers referred to the collaboration in their teams as a context for their learning experiences was low.

6.3 General conclusions and discussion

From the conclusions of the four studies described in the previous sections, five general conclusions can be drawn. In this section we elaborate on and discuss these five general conclusions.

1) In a context of collaboration in interdisciplinary teams over a period of one year, many experienced teachers changed their beliefs about teaching and learning in ways both congruent and incongruent with the underlying principles and ideas of the educational reform implemented in Dutch upper secondary education.
2) In a context of collaboration in interdisciplinary teams, experienced teachers changed their preferences for learning activities, and especially their preferences for the learning activities 'critical individual reflection' and 'experimentation' over a period of one year changed. Both lower and higher preferences for these two learning activities occurred.
3) Individual teacher learning in a context of collaboration in interdisciplinary teams occurred in sequences of learning activities, rather than in single learning activities.
4) In a context of collaboration in interdisciplinary teams, individual teachers often reported learning as a result of becoming acquainted with colleagues' ideas and experiences with particular teaching methods by simply listening or observing instead of solving individual problems by asking colleagues for advice.
5) 'Sharing' as a type of collaboration in interdisciplinary teams was firstly divided in exchanging ideas for alternative methods and exchanging both ideas and experiences of experimentation with alternative methods. Secondly, sharing was divided according to an aim for individual or for shared problem-solving. The combination of exchanging ideas and experiences of experimentation, and aiming at shared problem-solving appeared to relate positively with teacher learning.

Changes in beliefs about teaching and learning

Although it is known from previous studies that changing teacher cognition is difficult (Pajares, 1992), we found in this study that in total 21 of the 34 participating teachers did change their beliefs after a period of one year. At first sight, this finding is in line with the findings of Kember (1997), who argued that initiatives aimed at teacher professional development that operated over a period of time and that occurred in the context of a project are successful in changing teachers' beliefs. We found that teachers who collaborated with colleagues in interdisciplinary teams for a period of one year, and who often reported learning experiences in which they learned as a result of listening to or observing the teaching methods of colleagues, changed their beliefs about teaching and learning in a way congruent with the underlying principles and ideas of the reform. We also found changes in beliefs incongruent with the underlying principles and aims of the implemented educational reform in Dutch upper secondary education. This type of change in beliefs related to learning experiences in which teachers as a result of individual dissatisfaction with students' level of knowledge, skills, or attitudes, or with current teaching methods, experimented with alternative teaching methods.

Changes in preferences for learning activities

In examining teachers' preferences for learning activities and changes in these preferences, we aimed for a better understanding of how experienced teachers learn in the workplace. Our findings suggest that teachers mainly prefer to critically reflect and use their own knowledge and skills when they are confronted with a challenging or problematic task or situation. We found that teachers did change their preferences for particular learning activities. Especially teachers' preferences for the activities 'critical individual reflection' and 'experimentation' changed after the period of one year in which teachers collaborated with colleagues in an interdisciplinary team and had several learning experiences. Both significantly lower and significantly higher scores were found for these two learning activities.

In this study, we did not formulate an explicit norm about which learning activity teachers should prefer and, therefore, how they should change their preferences. However, based on our previous findings that teachers who reported many learning experiences in which they learned as a result of listening to or observing the teaching methods of colleagues during this year also changed their beliefs about teaching and learning in a way congruent with the underlying principles and ideas of the reform, it might be suggested that it is important for teachers to have a high preference for involving colleagues in their learning (see also general conclusion 4). Involving colleagues in one's professional development can occur in various ways; by listening to or observing colleagues' teaching

methods, by asking colleagues for advice, or by collectively brainstorming about a shared problem (e.g., Butler, et al., 2004; Shank, 2006). Also, because in most learning experiences teachers reported more than one learning activity, we suggested that teachers should be stimulated to become engaged in sequences of learning activities.

Sequences of learning activities

Based on the analysis of teachers' reported learning experiences we concluded that in general teachers report learning from sequences of learning activities. The basis for the sequences of learning activities were broadly divided into a) experiencing problems with current teaching methods or dissatisfaction with students' current level of knowledge, skills, or attitudes, and b) a more spontaneous cause, such as being confronted with an unexpected situation, observing students while performing a standard assignment, or listening to or observing colleagues' (experiences) with teaching methods. As a result of dissatisfaction with students' level of knowledge, skills, attitudes, or current teaching methods, or after listening to or observing colleagues, teachers often intentionally experimented with alternative teaching methods in their practices. They subsequently reflected on these experiments, either individually or together with colleagues and students. Such sequences of learning activities often resulted in new ideas, in confirmation or validation for the teacher's own newly acquired teaching methods, and occasionally in reported intentions to use certain teaching methods or assignments more often. The learning experiences in which teachers reported having learned as a result of being confronted with an unexpected situation, or from observing students as they worked on standard assignments, often did not result in experimentation with alternative teaching methods, but resulted in new or confirmed ideas or intentions to change their practice in future.

The description of teachers' learning experiences in sequences of activities can be seen as a contribution to our current understanding of teacher learning. In previous research on teacher workplace learning, learning was often described in terms of single learning activities teachers engage in (Van Eekelen, Boshuizen, & Vermunt, 2005; Kwakman, 2003; Lohman, 2005). In our opinion, this gives a restricted view of how teacher learning actually takes place in the workplace. We illustrate this with the fourth overall conclusion.

Learning through acquaintance with colleagues' teaching methods

Teachers often reported learning experiences which were the consequence of becoming acquainted with ideas and teaching methods of colleagues through listening to their ideas or their experiences with teaching methods or observing

colleagues' (experiences with) teaching methods, aimed at fostering active and self-regulated student learning. This finding is in line with recent findings of Shank (2006), who found that 'storytelling' is important for creating a powerful learning environment in which colleagues can support, challenge, and learn together. Shank found that teacher storytelling can, among other things, provide 'windows for seeing pedagogical possibilities' (p. 712). In addition, as a result of sharing stories, teachers might realize that their own doubts, needs, problems, and difficulties with regard to implemented educational reforms are not unique. In a context of educational reform this is important as it may make it easier for teachers to ask colleagues for advice in future (Rosenholtz, 1989). In other studies, the effects of exchanging ideas and experiences in brief encounters have been questioned (e.g., Little, 1990, 2003). Little states that "classroom accounts that surface in interactions tend to rely heavily on a certain shorthand terminology, and on condensed narratives that convey something of the press of classroom life without fully elaborating its circumstances or dynamics." (p.936). In order to actually learn from collaboration, teachers should try to really understand colleagues' teaching methods by asking them for the underlying principles and reasons for using a particular method or approach.

