

Teacher learning in the context of educational innovation: Learning activities and learning outcomes of experienced teachers

Inge Bakkenes^a, Jan D. Vermunt^{a,*}, Theo Wubbels^b

^a *VLOS Institute of Education, Utrecht University, Heidelberglaan 8, 3584 CS Utrecht, The Netherlands*

^b *Faculty of Social and Behavioural Sciences, Utrecht University, Heidelberglaan 1, 3584 CS Utrecht, The Netherlands*

Received 9 January 2008; revised 8 July 2009; accepted 22 September 2009

Abstract

This longitudinal study was aimed at increasing our understanding of how teachers learn. It was conducted within a national innovation programme in secondary education. During one year 94 teachers reported six learning experiences using digital logs. The learning experiences were content-analysed in terms of learning activities and learning outcomes. The former comprised six main categories, namely experimenting, considering own practice, getting ideas from others, experiencing friction, struggling not to revert to old ways, and avoiding learning—the first two categories being reported most frequently. Reported learning outcomes referred to changes in knowledge and beliefs, emotions, practices, and intentions for practice, with changes in knowledge and beliefs being reported most frequently and changes in teaching practices being reported rarely. Learning activities were associated significantly with all measures of learning outcomes. Type of learning environment was significantly associated with learning activities and learning outcomes. Results are discussed with respect to ways of fostering teacher learning. © 2009 Elsevier Ltd. All rights reserved.

Keywords: Teacher learning; Professional learning; Workplace learning; Educational innovation; Self-regulated learning; Teacher professional development

1. Introduction

Teachers are supposed to be experts in learning. Although there is a lot of research on how teachers may promote student learning, the scarcity of systematic research on understanding and improving the learning processes of teachers themselves is striking. However, teachers are the most important agents in shaping education for students and in bringing about change and innovation in educational practices. Too often educational innovations have failed because they did not recognize the need for teacher learning (cf. Lieberman & Pointer Mace, 2008).

There is a growing awareness of the necessity of assisting teachers in their professional development. Numerous efforts

are being made to enhance teacher learning, with varying degrees of success. Few of these efforts, however, are based on scientific understanding of how teachers learn at work (Beijaard, Korthagen, & Verloop, 2007). A sound conceptual framework for describing processes of teacher learning in professional practice does not yet exist. Moreover, systematic research on teacher learning is scarce. The present study aimed to contribute to such a conceptual framework by exploring secondary school teachers' learning activities and learning outcomes in the context of educational innovation.

Until recently, the study of learning mainly focused on student learning. Research on teacher learning focused on student teachers in initial teacher education (Oosterheert & Vermunt, 2001). In recent years some attention has been paid to the learning activities of experienced teachers in the workplace (Kwakman, 2003; Lohman & Woolf, 2001; Van Eekelen, Boshuizen, & Vermunt, 2005). These learning activities were, however, mostly characterized as concrete,

* Corresponding author. Tel.: +31 30 2532158; fax: +31 30 2532200.

E-mail address: j.vermunt@uu.nl (J.D. Vermunt).

visible activities, such as searching for information on the internet, exchanging ideas with colleagues, helping students during classroom activities, etc. The description of learning activities was not focused on teachers' thinking processes associated with their visible activities. Different teachers who are apparently engaged in the same visible activity may actually use quite different thinking processes leading to different learning outcomes. The present study focused on both the visible (overt) and covert learning activities that secondary school teachers engage in when confronted with educational innovation, on the learning outcomes teachers report, and on the relations between learning activities, learning outcomes, and type of learning environment.

1.1. Active and self-regulated student learning

A comprehensive introduction into active and self-regulated learning (ASRL) is beyond the scope of this article. In the scientific literature, a strong research base for the value of student ASRL can be found. Beginning with the pioneering work of Brown (1978) and Flavell (1979), over the last 30 years research on metacognition, self-regulation, and self-regulated learning has flourished (Alexander, 2008; Boekaerts, 2002). One line of research has focused on the metacognitive knowledge and beliefs learners have about their own cognitive functioning and related factors (the more static aspects of metacognition). Another line of research has focused on the more dynamic aspects of metacognition, that is, the actual, on-line regulation of learning processes, the skills learners need to self-regulate their learning processes and the metacognitive experiences associated with self-regulated learning (Efklides, 2006).

According to Pintrich (2004), most models of self-regulated learning (SRL) share four general assumptions: (a) the active, constructive assumption, according to which learners are viewed as active participants in the learning process; (b) the potential for control assumption, stating that learners can potentially monitor, control and regulate their own cognition, motivation and behaviour, as well as some environmental features; (c) the goal, criterion or standard assumption, stating that there is some kind of goal, criterion or standard against which the course of the learning process is assessed and decisions about continuation or adjustment are made; and (d) the assumption that self-regulatory activities are mediators between personal and contextual characteristics and actual achievement or performance. In his comprehensive framework for SRL, Pintrich (2004) discerns phases of SRL and areas for regulation. The phases correspond to the well-known ordering of consecutive self-regulatory activities: forethought, planning and activation (Phase 1); monitoring (Phase 2); control (Phase 3); and reaction and reflection (Phase 4). Areas for regulation include cognition, motivation/affect, behaviour and context. Several researchers have developed procedures and instruments to investigate SRL (Zimmerman, 2008), interventions to improve students' skill in SRL (Dignath & Büttner, 2008; Weinstein, Husman, & Dierking, 2000), comprehensive teaching models that incorporate fostering SRL (Boekaerts &

Corno, 2005), or have broadened the concept of SRL to include cooperative learning and co-regulation (Volet, Summers, & Thurman, 2009).

