Individual teacher learning in a context of collaboration in teams

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Chapter 5

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 not only 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 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.

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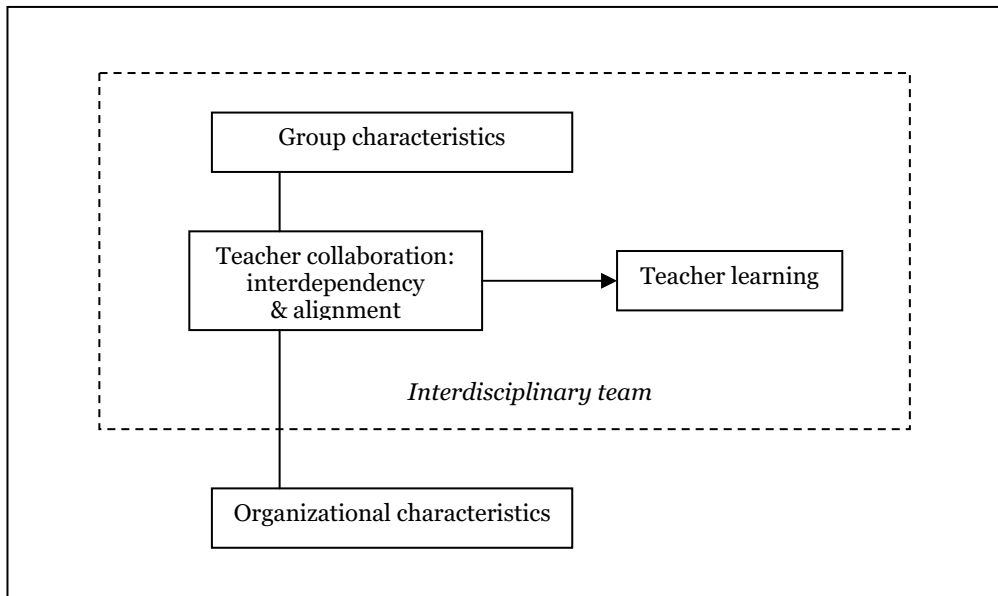
- How do teachers collaborate in interdisciplinary teams and how does this relate to teacher learning with respect to the topic 'active and self-regulated student learning'?

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? - how do teachers learn?	- changes in beliefs about teaching and learning - 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%).

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[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 2
	  colleagues
		- Content 6
		- Learning from 0
		  colleagues
			- Content 2
			- Learning from 0
			  colleagues
				- Content 7
				- Learning from 5
				  colleagues
					- Content 5
					- Learning from 2
					  colleagues

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 *congruent* with aims of reform	2	- Frequency of changed beliefs *congruent* with aims of reform	2	- Frequency of changed beliefs *congruent* with aims of reform	5	- Frequency of changed beliefs *congruent* with aims of reform	7
	- Frequency of changed beliefs *incongruent* with aims of reform	3	- Frequency of changed beliefs *incongruent* with aims of reform	1	- Frequency of changed beliefs *incongruent* with aims of reform	1	- Frequency of changed beliefs *incongruent* with aims of reform	1	- 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