We also found that *listening* to colleagues' ideas and experiences with particular methods often occurred in combination with other learning activities. As a result of becoming acquainted with the new or alternative teaching methods of colleagues, teachers reflected on their own teaching practice and experimented with the methods of colleagues in their own teaching practice. In many studies on teacher collaboration, it was assumed that the exchange of ideas, experiences, teaching methods, and feedback fosters learning. Based on the present findings, it might be argued that merely exchanging teaching methods may not be sufficient for learning. We found that teachers learn through sequences of activities, such as exchanging ideas, experiences, and teaching methods with colleagues in combination with experimentation in their own practice with alternative methods, and deliberate evaluation of this experimentation.

Collaboration in interdisciplinary teams

The collaboration in the interdisciplinary teams could be characterized as sharing, a type of collaboration with a relatively high level of interdependence. The hypothesis underlying levels of interdependency is that high levels of interdependency stimulate teacher learning (Little, 1990). Although the collaboration in the teams that participated in this study could be characterized as having a high level of interdependency, and was supposed to take place along the innovative dimension of learning (Hammerness, et al., 2005), differences were

found with regard to teacher learning. These differences could be explained with a further specification of the category 'sharing': the content of sharing and the aim of sharing. Sharing can consist of exchanging ideas for teaching methods, and exchanging both ideas and experiences for experimentation with alternative methods. Secondly, sharing can aim for individual problem-solving or shared problem-solving. Exchanging ideas and exchanging ideas and experiences with experimentation aimed at individual problem-solving corresponds with the category 'exchanging instructional materials and ideas' of Rosenholtz (1989) and with the description of cooperation put forward by Hord (1986). Exchanging ideas and experiences with experimentation aimed at shared instructional problem-solving corresponds with Rosenholtz's category 'instructional problem-solving and planning' and Hord's description of collaboration. Because of its aim of shared problem-solving, this type of collaboration resembles the category 'joint work', which is considered to be the type of collaboration with the highest level of interdependency. However, teachers' autonomy in deciding whether to use new or alternative teaching methods in their own practices remained high. In joint work or instructional planning teachers agree to work and teach in a similar way, which may involve decreased individual autonomy (Archbald & Porter, 1994; Crow & Pounder, 2000).

6.4 Limitations of the study

In this section we discuss three aspects of our study that limit its conclusions: 1) teacher perceptions, 2) changes in teacher cognition, and 3) individual teacher learning in a context of collaboration in teams.

Teachers' perceptions

Most of the data collected for this study concerned teachers' perceptions; self-reports, interviews, and questionnaires were used. With regard to how teachers learn, we relied on teachers' self-reports of learning activities in both the digital logs and interviews held directly after team meetings. Information about what teachers learned was gleaned from questionnaires on beliefs about teaching and learning. Data on the influence of environmental factors on what and how teachers learn in a context of collaboration in interdisciplinary teams (at both group and organizational level) were also based on teachers' perceptions reported in questionnaires.

Firstly, relying mostly on teachers' own perceptions of learning and the influence of the environment entailed the danger of an incomplete picture of how teacher learning occurred during the year that we examined the teachers. Our rationale for using self-reports to collect data on learning activities was that this

would allow teachers to indicate which learning experience they considered to be most meaningful for their learning. The relatively low number of learning experiences the teachers reported in their digital logs, however, limits the conclusions of this study. In the period of one (school) year, the teachers e-mailed six digital logs, which comes down to one reported learning experience every six weeks. We reasoned that when asked to report one learning experience every six weeks, teachers would e-mail their most important and relevant learning experiences. We did not explicitly instruct them to do so as we wanted to give them a certain amount of freedom. However, teachers probably have learning experiences more often both in and outside actual teaching practice. Asking teachers to report on meaningful learning experiences more frequently might have given a more comprehensive image of teacher learning. However, asking teachers to report on more learning experiences may also have resulted in reporting of less meaningful experiences.

Secondly, using self-perceptions entails the danger of differences arising between what teachers say they do and what they actually do (Mathijsen, 2006). In order to avoid socially desirable teacher responses, we stressed to the participating teachers that all data would be treated confidentially and reported anonymously, and that the results of this study would have no consequences for them. However, we do not know whether the teachers gave objective information and responses. The use of additional data collection methods in which teachers' actual practice and related learning was mapped as well, such as classroom observation (see Hoekstra, Beijaard, Brekelmans, & Korthagen, 2007), or observation of teachers in other settings, would have provided opportunities to triangulate data. In the scope of this study, the amount of time required for this additional data collection was practically impossible.

Changes in teacher cognition

In examining teacher learning, we took into account both what teachers learn and how they learn. In order to investigate what teachers learn, we mainly focused on teachers' changes in beliefs about teaching and learning. Of course, changes in beliefs are only a part of what teachers learn. Changes in teachers' classroom behavior are also an important element of teacher learning. In numerous studies on teacher professional development, it was assumed that teacher beliefs influence teacher behavior and vice versa (Calderhead, 1996; Pajares, 1992; Patrick & Pintrich, 2001). In the studies presented in Chapters 2 and 3, it was concluded that teachers reported more changes in cognition than changes in behavior as a result of undertaking learning activities. Teachers did experiment with alternative methods, which may be characterized as changes in situation-specific teaching behavior. It

was not clear, however, whether teachers actually incorporated these methods in their repertoire and thus changed their teaching behavior. Even though we examined the teachers for a period of one year, this period might have been too short, as changes in behavior require both time and effort (Guskey, 2002). Including instruments that specifically focus on changes in behavior would have provided a more inclusive picture of teacher learning in the workplace.

Individual teacher learning in a context of collaboration in teams
We focused on individual teacher learning in a context of collaboration in teams. It would be interesting also to investigate what and how the teams learned collectively. Do teacher teams, for example, develop a shared view on teaching and student learning? And how does the development of shared beliefs relate to the group activities in team meetings? The data collected in this study did not provide information about such questions. Considering that individual and collective learning in a context of collaboration in teams are closely intertwined, the data in this study reveal only part of the process of the teacher learning in collaboration.

6.5 Implications and suggestions for future research

The implications of the studies in this thesis are mainly theoretical and research-oriented. In this section we discuss these implications and present some suggestions for future research on teacher learning in the workplace in general, and specifically for research on teacher learning in a context of collaboration in teams. Some practical implications are also formulated.