Research on SRL is mostly focused on students at primary or secondary school level doing academic tasks in which the phases of SRL can be gone through in a time-ordered sequence. Within the SRL-perspective, student learning is often studied in a 'top-down' way, through the lens of theories or models of SRL (Pintrich, 2004). In the other main paradigm, the student approaches-to-learning perspective, student learning is mostly studied in a bottom-up way. In this perspective students' learning activities or approaches are studied through interviews, questionnaires of observations and categories of description are derived capturing the main similarities and differences found in the data, for example, by means of phenomenography or informed content analysis (Ellis, Goodyear, Calvo, & Prosser, 2008; Entwistle, McCune, & Scheja, 2006; Lonka, Olkinuora, & Mäkinen, 2004). Research on teacher learning and workplace learning is often conducted from a similar perspective as the approaches-to-learning perspective in student learning. Teacher learning studies from a SRL-perspective are rare, a few exceptions being the studies of Randi (2004) and Van Eekelen et al. (2005). Van Eekelen et al. (2005), for instance, showed that spontaneous teacher learning is almost never as planned and sequenced in a time-ordered sequence as models of SRL describe.

The roles that teachers are supposed to fulfil in teaching methods based on SRL are very different from those in more traditional, lecture-based teaching. In more traditional education teachers should be able to explain the subject-matter well, to regulate their students' learning and to motivate students to learn. In teaching methods based on ASRL, however, teachers are expected to fulfil roles such as diagnostician, challenger, model, and activator, and to monitor and reflect on students' learning processes (Vermunt & Verloop, 1999). They should be able to model metacognitive strategies for students, coach students in the acquisition of those strategies and fade their support when students become more proficient in their use (Collins, Brown, & Newman, 1989). Teachers should be able to design assignments, supervise project groups, coach cooperative learning, assess skills of self-regulated learning, etc. Elsewhere, this different pedagogy was described as process-oriented teaching (Vermunt, 1995); it is aimed at the integrated teaching of learning and thinking strategies, on the one hand, and domain-specific knowledge on the other. For many teachers this represents a fundamental change in their pedagogical role.

1.2. Teacher learning

What counts as good teaching is evidently subject to change. Shulman and Shulman (2004) developed a model of teaching with the following components: (a) *Vision*. A teacher must have a certain vision on teaching and student learning. (b) *Motivation*. A teacher must have the willingness and motivation to invest energy in a certain way of teaching. (c)

Understanding. A teacher must understand the concepts and principles on which a particular pedagogical model is based. (d) *Practice.* A teacher must be able to realize a certain way of teaching into practice. (e) *Reflection.* A teacher must be able to reflect on his or her experiences in order to learn from them. (f) *Community.* A teacher must be able to function as a member of a school community and to form learning communities with other teachers and colleagues. The relations between the various components are supposed to be particularly important. Small discrepancies, for example, between teachers' vision and practice, may generate motivation to learn. Large discrepancies, however, may discourage learning and lead to withdrawal, despair, or frustration.

Educational innovation succeeds or fails with the teachers who shape it (Lieberman & Pointer Mace, 2008). When a school leadership decides to change the pedagogy of the school, teachers are expected to adapt their way of teaching accordingly. This makes them learners along all dimensions of Shulman and Shulman's (2004) model: they have to develop another vision on learning and teaching, be motivated to learn about the new pedagogy, understand what the innovation is good for, develop skills to bring the innovation into practice, reflect on their experiments with the new pedagogy in order to learn, and form part of a community of teachers who all are learning new things.

There are many prescriptive models on how teachers should learn best. For example, Clarke and Hollingsworth (2002) discuss a model of teacher professional growth. Their interconnected model suggests that change occurs through the mediating processes of "reflection" and "enactment" in four domains that constitute the teacher's world: the personal domain (teacher knowledge, beliefs, and attitudes), the domain of practice (professional experimentation), the domain of consequence (salient outcomes), and the external domain (sources of information, stimulus or support). They suggest that there are multiple growth pathways between the domains. Little (2007) stresses the importance of exchanging teaching experiences with one another for teachers' professional growth. These experiences can refer to a range of workplace contexts: in staffroom or hallway encounters, regularly scheduled meetings, professional development events, and activities focused on reviews of school assessment data or samples of student work. She advocates the systematic research of, and talk about, one's own practices as a vehicle for fostering teachers' professional growth.

However, only a few empirical studies have been conducted so far on the way teachers actually learn and the learning activities they employ (Kwakman, 2003; Lohman & Woolf, 2001; Van Eekelen et al., 2005). In the main, these studies discerned four types of learning activities: (a) learning by experimenting, for example, trying out a new teaching method or lesson format, making new materials or tests, etc.; (b) learning in interaction, for example, talking with students and colleagues, sharing materials, participating in project groups; (c) using external sources, for example, reading books and magazines, attending a seminar; and (d) consciously thinking about one's own teaching practices (reflection).

A problematic feature of these categorizations is that there is no clear distinction between individual and interactive

activities. In our view, learning in interaction should not be a separate category because each of the other three types of learning activities can be conducted both individually and interactively. Another problem is that the categories do not distinguish mental processes. The kind of thinking processes teachers engage in, for example, seem to determine whether teachers learn from collaboration and what they learn (Little, 2002). Similarly, in student learning, the fact that a student underlines fragments in a study text as such does not make the primary difference; but whether he or she does so as a function of a deep or surface approach to learning does.

