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Individual teacher learning in a context of collaboration in teams

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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 correct 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 work 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.

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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. Mathijssen, 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 (Mathijssen, 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, Beijgaard, 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.