In order to enhance our understanding of individual teacher learning in a context of collaboration in interdisciplinary teams, we included a number of variables and corresponding data collection instruments in this study. We examined both *how* and *what* teachers learn in a context of collaboration, and how these two aspects are connected.

With regard to *how* individual teachers learn in a context of collaboration, we examined teachers' reported learning experiences in digital logs and teachers' preferences for learning activities using a questionnaire. In most studies on teacher learning the focus is on *single* learning activities. From the results of the digital logs and the questionnaire on teachers' preferences for learning activities, we found that teachers often report engagement in *sequences* of learning activities that result in changes in cognition. For example, based on the teachers' reported learning experiences in the digital logs, we found that teachers learn not merely from interaction with colleagues, but in combination with experimentation on an adjusted teaching method of a colleague in their own teaching practice, succeeded by individual reflection or reflection with colleagues. Describing teacher learning

experiences in sequences of learning activities provided a more fine-grained view of how teacher learning occurs, and better fits what actually happens in the workplace. For future studies on teacher learning in the workplace in general, we therefore suggest focusing on sequences of learning activities, for instance, by taking the sequences found in this study as a starting point and examining them in more detail, over a longer period of time, and for a larger number of teachers. Collecting more data on teachers' sequences of learning activities would also make it possible to examine connections between sequences of learning activities of individual teachers during a certain period in order to gain a better understanding of how teacher learning unfolds over a period of time.

We found that many of the teachers' individual learning experiences that occurred in a context of collaboration started out with listening to colleagues' ideas and experiences of teaching methods, succeeded by experimentation with alternative methods in their own practices, and closing with evaluation of these experiments. This finding can be seen as an addition to the current knowledge of teacher learning in collaboration, in which collaborative reflection on problems experienced and current teaching practices is often considered important for teacher learning (e.g., Butler, et al., 2004). For future research it would be interesting to examine in what way teachers communicate about their ideas and experiences together. Examining this communication in more detail may provide insight into what makes listening to colleagues' ideas and experiences important for teacher learning (Little, 2003).

Previous research (Little, 2002) has shown that locating learning and learning activities that occur during collaboration is quite difficult. In the present study we interviewed one teacher from each team after each meeting instead of observing and making video-recordings of team meetings. As a result of asking teachers to indicate at which moment in a meeting their learning experience took place, and to describe what happened at that moment, we found that listening to colleagues' ideas and methods is an important learning activity. This type of data collection can, therefore, be considered a useful method for examining teacher learning in collaboration. In future research it would be worthwhile to interview more teachers from one team after their meetings, as teachers from the same team can learn different things. The learning activities and outcomes can then be compared within and between teams, which can ultimately result in an overview of potential learning activities sequences in team meetings. Such an overview might be useful for optimizing and stimulating teacher learning in collaborative settings.

With regard to *what* teachers learn, we first focused on changes in teachers' beliefs about teaching and learning, and used a questionnaire to collect data on these beliefs. Using this questionnaire on two measurement occasions with

an intermediate period of one year, we were able to examine changes in beliefs. Although beliefs are assumed to be difficult to change (e.g., Pajares, 1992), a majority of the participating teachers in our study did change their beliefs. This finding confirms the findings of a previous study by Kember (1997), who argued that teacher professional development initiatives that function over a longer period of time and operate in a project are successful in changing teachers' beliefs. The interdisciplinary teams of this study can be regarded as examples of such initiatives. However, not all changes in beliefs found were congruent with the underlying ideas and principles of the implemented educational reforms. We also found that the initial beliefs about teaching and learning of some teachers were already congruent with the aims of the reform, which made it unlikely that they would become even more congruent. For future studies on teacher learning in the workplace we suggest taking these initial beliefs more into account when interpreting beliefs changes.

By relating changes in beliefs about teaching and learning to reported sequences of teacher learning activities, we contributed to current insights into how teachers' changes in beliefs may be fostered. It is often assumed that collaboration with colleagues fosters teacher learning. In this study we found empirical evidence for this assumption, and showed that teachers who changed their beliefs in a way congruent with the aims of educational reforms had been engaged in learning experiences in which they as a result of becoming acquainted with colleagues' methods experimented with alternative methods in their own teaching practices. Also, we further specified 'sharing', a type of collaboration with a relatively high level of interdependency (Little, 1990), based on differences between teams in learning outcomes. We found that collaboration which consisted of exchanging both ideas for alternative teaching methods and experiences of experimentation with these methods, and collaboration which aimed at shared instructional problem-solving, resulted in relatively more changes in beliefs congruent with the aims of the reform. Collaboration that consisted of exchanging ideas or exchanging both ideas and experiences with experimentation aimed at individual problem-solving, appeared to be less effective with regard to changes in beliefs about teaching and learning.

In sum, using and combining multiple data sources, using both quantitative and qualitative data collection instruments, and examining teacher learning in collaboration for a period of one year gave us the opportunity to investigate teacher learning in a context of collaboration in interdisciplinary teams in depth. By triangulating data we contributed to a more comprehensive understanding of the complexity of teacher learning in a context of collaboration in interdisciplinary teams (Meijer, Verloop, & Beijaard, 2002).

Finally, we would briefly like to point to some practical implications of this study for future initiatives aimed at supporting and stimulating the professional development of experienced teachers in a context of collaboration. We found that in teams which aimed at shared instructional problem-solving, and consequently exchanged ideas and discussed their experiences of experimentation with new or alternative teaching methods, relatively more teachers changed their beliefs about teaching and learning in a way congruent with the aims of the reform. We therefore suggest that (interdisciplinary) teacher teams explicitly stimulate each other to focus on adjusting or copying colleagues' methods in their own practice, experimenting with these methods in their own teaching practice, and collaboratively reflecting on such experimentation. Additionally, for teams who are starting up collaboration it is important to explicitly deal with finding shared problems as a focus for their collaboration. Collaboratively reflecting on shared problems and consequently thinking up ideas for alternative teaching methods results in a higher level of interdependency, which may have positive effects on teacher learning.

We further recommend that for supporting and optimizing teachers' continuous development it is important to pay attention to teachers' ways of learning. Stimulating teachers to become aware of their ways of learning and how to regulate their learning processes might assist them in thinking up ways of fostering students to regulate their learning processes. It might also help them to continuously improve and develop their practices in general. Collaboration with colleagues is also essential here. After having positive experiences with collaboration, teachers will more often involve colleagues in their professional development. More specifically, listening to colleagues' ideas and experiences and observing colleagues appear to stimulate teachers to change their own practice. Therefore, we recommend that teachers be stimulated to undertake such activities for their professional development.