In the absence of much knowledge about the thinking component of teachers' learning activities, we can draw on studies of student learning. In those studies, learning activities are conceptualized as the thinking activities students use to learn. The quality of these learning processes determines the quality of the learning outcomes students achieve (Lonka et al., 2004; Richardson, 2000; Vermunt, 2005). In a review of research on student learning, Vermunt and Vermetten (2004) concluded that four qualitatively different ways of learning were repeatedly found: (a) *Reproductive learning*, meaning that students study subject-matter thoroughly and in detail, trying to memorize it to be able to reproduce it. (b) *Meaning-oriented learning*, in which students try to relate different parts of the study materials, try to gain an overview, critically process information and focus on understanding what they study. (c) *Application-oriented learning*, which focuses on applying the things one learns in practice, visualizing the subject-matter and thinking about how it can be used in real life. (d) *Undirected learning*, meaning that students do not really know how to learn, and experience a lot of problems in learning. Recent studies yielded some insights into the learning activities of student teachers. Oosterheert and Vermunt (2001) found three main approaches to learning to teach. Student teachers adopting a *performance-oriented approach* concentrate on improving their immediate performance in teaching practice. Student teachers adopting a *meaning-oriented approach* also try to understand the underlying processes that play a role in teaching practice. A *survival-oriented approach* is characterized by experiencing a lot of problems, the main aim being to survive every new day of classroom teaching, and learning not being a primary concern.

Tynjälä (2008) presented a comprehensive review of recent research on workplace learning. Based on recent studies, she summarized how people learn at work as follows: (a) by doing the job itself; (b) through co-operating and interacting with colleagues; (c) through working with clients; (d) by tackling challenging and new tasks; (e) by reflecting on and evaluating one's work experiences; (f) through formal education; and (g) through extra-work contexts. Eraut (2004) presented a typology of learning outcomes in the context of workplace learning. He discerns outcomes in a broad array of domains: (a) task performance; (b) awareness and understanding; (c) personal development; (d) teamwork; (e) role performance; (f) academic knowledge and skills; (g) decision making and problem solving; and (h) judgement.

According to Tynjälä (2008), workplace learning refers to processes through which the individual or group transforms its ways of thinking and acting. Accordingly, we define teacher learning as an active process in which teachers engage in activities that lead to a change in knowledge and beliefs (cognition) and/or teaching practices (behaviour). The word change here is used in a neutral way. Learning is not necessarily an improvement in terms of educational norms or policy goals. Based on Fenstermacher (1994), Korthagen (2001), and Putnam and Borko (1997), we define teacher cognition as an integrated whole of theoretical and practical insights, beliefs, and orientations (personal goals, expectations, attitudes, etc.). Changes in behaviour are described in terms of changes in teaching practices. In principle every activity can lead to a change in knowledge, beliefs or practices. Therefore, every activity can be a learning activity, even when a teacher did not have the intention to learn from that activity.

1.3. The present study

The present study was conducted within the context of a national innovation programme in Dutch secondary education, aimed at encouraging teachers to foster students' ASRL. The innovation focused on the higher grades (15–18 years of age) of upper level secondary education, the grades preparing for higher education. It was based on three general ideas (see *Inspection of Education*, 2003): (a) *Self-regulation of learning*. Students have to learn to regulate their own learning process, considering the importance of life-long learning. This means that students should gradually become the owners of their own learning process. It also implies more attention to the affective aspects of learning. (b) *Learning as active construction of knowledge*. Students learn better when they actively construct their own knowledge; and (c) *Collaborative learning*. Students should learn in interaction with fellow students. Collaborative learning is seen as a powerful learning environment and collaborative skills are believed to be necessary for future work.

The reform implied a fundamental change in teachers' educational and pedagogical role. The general aim of the renewal was to prepare students more effectively for higher education and lifelong learning. A more specific aim was for students to learn how to regulate their own learning processes. Teachers were therefore expected to focus more on facilitating, supporting and monitoring student learning processes and less on transmitting subject-matter knowledge to students, and to foster students' ASRL in their daily work practice. However, in the period of early implementation of the reform, hardly any practical examples of instructional methods for this new teaching approach were available. Schools were expected to develop suitable pedagogy themselves, with the help of educational advice centres. Evaluation studies (see *Inspection of Education*, 2003) reported implementation processes that often lacked a clear vision and policy. Teachers' daily classroom practice did not show much self-regulated learning and activating pedagogy. Many teachers still focused particularly

on the subject-matter and learning outcomes and far less on students' learning processes (De Kock, 2004). In general, teachers varied in the extent to which they stimulated students to learn actively, regulated the learning processes of pupils, and guided, discussed and evaluated learning processes of individual students and groups (Bolhuis & Voeten, 2004).

1.3.1. Research questions – hypotheses

The present study addressed the following research questions: (a) Which learning activities do experienced secondary school teachers undertake when dealing with educational innovations? (b) Which learning outcomes do experienced secondary school teachers report? (c) How are teachers' learning activities related to the learning outcomes they report, in terms of changes in knowledge and beliefs, emotion and practices? (d) How is the type of learning environment related to the learning activities teachers employ and the learning outcomes they attain?

Although the present study is exploratory in many respects and no "real" hypotheses can be drawn as in experimental research, some predictions can be derived from the theoretical framework on teacher learning and student learning described above. First, the main categories of learning activities found in earlier research on teacher learning and workplace learning are expected to be found also in the present study (Kwakman, 2003; Tynjälä, 2008), mainly experimenting, getting ideas from others, and reflecting on practice (Hypothesis 1a). Second, it was predicted that in the present study also the more problematic aspects of learning as found in the literature on student learning, such as undirected learning, disorganized studying and a survival-oriented approach, will show up as distinct categories (Lindblom-Ylänne, 2003; Meyer, 2000; Richardson, 2000) (Hypothesis 1b). Third, the study was expected to illuminate the more covert aspects of teacher learning, teachers' thinking processes during learning (Oosterheert & Vermunt, 2001), such as a meaning, performance and reproduction orientation (Hypothesis 1c). Fourth, teacher learning in the workplace was not expected to show the time-ordered sequence, that is, forethought, monitoring, control and reflection afterwards (Hypothesis 1d), as the main models of SRL describe for academic student learning (Pintrich, 2004; Van Eekelen et al., 2005).

With respect to the second research question, a broad spectrum of learning outcomes was predicted to be found (Hypothesis 2), being cognitive, affective and behavioural in nature (Eraut, 2007; Pintrich, 2004).