Finally, we recommend that teachers be stimulated to collaborate with colleagues with different subject matter backgrounds. In previous research on collaboration in secondary education it was found that teachers mainly work together with colleagues from the same or directly related subject-matter departments (Witziers, et al., 1999; Imants, et al., 2001). In subject-matter departments exchanges and discussions of instructional problems are rare. Based on the findings of this study, we argue that collaboration in interdisciplinary teams can foster teacher learning when it aims at collective problem-solving and when teachers communicate in an open way about their teaching practices by sharing and discussing their experiences with experimentation. Giving teachers the opportunity to get acquainted with the ideas and teaching methods of colleagues

with different subject-matter backgrounds may be regarded as a promising additional type of collaboration for secondary school teachers.

Nederlandse samenvatting

Nederlandse samenvatting

In dit proefschrift staat het leren van ervaren docenten in een context van samenwerking in interdisciplinaire teams centraal. Van docenten wordt verwacht dat zij op de hoogte blijven van de laatste ontwikkelingen en vernieuwingen en waar mogelijk hun onderwijspraktijk hierop aanpassen. Samenwerking in teams wordt gezien als een belangrijke leeromgeving voor docenten en wordt steeds gebruikelijker in schoolorganisaties. Om docentprofessionalisering zo goed mogelijk te ondersteunen en te optimaliseren is meer systematisch en empirisch gevalideerd onderzoek nodig (Hasweh, 2003). Het doel van de vier deelstudies in dit proefschrift is dan ook bij te dragen aan een zo compleet mogelijk beeld van het leren van docenten in een context van samenwerking in interdisciplinaire teams.

In **hoofdstuk 1** worden de context, de theoretische uitgangspunten en de onderzoeksvragen van het totale onderzoek toegelicht.

In het voortgezet onderwijs is het voor docenten gebruikelijk samen te werken met collega's van dezelfde of verwante secties (Van Wessum, 1997; Witziers, Sleegers, & Imants, 1999). In dit onderzoek is echter gekozen voor een context van samenwerking tussen ervaren docenten van verschillende vaksecties. In interdisciplinaire teams kunnen docenten in aanraking komen met een grotere diversiteit van ideeën en lesmethoden dan in hun eigen vaksectie. Hierdoor zouden docenten gestimuleerd kunnen worden te reflecteren op hun eigen lespraktijk, te experimenteren met de ideeën en methoden van collega's, en mogelijk hun eigen lespraktijk te veranderen. Een ander belangrijk kenmerk van deze context is dat het leren op de werkplek plaatsvindt, in tegenstelling tot bijvoorbeeld het volgen van een cursus op een locatie buiten school waarin (theoretische) kennis aan docenten wordt aangeboden (Grossman, Wineburg, & Woolworth, 2001). Deze kenmerken van de gekozen professionaliseringscontext hangen samen met een 'situatieve' benadering van kennis en leren. In deze benadering wordt benadrukt dat leren niet los gezien kan worden van de context (i.c. de werkplek) waarin dit leren plaatsvindt (Putnam & Borko, 2000). Tevens wordt in deze benadering het belang van interactie met anderen voor het leren van docenten benadrukt.

Voor dit onderzoek is gezocht naar een onderwerp waarvan we verwachtten dat docenten er nog veel over konden leren in interdisciplinaire teams. Gekozen is voor het onderwerp 'actief en zelfstandig leren van leerlingen'. Dit onderwerp sluit goed aan bij de invoering van de Tweede Fase en de daarbij horende pedagogisch-didactische aanpak van het Studiehuis. Voor docenten betekent deze aanpak dat zij, met een grondige vakkennis, leerlingen moeten coachen en hen moeten leren meer verantwoordelijkheid te nemen voor hun eigen leerproces (Bolhuis & Voeten, 2004;

Oolbekkink-Marchand, Van Driel, & Verloop, 2006). Voor veel docenten in het voortgezet onderwijs betekent dit dat zij hun lesgedrag en cognities moeten aanpassen of veranderen.

We beschouwen 'leren' hier als een *continu werkgerelateerd proces waarin docenten activiteiten ondernemen die leiden tot een verandering in cognities en/of gedrag*. In dit proefschrift wordt derhalve onderzocht *wat* docenten leren in een context van samenwerking in interdisciplinaire teams, door te kijken naar veranderingen in hun cognities en/of gedrag. Ook wordt onderzocht *hoe* docenten leren, door leeractiviteiten in kaart te brengen die leiden tot deze veranderingen. Tot slot wordt ook de *omgeving* waarin docenten leren beschreven, door middel van het karakteriseren van de samenwerking in de teams en de invloed van groeps- en organisatiekenmerken op de samenwerking. Deze verschillende onderdelen zijn terug te vinden in de vier onderzoeksvragen, welke achtereenvolgens beantwoord worden in de vier deelstudies die beschreven staan in dit proefschrift.

1) Welke leeractiviteiten ondernemen docenten in samenwerking in interdisciplinaire teams gedurende een periode van een jaar en wat leren ze daarvan?
2) Wat is de relatie tussen leeractiviteiten die docenten ondernemen in een context van samenwerking in interdisciplinaire teams en veranderingen in hun opvattingen met betrekking tot 'actief en zelfstandig leren' gedurende een jaar?
3) Wat is de relatie tussen leeractiviteiten die docenten ondernemen in een context van samenwerking in interdisciplinaire teams en veranderingen in hun voorkeuren voor bepaalde leeractiviteiten gedurende een jaar?
4) Hoe werken docenten samen in interdisciplinaire teams en hoe is dit gerelateerd aan het leren van docenten met betrekking tot 'actief en zelfstandig leren'?

Om deze vier onderzoeksvragen te beantwoorden zijn vijf interdisciplinaire docententeams (in totaal 34 docenten) gedurende een jaar gevolgd. Er is gebruik gemaakt van verschillende onderzoeksinstrumenten om een zo compleet mogelijk beeld te krijgen van het leren van docenten.

In **hoofdstuk 2** staat de eerste onderzoeksvraag centraal. Voor het beantwoorden van deze onderzoeksvraag is een kleinschalige kwalitatieve dieptestudie uitgevoerd. Direct na afloop van een aantal teambijeenkomsten zijn uit elk van de vijf teams één of twee docenten geïnterviewd. De docenten werd gevraagd wat en hoe ze geleerd hadden van de teambijeenkomst. Daarnaast beschreven de docenten

gedurende het jaar in een digitaal logboek hun leerervaringen met betrekking tot het bevorderen van 'actief en zelfstandig leren van leerlingen'. Voor het beantwoorden van de onderzoeksvraag vormden de leerervaringen waarin de docenten expliciet refereerden aan de samenwerking in hun team de basis.

De interviews en de logboeken werden geanalyseerd in termen van leeropbrengsten en daarbij horende leeractiviteiten. Op basis hiervan werd geconcludeerd dat leeractiviteiten van docenten in samenhang voorkomen en dat in deze samenhang van activiteiten specifieke sequenties te onderscheiden zijn. De koppeling van deze sequenties aan de gerapporteerde leeropbrengsten resulteerde in zeven configuraties. Deze configuraties laten zien op welke manier sequenties van leeractiviteiten en leeropbrengsten samenhangen. In zes van de zeven configuraties is de aanleiding voor leren het kennisnemen van alternatieve lesmethoden, door bijvoorbeeld te luisteren naar de ervaringen van collega's of door collega's te observeren. De meeste sequenties van leeractiviteiten blijken te resulteren in veranderingen in cognities. Deze veranderingen in cognities konden worden gespecificeerd in nieuwe ideeën over het leren van leerlingen of intenties om de eigen lespraktijk te veranderen (vgl. Borko, et al., 1997). Ook rapporteerden docenten vaak dat zij door het luisteren naar ervaringen van collega's werden bevestigd in hun ideeën over of gebruik van nieuwe lesmethoden en/of opdrachten (vgl. Shank, 2006).

In **hoofdstuk 3** staat de beantwoording van de tweede onderzoeksvraag centraal. Hiertoe zijn eerst de digitale logboeken van de 34 docenten uit de vijf teams geanalyseerd op overeenkomstige patronen en vervolgens beschreven in sequenties van leeractiviteiten. Daarnaast zijn veranderingen in opvattingen over leren en onderwijzen geanalyseerd op basis van een vragenlijst die alle docenten aan het begin en aan het eind van het jaar hebben ingevuld.

De kwalitatieve analyse van de digitale logboeken resulteerde in een lijst van vijftien sequenties van leeractiviteiten. De analyse van de veranderingen in de opvattingen van docenten leverde drie categorieën op: 1) docenten met een verandering in opvattingen overeenkomstig de achterliggende ideeën van de hervormingen in het voortgezet onderwijs, 2) docenten met een verandering in opvattingen niet overeenkomstig de achterliggende ideeën van de hervormingen in het voortgezet onderwijs en 3) docenten waarbij de opvattingen niet veranderd zijn na een periode van een jaar (vgl. Tillema & Knol, 1997). In totaal veranderden 21 docenten hun opvattingen en hielden 13 docenten in essentie dezelfde opvattingen.

Vervolgens is gekeken of deze drie groepen docenten verschilden in de typen sequenties van leeractiviteiten die zij rapporteerden in hun logboeken. Deze analyse resulteerde in drie bevindingen. Ten eerste bleek dat docenten die hun

opvattingen veranderden overeenkomstig de ideeën van de hervormingen relatief veel leerervaringen rapporteerden waarin ze experimenteerden met alternatieve lesmethoden op basis van het kennisnemen van de methoden van collega's. Deze bevinding bevestigt eerder onderzoek waarin verondersteld wordt dat samenwerking de professionele ontwikkeling van docenten stimuleert (Butler, et al., 2004; Putnam & Borko, 2000; Shank, 2006). Ten tweede bleek dat docenten die hun opvattingen veranderden op een manier die *niet* overeenkomt met de ideeën van de hervormingen relatief veel leerervaringen rapporteerden, waarin ze experimenteerden met alternatieve lesmethoden op basis van eigen ontevredenheid. Deze ontevredenheid had te maken met het niveau van kennis, vaardigheden en/of attitude van leerlingen ofwel met de effectiviteit van de huidige lesmethoden. Ten derde bleek dat docenten die hun opvattingen niet veranderden veel leerervaringen rapporteerden, waarin ze leerden door het observeren van leerlingen bij een opdracht die deel uitmaakte van het standaardcurriculum.

In **hoofdstuk 4** wordt de derde onderzoeksvraag beantwoord. Het betreft een deelstudie waarin de sequenties van leeractiviteiten, zoals beschreven in hoofdstuk 3, zijn gerelateerd aan de (veranderingen in) voorkeuren van docenten voor bepaalde leeractiviteiten.

De voorkeuren voor leeractiviteiten zijn in kaart gebracht met behulp van een vragenlijst die alle docenten aan het begin en aan het einde van het jaar hebben ingevuld. De vragenlijst bestond uit acht beschrijvingen van mogelijk uitdagende en/of problematische situaties uit de dagelijkse lespraktijk. De docenten is gevraagd voor de acht situaties op 5-puntsschalen aan te geven in welke mate ze zouden kiezen voor vijf opties: a) collega's raadplegen, b) kritisch bij zichzelf te rade gaan, c) vertrouwen op eigen intuïtie en gevoelens, d) informatie zoeken in boeken, internet, etc. en e) van alles uitproberen.

De analyse van de vragenlijst liet zien dat docenten zowel aan het begin als aan het einde van het jaar de grootste voorkeur hadden voor 'kritisch bij zichzelf te rade gaan' wanneer ze geconfronteerd werden met een uitdagende en/of problematische situatie. Ook scoorden de docenten hoog op het raadplegen van collega's en het vertrouwen op eigen gevoelens en intuïtie. Hoewel het merendeel van de docenten hun voorkeuren voor leeractiviteiten niet veranderde gedurende het onderzoeksjaar, werd op basis van het aantal docenten dat wel hun voorkeuren veranderde geconstateerd dat de voorkeur voor leeractiviteiten geen onveranderbare eigenschap is (vgl. Vermunt, 1998; Vermunt & Vermetten, 2004). De veranderingen in voorkeuren konden verklaard worden vanuit het type leerervaringen dat docenten in hun logboeken rapporteerden.

Ten eerste werd vastgesteld dat van de 34 docenten maar 1 docent een grotere voorkeur voor de activiteit 'collega's raadplegen' rapporteerde. Op basis van het aantal leerervaringen in logboeken waarin docenten positief rapporteerden over de manier waarop collega's betrokken waren bij hun leerervaringen (63 van de 204 gerapporteerde leerervaringen) zou het te verwachten zijn dat docenten meer voorkeur ontwikkelen voor deze activiteit. Uit de analyse van de logboeken bleek echter dat de rol van collega's bij leerervaringen niet bestond uit het geven van advies, maar uit het laten kennismaken met andere lesmethoden door middel van uitwisseling van ideeën en ervaringen of klassenobservatie (vgl. Shank, 2006).