Regarding the third research question, significant associations between learning activities and learning outcomes were expected to be found; specifically, between learning activities such as reflecting on practice and getting ideas from others, on the one hand, and learning outcomes such as changes in knowledge and beliefs, on the other, and between experimenting and changes in practice (Hypothesis 3). The associations were expected to point to qualitatively different forms of teacher learning (Entwistle & McCune, 2004; Lonka et al., 2004; Oosterheert & Vermunt, 2001).

Finally, as regards the fourth research question, it was expected (Hypothesis 4) that learning environments organized to promote teacher learning would lead to better learning activities and outcomes than informal learning in the workplace (Hoekstra, Beijaard, Brekelmans, & Korthagen, 2007; Meirink, Meijer, & Verloop, 2007; Zwart, Wubbels, Bergen, & Bolhuis, 2007).

2. Method

2.1. Sample

Originally, a total of 100 teachers participated in the study. However, during the year of data collection six teachers fell out for various reasons, such as sickness and pregnancy, so 94 experienced teachers participated in the study, spread over 30 schools in different parts of the Netherlands. Teachers who taught in the upper level of secondary education and had from 3 to 40 years ($M = 18.55$ years, $SD = 9.67$; see Table 1) of teaching experience were recruited – the criterion of a minimum of three years was based on Berliner's (1988) professional stages. There were 53 male and 41 female teachers. Their subjects covered all the major areas, with science, languages, mathematics, and economics being the groups with higher frequency (see Table 2).

Since the present study was focused on teachers' learning activities and outcomes at the workplace, teachers from three different learning environments were selected to ensure a variety of learning contexts and activities. Approximately one-third of the teachers ($n = 32$) in our sample were not engaged in any form of organized learning environment at their school. These schools were included to illuminate informal learning activities and these teachers were recruited individually via school principals and teachers' subject-specific association mailing lists, and joined the study voluntarily. About one-third of the teachers ($n = 28$) were engaged in a reciprocal peer-coaching project at their school, and about another one-third ($n = 34$) participated in collaborative project groups at their school. The reciprocal peer-coaching and the collaborative project groups were both organized around the topic of "promoting students' ASRL". The teachers who participated in peer-coaching projects and those in collaborative project groups were recruited through existing contacts between the university and schools, through their principal. Most of these teachers joined the project and the research voluntarily.

2.2. Instrument and procedure

Data were collected by e-mail through digital logs. The teachers were asked to describe a learning experience once

Table 1
Number of teachers as a function of teaching experience.

	Years of teaching experience							N
	3–5	6–10	11–15	16–20	21–25	26–30	>30	
Number of teachers	5	23	14	8	18	15	11	94

Table 2
Distribution of participants by teaching subject and gender.

Teaching subject	Male	Female	Total
Mathematics	6	5	11
Chemistry/Science/Biology	19	5	24
Languages	11	18	29
Art History	1	4	5
Economics	10	3	13
History	1	1	2
Geography	2	2	4
Social Studies	2	3	5
Physical Education	1	0	1
Total	53	41	94

every six school weeks, over a period of one year. They were explicitly told that both positive and negative learning experiences could be described and that they could report any of their learning experiences they had during the six-week period. This means that teachers who were involved in organized learning (peer-coaching or collaborative project groups) were not obliged to write about something they had learned in coaching or the project group. They could report any learning experience that had been significant to them and that had to do with student ASRL. This resulted in a total of six learning experiences per teacher.

At the start of the study the teachers were trained in writing a log. They were asked to describe their learning experience as a small story containing seven elements. They were asked to express in their own words *what* they had learned, *how* they had learned it, and which *thoughts, feelings, and concerns/goals* had been involved (if any). Furthermore, teachers were asked to indicate what had served as a *reason* (if any) for the learning experience and whether and how *other people* had been involved. The last two elements were included because learning, even when considered from an individual perspective, often is a social and interactive process. Finally, teachers were asked to describe how the learning experience was *linked to the topic* of student ASRL. As an aid to writing the logs the teachers received a plastic card on which the requested elements were visualized (see Appendix A). If elements of the description by any teacher were unclear to us, we asked for a clarification by e-mail.

2.3. Data analysis

Every digital log consisted, in principle, of six reported learning experiences. These learning experiences were content-analysed in terms of learning activities and learning outcomes. Out of each learning experience text fragments were selected that referred to changes in knowledge, beliefs or practices and to the activities that led to such alterations. These fragments were summarized in the reported chronological order so a sequence could become visible. Sequences were different in length. Often a sequence consisted of a chain of activities and (intermediate) learning outcomes. Learning

Table 3
Indicators of change and typical examples in teacher reports (derived from Zwart et al., 2007).

Indicator of change	Example
1. Statements regarding learning outcomes, made by the teachers themselves	I have learned that...
2. Teacher reports of the wish to carry out the behaviour more often	I'm sure I'm going to do this the same way next time
3. The use of comparative and superlative degree in teacher reports of events	I think about these things now much more than I used to do
4. The use of verbs that incorporate change in teacher reports of events, like: to change, to move, to gain, to go back to, etc	I think I gain a lot by using this method
5. The use of change signalling adverbs in teacher reports of events, like: before, different, a different way, suddenly, never before, etc.	I tend to do things differently now
6. Utterances regarding spontaneous insights made by the teacher.	Now I see!
7. Utterances indicating surprise, pride or uncertainty made by the teacher.	I was very surprised that the students liked it

outcomes were distinguished from learning activities by looking for indicators of change in the language used (see Table 3).

To identify learning activities and outcomes the sequences were analytically “cut up”. Each time a (intermediate or final) learning outcome was reported, the activity that the teacher had connected to this outcome was treated as a separate learning activity.

Based on all summarized sequences, an overview was made of learning activities and learning outcomes with the help of the sensitizing concepts (Glaser & Strauss, 1967) of our theoretical framework. Based on the literature on learning activities and learning outcomes discussed in the Introduction, three categories of learning activities and two categories of learning outcomes were initially defined.

The initial categories of learning activities were: (a) *experimenting* (trying out new practices); (b) *getting ideas from others* (through observing, conversation, attending a course, reading books, etc.); and (c) *reflecting on practice*. These three categories allowed us to combine overt (visible) activities with covert (thinking) activities and other process characteristics, because each of these three learning activities can be done or planned spontaneously, individually or together with others, and in a performance-oriented or meaning-oriented way.

As categories of learning outcomes the following two were initially defined: (a) *changes in practices*, and (b) *changes in knowledge and beliefs* (including emotions). This distinction was based on our definition of teacher learning as an active process in which teachers engage in activities that lead to a change in knowledge and beliefs (cognition) and/or teaching practices (behaviour). Since basically any change in practices or knowledge and beliefs could be reported to be a learning outcome, we started from these two basic categories. The only restriction we had given to the respondents was that the reported learning experiences had to be related to the innovation of the curriculum. Therefore, we specifically looked for changes in practices and/or knowledge and beliefs regarding student ASRL and process-oriented teaching.

In addition to these basic categories, new concepts were derived from the data which were used to develop our analytical framework further. Four researchers each independently analysed 15 digital logs and listed the learning activities and learning outcomes they identified in the data. Discussing

and aligning the independent findings led to a shared framework that distinguished six different types of learning activities and eleven types of learning outcomes that will be discussed in the Results section (see Table 7 for an overview). Subsequently, each of the six sequences (summarized learning experiences) per teacher was coded for learning activities and learning outcomes.

2.3.1. Interrater reliabilities

Interrater reliabilities were determined separately for learning activities (six categories), learning outcomes (four categories), changes in knowledge and beliefs (three categories), intentions for practice (three categories), changes in practices (two categories), and changes in emotions (three categories). Two independent raters coded subsets of the digital logs. To determine the number of fragments needed, the $2n^2$ rule was used.¹ This rule, first proposed by Cicchetti (1976), states that the number of observations needed for a reliable interpretation of a computed kappa should be $2n^2$ or more. Thus, with $n = 3$ observational categories the number of observations should be 18 or higher and with $n = 7$ categories the number of observations should be 98 or higher. For example, the minimum number of fragments from the digital logs needed to determine the interrater reliabilities for learning activities was $2(6)^2 = 72$. For learning activities, 74 fragments were used, resulting in 67 agreements in coding (90.5%; Cohen's kappa = .88). For the main categories of learning outcomes, 32 fragments were used (2×4^2), resulting in 30 agreements (93.7%, Cohen's kappa = .92). For changes in knowledge and beliefs, 18 fragments were used and in 16 cases there was agreement between the raters (88.9%, Cohen's kappa = .83). For intentions for practice also 18 fragments were used, resulting in 17 agreements (94.4%, Cohen's kappa = .91). Eight fragments were used for changes in practices and in seven cases there was agreement between the raters (87.5%; Cohen's kappa = .75). Finally, for changes in emotions, 18 fragments were used resulting in 100% agreement between the two raters (Cohen's kappa = 1.00).

Frequencies and total percentages of reported learning activities, learning outcomes and combinations of learning activities by learning outcomes were then calculated for the

¹ For the number of categories the symbol n is used here.

whole group of teachers and for the subgroups which were in the three different types of learning environments. Cross-tabulations were conducted with chi-square tests of statistical significance to determine the associations between learning activities, learning outcomes and learning environments.

3. Results

3.1. Types of learning activities

To answer the question which learning activities were undertaken by experienced school teachers, the analysis resulted into the following six different categories. Analysis of the six learning logs of the 94 teachers revealed 735 instances of reported learning activities. Most instances reported by the teachers were “considering own practice” and “experimenting”, each accounting for about 33% of all learning activities. Each of the categories “getting ideas from others” and “experiencing friction” comprised about 15% of all reported learning activities, while “struggling not to revert to old ways” and “avoiding learning” were reported least. In Table 4 the frequencies and percentages of the various instances of teachers’ reported learning activities by category are presented.

3.1.1. Experimenting

Experimenting is a combination of purposefully trying out something new in practice and some form of reflection about it. The new thing that was tried out could be a new lesson format or teaching strategy, a new approach to interacting with students, a new way to prepare lessons, etc. Teachers had different reasons for experimenting in their teaching. One reason was a positive or negative event in one’s own classroom practice, for example, unexpectedly good or bad student achievements, or a request from students. Another incentive for experimenting was when others stimulated, required or expected the teacher to experiment. A third incentive to experiment was a sudden event or situation in which the teacher decided, impulsively, and on the spot, to do things differently. An example from the digital logs of such a spontaneous experimenting is the following:

I was standing in front of my classroom, ready to start with my demonstration, when a student asked me what I was

going to show them. I opened my mouth to start explaining it to her when all of a sudden I thought of doing things completely differently for a change. Instead of telling her what I was going to do I asked her to come forward, to look at the instruments on the table and to tell the classroom what she thought I was going to do and what the results could be. I never did such a thing before but it worked out great. She started thinking out loud and other students responded, and it became an intensive group discussion in which students used the things we had discussed in the previous lesson. It felt great! (Teacher of Chemistry)

Another teacher gave an example of planned experimenting:

I noticed that the students view the lessons as separate entities, they don’t seem to connect them. In Art history it is important that they understand how one movement is based on another and that artists often use aspects out of earlier periods. I experienced that students have trouble with that. That’s why I decided to let them make a summary on a big timeline that I hung on the wall. I wanted them to visualize the chronological course of movements and the fact that they overlap. I really tried to think of a way in which the students had to do it for themselves and I’m very pleased with the results. Students really seem to get it now and they enjoyed the assignment. (Teacher of Art History)