Ten tweede werd vastgesteld dat een relatief groot aantal docenten hun voorkeur veranderde voor de leeractiviteiten 'kritisch bij jezelf te rade gaan' en ' van alles uitproberen' (respectievelijk 11 en 16 van de 34 docenten). Deze veranderingen konden eveneens verklaard worden door het type leerervaringen dat zij rapporteerden. Docenten met een toegenomen voorkeur voor 'uitproberen' rapporteerden vaker leerervaringen waarin zij alternatieve lesmethoden uitprobeerden dan docenten met een afgenomen voorkeur voor deze leeractiviteit. Docenten met een afgenomen voorkeur voor 'kritisch bij jezelf te rade gaan' rapporteerden meer leerervaringen waarin collega's betrokken waren dan docenten met een toegenomen voorkeur voor deze activiteit. Dit laatste resultaat suggereert dat positieve ervaringen met het betrekken van collega's in het eigen leren de voorkeur om te vertrouwen op eigen kennis en vaardigheden verlaagt.

Verder werd vastgesteld dat de activiteit 'uitproberen' een belangrijke rol speelde in de gerapporteerde leerervaringen (8 van de 15 gevonden sequenties van leeractiviteiten in de digitale logboeken bevatten deze activiteit). De voorkeur van docenten voor 'uitproberen' bleek echter laag te zijn (gemiddeld 2.3 op een 5-puntsschaal). Het is echter mogelijk dat docenten de formulering in de vragenlijst geïnterpreteerd hebben als een 'trial and error'-vorm van leren (vgl. Lohman, 2005), hetgeen anders is dan de doelbewuste vorm van uitproberen zoals veelal werd gerapporteerd in de logboeken (vgl. Dunn & Shriner, 1999). Een andere verklaring voor deze discrepantie is dat 'uitproberen' vaak deel uitmaakt van een *sequentie* van leeractiviteiten en vooraf wordt gegaan door andere leeractiviteiten zoals 'kritisch bij zichzelf te rade gaan'.

In **hoofdstuk 5** staat de beantwoording van de vierde onderzoeksvraag centraal. Om de aard van de samenwerking in de vijf interdisciplinaire teams te onderzoeken en vervolgens te relateren aan het leren van docenten is een vergelijkende case-studie uitgevoerd (Miles & Huberman, 1994; Yin, 2003). Verschillende kwalitatieve en kwantitatieve onderzoeksinstrumenten zijn gebruikt, zoals observaties van teambijeenkomsten, digitale logboeken en vragenlijsten.

Op basis van de kwalitatieve analyses van de observaties van de teambijeenkomsten kon geconcludeerd worden dat de samenwerking in alle vijf teams te karakteriseren was als een type samenwerking dat Little (1990) aanduidt als 'sharing' en minder als de typen 'storytelling', 'aid and assistance' of 'joint work'. Het type samenwerking 'sharing' wordt getypeerd door een hoog niveau van wederzijdse afhankelijkheid en wordt verondersteld stimulerend te zijn voor het leren van docenten. Om de samenwerking in de vijf teams verder te specificeren, is het concept 'sharing' verder opgesplitst in de *inhoud* en het *doel* van 'sharing'. Met betrekking tot de *inhoud* kon een onderscheid worden gemaakt tussen teams die ideeën voor alternatieve lesmethoden uitwisselden en teams die daarnaast ook ervaringen met experimenten deelden. Met betrekking tot het *doel* kon een onderscheid worden gemaakt tussen teams die individuele problemen en/of ontwikkelpunten identificeerden en teams die gezamenlijke problemen en/of ontwikkelpunten identificeerden.

Deze specificatie in subcategorieën van de activiteit 'sharing' bleek van belang voor het relateren van het *type* samenwerking aan het *leren* van docenten. In drie teams wisselden de docenten zowel ideeën als experimenten met alternatieve lesmethoden uit, gericht op gedeelde probleemoplossing. In deze drie teams veranderden relatief veel docenten hun opvattingen over leren en onderwijzen overeenkomstig de onderliggende ideeën van de hervormingen in de bovenbouw van het voortgezet onderwijs. Ook verwezen docenten uit deze drie teams relatief vaak naar de samenwerking in hun teams als de context voor hun leerervaringen. In de andere twee teams wisselden de docenten alleen ideeën uit of was de samenwerking gericht op individuele problemen en/of ontwikkelpunten van de teamleden. In deze twee teams kwamen minder veranderingen in opvattingen voor. Ook waren de gerapporteerde leerervaringen van deze docenten minder vaak te herleiden tot de samenwerking in hun team. Samenwerking in interdisciplinaire teams waarbij docenten zowel ideeën als ervaringen met experimenten uitwisselen, gericht op gedeelde probleemoplossing, lijkt daarmee een positieve bijdrage te kunnen leveren aan de professionele ontwikkeling van docenten.

In **hoofdstuk 6** worden de belangrijkste conclusies, beperkingen en theoretische en praktische implicaties van het onderzoek besproken. Ook worden aanbevelingen geformuleerd voor vervolgonderzoek naar het leren van docenten op de werkplek in het algemeen, en in een context van samenwerking in interdisciplinaire teams in het bijzonder.

Op basis van de vier deelstudies werden vijf algemene conclusies geformuleerd:
1) In een context van samenwerking in interdisciplinaire teams veranderden veel van de onderzochte docenten hun opvattingen over leren en onderwijzen, zowel overeenkomstig als niet overeenkomstig de achterliggende ideeën en principes van de hervormingen in de bovenbouw van het voortgezet onderwijs.
2) In een context van samenwerking in interdisciplinaire teams veranderden sommige docenten hun voorkeuren voor leeractiviteiten, vooral voor 'kritisch bij jezelf te rade gaan' en 'uitproberen'.
3) Individueel leren van docenten in een context van samenwerking in interdisciplinaire teams vond plaats in sequenties van leeractiviteiten in plaats van in afzonderlijke losse leeractiviteiten.
4) In een context van samenwerking in interdisciplinaire teams rapporteerden docenten veel ervaringen waarin zij leerden door te luisteren naar de ideeën en ervaringen met lesmethoden van collega's, of door collega's te observeren. Het leren door middel van het oplossen van eigen individuele problemen door het vragen van advies aan collega's werd veel minder vaak gerapporteerd.
5) Samenwerking in teams waarin docenten zowel ideeën als ervaringen met alternatieve lesmethoden uitwisselden, gericht op gedeelde probleem-oplossing, verhoudt zich positief tot veranderingen in docentopvattingen overeenkomstig de ideeën van de vernieuwingen.

Vervolgens werden enkele beperkingen van het onderzoek beschreven. Doordat de focus gericht was op docent*percepties* en niet op *observaties* van docenten in hun lespraktijk, bestaat het gevaar van een onvolledig beeld van het leren van docenten. Een andere beperking van het onderzoek betreft de focus op individueel leren in een context van samenwerking in teams en niet op teamleren. Het leren van individuen in een team hangt nauw samen met het leren van het team. De focus op individueel leren geeft daarmee alleen zicht op een beperkt deel van de leerprocessen die zich afspelen in teams.

Het hoofdstuk sluit af met een bespreking van de theoretische en praktische implicaties. Door te onderzoeken *hoe* docenten leren werd duidelijk dat leeractiviteiten vaak in samenhang voorkomen en dat hierin sequenties te onderscheiden zijn. In eerdere studies over het leren van docenten werd het leren van docenten veelal beschreven in termen van afzonderlijke losse activiteiten (vgl. Kwakman, 1999; Lohman & Woolf, 2001; Van Eekelen, Boshuizen, & Vermunt, 2005). Door de leerervaringen van docenten te beschrijven in sequenties van leeractiviteiten werd een meer gedetailleerd beeld verkregen van het leren van docenten.

Het onderzoek resulteerde eveneens in een nieuw inzicht met betrekking tot de manier waarop docenten leren in een context van samenwerking in interdisciplinaire teams. Gezamenlijke reflectie op problemen wordt veelal gezien als een belangrijke leeractiviteit in samenwerking tussen docenten (vgl. Briscoe & Peters, 1997; Butler, Novak Lauscher, Jarvis-Selinger, & Beckingham, 2004). Uit het onderzoek zoals beschreven in dit proefschrift blijkt echter dat docenten vooral veel leren door te luisteren naar de ideeën of ervaringen van collega's met alternatieve lesmethoden of door hen te observeren, vervolgens te experimenteren met deze methoden in de eigen lespraktijk en deze experimenten tot slot te evalueren (vgl. Shank, 2006). Dit type leerervaring blijkt eveneens positief samen te hangen met veranderingen in opvattingen van docenten. Dit resultaat bevestigt eerder onderzoek waarin verondersteld wordt dat samenwerking het leren van docenten bevordert (vgl. Putnam & Borko, 2000; Schwarz McCotter, 2001).

De analyse van de aard van de samenwerking resulteerde in een verdere specificatie van het type samenwerking 'sharing'. Samenwerking waarin docenten zowel ideeën als ervaringen met experimenten delen, gericht op gezamenlijke probleemoplossing, verhoudt zich positief tot veranderingen in opvattingen die overeenkomen met de ideeën van de vernieuwingen. Een praktische implicatie daarvan is de aanbeveling dat in toekomstige samenwerkings- en professionaliseringstrajecten docenten gestimuleerd zouden moeten worden te experimenteren met de lesmethoden van collega's om vervolgens hun (nieuwe) ervaringen met elkaar uit te wisselen. Hierbij is het vinden van een gedeeld probleem of gedeeld doel belangrijk omdat daardoor de wederzijdse afhankelijkheid van docenten wordt vergroot en de professionele ontwikkeling wordt gestimuleerd.

Tot slot werd gesteld dat samenwerking in interdisciplinaire teams veel leerpotentieel bevat voor ervaren docenten en daarmee beschouwd kan worden als een veelbelovende aanvulling op de thans meer gebruikelijke manieren van samenwerking tussen docenten in het voortgezet onderwijs.

Ann, digital log number 1

My first learning experience started off during our first team meeting. Just before the meeting I had marked a test of one of my classes who had got really low grades. […] Something had to change in that class. My first thought was: the students don't learn, they underestimate the subject matter. […] My goal was to control students' homework very strictly in future and to confront them with the fact that they did not study well since I could point out in their textbooks and assignments exactly where they could have found the corrects answers to the test questions. […] During the meeting I realized that it would be worthwhile to examine first why students caught on to the subject matter so badly, because it is a rather quick conclusion to say that they just do not work hard enough. […] In this meeting, colleagues often mentioned motivation and positive feedback as the key to activate students' learning. I realized that this was the problem in my own teaching practice. I formed the habit to control homework but mainly to compliment students in order to improve the atmosphere and work climate. So far, I do not have new grades to prove that this approach is working, but the atmosphere has improved and I notice that students are indeed more motivated when they receive a compliment. Actually, I knew this for years, but the consultation with colleagues has opened my eyes and stimulated me to use this knowledge in my teaching practice.

Iris, digital log number 3

I went to Eric in his class as I had a question. It was so much fun that I decided to stay (just by coincidence, I had a free hour). […] The students had to individually show Eric what they had done for the drawing teacher. When a student had not done the work, it was immediately agreed that it had to be done by the next class. This was done with a joke, but thereafter order and clarity and he wants immediate explanation from the students. The students who did do the work were asked to explain what the assignment entailed and how they interpreted it. The rest of the class watches and discusses as well. […] Good atmosphere, involvement, and clarity. I left the classroom with the idea that I should have attention for every student, good or bad but in a positive manner, because then you can do almost anything. My learning experience is that you can confront students with their failures and also compliment them with their product as long as you do that with humor and clarity. And the students learn from each other: how things should be done and what is expected of them.

Jeff, digital log number 6

Three weeks ago, we were in an Education Group meeting to prepare the first study afternoon. […] One of my colleagues introduced the concept 'visible learning' that requires a high level of action for both the teacher and the students during a lesson. […] In a short enumeration of possible teaching methods for 'visible learning,' my colleague mentioned the 'half-time conversation'. The teacher asks small groups of students to briefly talk with him or her about what has been done during the past few lessons. The students can learn from each other in such a manner and are, of course, forced to put aspects of the subject matter into words. […] In the two weeks following this preparatory meeting, I used the half-time conversations in four lessons and they really worked! Of course, you have to ask the right questions. […] A pleasant side effect is that you can pay more personal attention to the students in a serious environment.