3.1.2. Considering own practice

This learning activity refers to reflecting on teacher’s own teaching practice and/or on students’ learning or functioning. Teachers considered their own practice and/or students’ learning either in a self-initiated way based on their own ideas, or because of an external stimulus (e.g., feedback from a colleague). Some teachers reported having considered a situation on their own, but including the arguments of colleagues from an earlier discussion about a similar situation. Others wrote about bringing in a case during a meeting and reflecting together with colleagues on that specific case. Similarly with the other learning activities, considering one’s own practice could be connected to a specific incident or cover a longer period, and be conducted in a performance-oriented way or in a more meaning-oriented way. An example of self-initiated individual consideration is:

A few days after my bad experience, when I was preparing the next lesson, I was aware of the fact that the lesson didn’t go as I had planned it and I started to think about my own contribution to it. The day itself I felt angry and frustrated but now I realized that the students needed more structure. In my attempt to let students regulate their own learning process I took it a little too far and gave them too much responsibility all at once. I have to build it up more. (Teacher of Dutch)

3.1.3. Experiencing friction

A friction refers to a discrepancy between what is expected or wanted and what actually happens. Experiencing friction consists of noticing this discrepancy and appraising it. In the

Table 4
Frequencies and percentages of reported learning activities.

Learning activities	<i>f</i>	%
Experimenting	234	31.8
Considering own practice	244	33.2
Experiencing friction	109	14.8
Struggling not to revert to old ways	33	4.5
Getting ideas from others	110	15.0
Avoiding learning	5	0.7
Total	735	100.0

teachers' logs two forms of frictions were reported: (a) a completely unexpected event (positive or negative) took place, and (b) the realization that a teacher's usual teaching approach did not work any longer. The former always took the form of an incident, the latter usually referred to a longer period of time during which there was a growing feeling of discontent. Experiencing friction usually was an incentive for other learning activities such as considering own practice (see above) and/or experimenting. However, experiencing friction was also reported as a distinct learning activity that led to awareness of a discrepancy and/or a strong emotion, such as disappointment or pride, related to the discrepancy. Teachers experienced friction individually or with others. An example of experiencing a negative unexpected event is:

I had a spontaneous accidental experience. I had given my students an assignment that they could work on independently. I felt confident and enthusiastic because I had worked hard on the assignment and I was well-prepared. As it turned out only half of the students started working, the other half didn't seem interested at all. I felt irritated and disappointed because the majority of the students acted very passively. It made me feel passive too. If they don't care why should I care? Why bother? (Teacher of English)

3.1.4. *Struggling not to revert to old ways*

When teachers try to change their way of teaching they sometimes fall back on old patterns, even when they are no longer in the experimental phase. Two forms of struggling with this tendency emerged from the data: (a) consciously suppressing "old teaching practices" (and replacing them with new practices), and (b) submitting to the behavioural tendency and, thus, showing "old" practices (often connected with feelings of guilt). When this learning activity was conducted in a meaning-oriented way, the teachers' reflection was often directed at the personal struggle with their behavioural tendencies (why am I doing/wanting this?) and its consequences. An example of struggling not to revert to old ways is:

The second half of my lesson became a bit of a mess. All students were talking. I wasn't sure about the effectiveness of it all. I looked at my watch and I worried about the short amount of time left. I really felt tempted to take things in my own hand again and give a nice, frontal, efficient summary. But I didn't. I visited each of the groups and noticed that there was a lively discussion going on and that the students came with really good arguments. I felt proud of myself for being able to resist that little voice inside me. Maybe I should have more confidence in the students. (Teacher of Biology)

3.1.5. *Getting ideas from others*

"Getting ideas from others" refers to activities in which a teacher consciously takes notice of the views or practices of others and evaluates them. Teachers employed such learning

activities individually (e.g., reading a book, attending a lecture, observing a colleague doing something), or with others (e.g., developing materials together, discussing student behaviour with a colleague, getting tips or ideas from a colleague). These activities were not necessarily aimed at learning, sometimes the teachers' aim was just working together and the learning outcome might in that case be considered as a by-product of working with others.

The ideas, insights, etc., that resulted from these learning activities often formed an incentive for other learning activities. Teachers reported that seeing a colleague do something gave them an idea for an experimenting of their own. Likewise, teachers often used ideas from others as an incentive for considering their own practice. However, getting ideas from others also stood on its own in some of the instances. Some examples of getting ideas from others are:

I saw that my colleague had placed the tables in her classroom in small groups. It gave me the idea that maybe I could try working in small groups once. Students might like it. (Teacher of Economics)

I participated in a workshop in which one of my colleagues demonstrated how he works with 'thinking skills'. It really inspired me. It's another subject of course, but the basic ideas I can use as well. It could be helpful in fighting the passiveness of students. (Teacher of French)

3.1.6. *Avoiding learning*

Some teachers engaged in activities that allowed them to avoid learning about the new teaching methods. They made sure that they would not learn certain things by organizing their lessons, materials or experiments in such a way that the results would certainly prove that the new approach did not work and their existing theory of practice would be confirmed. An example was a teacher who was convinced that students were unable to plan their own work and were too lazy to properly spread their work over time. He gave the students an assignment at the beginning of the year, consisting of different parts that had to be done before the end of the year. For the whole year, he did not remind the students of the assignment or guide the students towards completing it. At the end of the year, he reported he had learned that he had been right all along, since the majority of the students had not finished the assignment in time. Another example is:

From time to time I use a different teaching format, just to confirm to myself that all these new ideas are naive and idealistic. Last week I didn't give instruction. Instead, I let the students work on the assignments in their book, and when they had questions I told them to look them up on the internet or I reminded them that they had to find the answers in their book. In another, comparable class I gave my lessons as usual. At the end of that week I gave the students a test. The results in my experimental group were clearly lower than the results in my control group. This proves that there is nothing wrong with my way of teaching

and that new methods aren't good just because they are new. (Teacher of Mathematics)

I realized I don't often do that in my class: gearing my teaching to students' everyday lives. (Teacher of Dutch)

3.2. Types of learning outcomes

The second research question referred to the learning outcomes the teachers reported. In line with the description of learning given earlier, learning outcomes were defined as changes in knowledge and beliefs or in teaching practices. Table 5 presents an overview of the frequencies and percentages of the various instances of teachers' reported learning outcomes by category. As shown in Table 5, teachers reported mainly changes in knowledge and beliefs (50% of all instances) followed by changes in emotions (35%), intentions for practice (13.5%), and changes in actual teaching practices (1.4%). News ideas were reported most frequently of all learning outcomes. The various categories of reported learning outcomes are described below.