Susan, digital log number 1

This year I wasn't very pleased with my own method of controlling students' homework. I want students to do their homework as asked, but I don't want to use punishment exercises. I would rather motivate them to do their homework in a different manner. In the second term of this school year, I started off with a different method. I got the idea by visiting schools in France and observing a teacher at one school. This teacher pulled out a number out of a bag at the start of each lesson and asked the student whose number on the student list corresponded to this number, to write his or her homework on the blackboard. […] I don't control students' homework anymore, but I let chance decide which student has to write down his or her answer to a homework assignment on the blackboard. […] Students think it is important to have their homework in order when it

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Scientific publications

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Lunenberg, M., Loughran, J., Schildkamp, K., Beishuizen, J., Meirink, J., & Zwart, R. (in press). Self-study in a community of learning researchers; What can we do to support teachers/teacher educators to benefit from our research? *European Educational Research Journal.*

Manuscripts submitted for publication

Meirink, J.A., Meijer, P.C., Verloop, N., & Bergen, T.C.M. (resubmitted to Teaching and Teacher Education). Understanding teacher learning: The relations of teacher activities to changed beliefs about teaching and learning.

Meirink, J.A., Meijer, P.C., Verloop, N., & Bergen, T.C.M. (submitted). How do experienced teachers learn in the workplace? Changes in teacher preferences for learning activities related to teacher learning experiences.

Meirink, J.A., Imants, J., Meijer, P.C., & Verloop, N. (submitted). Teacher learning and collaboration in interdisciplinary teams.

Other publications

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Papers

Meirink, J.A., Imants, J., Meijer, P.C., & Verloop, N. (2007, April). Learning apart together: Individual teacher learning in a context of collaborative teams. Paper presented in a symposium conducted at the annual meeting of the American Educational Research Association (AERA), Chicago, USA.

Meirink, J.A., Meijer, P.C., Verloop, N., & Bergen, T.C.M. (2006, May). *Leren van docenten in en door samenwerking nader onderzocht*. [A closer look at teacher learning in collaboration]. Paper presented in a symposium conducted at the Onderwijs Research Dagen (ORD), Amsterdam, The Netherlands.

Meirink, J.A. (2005, June). *Leren in vakoverstijgende projectgroepen?* [Learning in interdisciplinary projectgroups?] Paper presented in a symposium conducted at the Onderwijs Research Dagen (ORD), Gent, Belgium.

Meirink, J.A. (2005, May). *Tracing learning and learning activities in collaborative groups of teachers*. Paper presented at the ICO Summerschool, Nicosia, Cyprus.

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Poster presentation

Meirink, J.A. (2004, April). *Teacher collaboration: Measuring shared conceptions about learning and teaching*. Poster presented at the VOR Learning and Instruction symposium 'Collaboration: From individual to collective thinking?', Utrecht, The Netherlands.

Curriculum Vitae

Jacobiene Meirink was born in Leiden, the Netherlands on October 26th 1980. She attended secondary education at the Andreas College in Katwijk aan Zee, where she graduated in 1998. From 1998 to 2002 she studied Education and Child Studies at Leiden University, and specialized in Educational Studies and Learning Problems and Impairments. Her master's thesis focused on the development and evaluation of an orientation course for final year pupils who have an interest in studying Education and Child Studies at Leiden University. While developing the course she examined how assignments can be optimized for students with different learning styles.

In 2003, Jacobiene started as a PhD student at ICLON, Leiden University Graduate School of Teaching. Her PhD research project "Individual teacher learning in a context of collaboration in teams" was part of a concerted research program "Teacher learning in the workplace" which aimed at examining teacher learning in different learning environments. In this research program she closely worked together with two other PhD students and a postdoctoral researcher. She followed master classes and courses on *teaching and teacher education, qualitative analysis,* and on *constructing tests and questionnaires* and presented her research at both national (ORD) and international conferences (AERA). Furthermore, she was member of the board of the special interest group Learning and Instruction of the Netherlands Educational Research Association.

Currently, Jacobiene works at a new national teacher learning centre at ICLON, Leiden University Graduate School of Teaching which aims at structurally collecting current knowledge and expertise on teacher learning and training and making this knowledge accessible for schools and teacher education institutes.

Dankwoord

In dit proefschrift staan de leerervaringen van ervaren docenten in het voorgezet onderwijs centraal. Ik heb geprobeerd mijn eigen leerervaringen gedurende mijn aio-tijd te analyseren en te beschrijven op eenzelfde wijze als ik dat voor de leerervaringen van docenten heb gedaan, m.a.w. door configuraties te maken van leeractiviteiten en leeropbrengsten. Uit de onderstaande drie leerervaringen blijkt dat ik de docenten die aan mijn onderzoek hebben deelgenomen, mijn collega's, vrienden en familie veel dank verschuldigd ben. Zonder hun hulp en steun was dit proefschrift niet tot stand gekomen!

Leerervaring 1

Observeren, interviewen en mailen met docenten

↓

Nogmaals observeren, interviewen en mailen met docenten

↓

Realiseren dat docenten gek van me worden

↓

Stug volhouden; het is tenslotte voor een goed doel

↓

Leeropbrengst: Trots en blij gevoel over de inzet van de docenten voor mijn onderzoek

DOCENTEN BEDANKT!

Leerervaring 2

Brainstormen met collega's over mijn onderzoek (tijdens onderzoeksgroep of de vele koffiepauzes en borrels)

↓

Reflecteren op eigen onderzoek

↓

Bewust worden van sterke en zwakke punten in het onderzoek

↓

Experimenteren met ideeën van collega's voor de opzet en analyses van het onderzoek en voor te schrijven artikelen

↓

Leeropbrengst: Tevreden gevoel over onderzoek en bevestiging van eerder idee dat collega's heel belangrijk zijn tijdens een promotietraject

COLLEGA'S BEDANKT!

Leerervaring 3

Frustratie of blijdschap voelen over voortgang van onderzoek

Gevoelens uiten bij familie en vrienden tijdens koffie, borrels en etentjes

Luisteren naar hun opbeurende woorden of samen vieren van een tussentijds succes

Leeropbrengst: Nieuwe energie voor afronden promotieonderzoek

FAMILIE & VRIENDEN BEDANKT!

ICLON

Leiden University Graduate School of Teaching

PhD dissertation series

Hoeflaak, A. (1994). *Decoderen en interpreteren: een onderzoek naar het gebruik van strategieën bij het beluisteren van Franse nieuwsteksten.*

Verhoeven, P. (1997). *Tekstbegrip in het onderwijs klassieke talen.*

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Meirink, J.A. (2007). *Individual teacher learning in a context of collaboration in teams.*

Nijveldt, M. (2007). *Validity in teacher assessment: An exploration of the judgement processes of assessors.*