3.2.1. Changes in knowledge and beliefs

The following type of changes in knowledge and beliefs were manifested in the teachers' reports:

3.2.1.1. Awareness. When teachers reported awareness, alertness, attentiveness or consciousness as learning outcomes, they were coded as "awareness". Awareness refers to a situation in which teachers consciously noticed or detected something that they valued as important. They were not, or less, aware of it before. That which was noticed or detected, however, had not yet been analysed and converted into a theoretical or practical insight. For example:

I noticed that after all I do like to keep matters in my own hands. (Teacher of Latin)

3.2.1.2. Confirmed ideas. A reported outcome was coded as "confirmed ideas" when the text of the log clearly indicated that the idea or insight already existed before, and that the result of the learning activity was that the teacher felt more strongly about the idea, or that the idea became more deeply rooted. For example:

For some years now I've been thinking about what a school should be and what a school should do. I got more and more convinced that schools should not just deliver what society asks for, but should try to produce students who can give new impulses to society, who are critical and who do more than just consuming. Reading two articles in an educational journal made me even more convinced. (Teacher of English)

3.2.1.3. New ideas. An outcome was coded as "new ideas" when the teacher's report clearly indicated that the idea or insight did not exist in this form before the learning activity had taken place. An example is:

The students had to write an essay. (...) To start the creative process I drew a concept map on the blackboard and invited the students to come up with different aspects of the subject. I started by giving them two aspects myself, but I didn't want to impose any other ideas on them. The students hardly responded and I started to feel irritation. To buy myself some time to think of a good strategy, I announced that I would go away for a few minutes, to get a cup of coffee. When I came back the concept map had sufficiently been expanded. (...) I found out that for some learning activities the students absolutely don't need me. (Teacher of Dutch)

Table 5
Frequencies and percentages of reported learning outcomes.

Learning outcomes	<i>f</i>	%
Changes in knowledge and beliefs	644	50.0
Awareness	139	10.8
Confirmed ideas	152	11.8
New ideas	353	27.4
Intentions for practice	174	13.5
Intention to try new practices	65	5.1
Intention to continue new practices	82	6.4
Intention to continue current practices	27	2.1
Changes in practices	18	1.4
New practices	12	0.9
Back to old practices	6	0.5
Changes in emotions	451	35.0
Positive emotion	214	16.6
Negative emotion	190	14.8
Surprise	47	3.7
Total	1287	100.0

3.2.2. Intentions for practice

The teachers in our study did not report outcomes in terms of goals, ambitions, aspirations, aims or targets. However, they did report intentions for practice of several kinds.

3.2.2.1. Intention to try new practices. Sometimes teachers reported the intention to do things differently in the future. An example is:

After my meeting with the deputy head I started to think about possible improvements. I came to the conclusion that I have to do things differently. I will give the students a diagnostic test every three months and I want to let them work in small groups in which the students discuss the reading material themselves. (Teacher of Geography)

3.2.2.2. Intention to continue new practices. This intention was often expressed after teachers had conducted an experiment. Sometimes teachers indicated that they wanted to

continue new teaching practices, but also make adjustments to improve them. This was also coded as an intention to continue new practices. For example:

I will surely do this more often. (Teacher of Economics)

I definitely want to try this new approach again, but I do want to adjust it a little bit. Next time I want to respond more adequately and quickly to the students. (Teacher of Geography)

3.2.2.3. Intention to continue current (old) practices. Sometimes teachers expressed the intention to continue teaching in the way they were used to before the innovation. For example:

The students' presentations were superficial and the subject-matter was not deeply processed. The conclusion for me is that this is something I shouldn't do again, I think it's nonsense, its talking through one's hat. (Teacher of Economics)

3.2.3. Changes in practices

Reported changes in practices were rare. In a few instances, however, teachers reported that they had changed their teaching practice. To distinguish changed practice from temporary experiments, we coded reported outcomes as changes in practices when teachers themselves clearly indicated that they had changed their teaching practice in a more permanent way and not just for a few lessons.

3.2.3.1. New practices. Some behavioural changes were in accordance with the ASRL-renewal agenda. For example:

I teach differently now. I walk through the classroom more often. I have much more time and attention for the individual student. (...) Students tell me that things are different now, they make positive remarks. (Teacher of Economics)

3.2.3.2. Back to old practices. Some reported changes in teaching practices represented a change in the opposite direction, away from ASRL, which was coded as a return to old practices. For example:

I decided to forget about active and self-regulated learning and start teaching again. The last semester I turned back to whole class instruction, which enabled me to go through all of the subject-matter. Everything is now well structured again and the students love it! (Teacher of Dutch)

3.2.4. Changes in emotions

3.2.4.1. Positive emotions. When teachers reported feelings of pride, satisfaction, happiness, hope, courage, or positive expectation, they were coded as positive emotions. These

positive emotions could be connected to a specific situation or refer to a more general feeling. For example:

This experience gave me courage, the feeling that what I'm doing is not so bad, and I no longer feel apprehension about teaching the fifth grade as I did before. (Teacher of Art History)

A positive attitude towards the renewal was also coded as a positive emotion. For example:

The conference's starting point was to focus on positive experiences, on the "pearls" of active and self-regulated learning. This gave me a positive feeling. I often look at the things that go wrong with active and self-regulated learning. This had a refreshing effect on me. I want to take up the challenge. (Teacher of German).

3.2.4.2. Negative emotions. Reported outcomes were coded as negative emotions when they referred to feelings of irritation, anger, shock, fear, concern or doubt. Like positive emotions, negative emotions could be connected to a specific situation or could refer to a more general feeling. For example:

The result is a state of mind. I feel disappointment. You lose grip and you try to analyse it, but you don't know what to change. It makes it hard not to give up hope. You just feel tempted to fall back on your old teaching methods. (Teacher of Social Studies)

A negative attitude towards the renewal was also coded as a negative emotion. For example:

I feel uneasy, disappointed and irritated. I have doubts about the current educational system. I don't see the meaningfulness of this way of learning. (Teacher of Dutch)

3.2.4.3. Surprise. Surprise referred to indications of unexpected revelation or disclosure. These unexpected events were often combined with feelings of shock or concern (negative emotions) or with feelings of happiness or hope (positive emotions). However, surprise was also frequently reported on its own and, therefore, it was treated as a separate category. For example:

I felt really surprised. Students who normally hardly participate, now worked fanatically to finish the assignment in time. (Teacher of Physics)

3.2.5. Relations between learning activities and learning outcomes

An example of the way learning activities were qualitatively connected to learning outcomes is presented in Table 6. Table 7 shows the quantitative relations between learning activities and learning outcomes. One case (learning experience) in the data file consisted of one learning activity and one or more learning outcomes.

The variable Learning Activities was coded as a categorical variable with six values, and the 11 learning outcomes were

Table 6

An example of the way learning activities were *qualitatively* connected to learning outcomes in the logs of a Teacher of English.

Summarized text fragments	Learning activity	Learning outcome
I have noticed that writing skills do not get enough attention in my lessons. I hardly put into practice the intended lesson format of writing and repeatedly re-writing, and that is not good because writing is a process.	- Experiencing friction	- Awareness
The reason that I minimize the process into a single product is lack of time. I think it is tragic that practical considerations are more important to me than pedagogical ones. I now want to use different teaching methods for writing.	- Considering own practice	- Negative emotions - Intention to try new practices
At a seminar for counselors a teacher gave me an example of a writing assignment that appealed to me. I intend to use this assignment after adjusting it a little bit. I want to use a topical subject because it is my experience that current events motivate students. I'm still in doubt about over the precise format. An intermediate assignment might be helpful if I want students to form their own opinions, but in that case I'll have to motivate them again for the second round. If I leave out the extra assignment I'll save time for a feedback and revision round, which is very important to me.	- Getting ideas from others - Considering own practice	- Intention to try new practice - New ideas

coded as 11 dichotomous variables with values 0 (absent) and 1 (present). Because of the low frequency of the learning activity “avoiding learning”, this activity was excluded from the analyses. Eleven cross-tabulations were conducted with chi-square tests of statistical significance of the associations between five learning activities and 11 learning outcomes. To interpret the differences, the column percentages in the cells of Table 7 under the various learning outcomes should be compared with the column percentages in the column “Total Learning Activities”.

Learning activities were associated significantly with all the measures of learning outcomes. First, with changes in knowledge and beliefs, that is, with Increased Awareness, $\chi^2(4, N = 730) = 19.9, p < .001$, with Confirmed Ideas, $\chi^2(4, N = 730) = 56.9, p < .001$, and with New Ideas, $\chi^2(4, N = 730) = 160.4, p < .001$. Increased Awareness was mainly associated with Considering Own Practice and least with Getting Ideas from Others; Confirmed Ideas was highly associated with Experimenting and least with Getting Ideas from Others and Experiencing Friction, while New Ideas was mainly associated with Getting Ideas from Others and least with Experiencing Friction.

Second, learning activities were also significantly associated with all intentions for practice, that is, with Intention to Try New Practices, $\chi^2(4, N = 730) = 46.0, p < .001$, with Intention to Continue New Practices, $\chi^2(4, N = 730) = 118.5, p < .001$, and with Intention to Continue Current Practices, $\chi^2(4, N = 730) = 39.0, p < .001$. Intention to Try New Practices was mainly associated with Considering Own Practice and Getting Ideas from Others, and least with Experimenting and Experiencing Friction. Intention to Continue New Practices was far more associated with Experimenting and least with almost all other learning activities. Intention to Continue Current Practices was highly associated with Considering Own Practice and least, or not at all, with all other learning activities.

Third, learning activities were also significantly associated with changes in practices, that is, with New Practices, $\chi^2(4, N = 730) = 14.2, p < .01$, and with Back to Old Practices, $\chi^2(4, N = 730) = 13.9, p < .01$. New Practices was associated with Considering Own Practice and not with all

other activities, and Back to Old Practices was mainly associated with Considering Own Practice and Struggling Not to Revert to Old Ways, and least or not at all with all other activities.

Finally, learning activities were significantly associated with changes in emotions, that is, with Positive Emotions, $\chi^2(4, N = 730) = 112.6, p < .001$, with Negative Emotions, $\chi^2(4, N = 730) = 167.0, p < .001$, and with Surprises, $\chi^2(4, N = 730) = 17.6, p < .001$. Positive Emotions were mainly associated with Experimenting and least with Getting Ideas from Others and Experiencing Friction, while Negative Emotions mainly with Experiencing Friction. Surprises was associated mainly with Experimenting and Experiencing Friction and least with Getting Ideas from Others and Considering Own Practice.

3.3. Relations of learning activities and outcomes with type of learning environment

Table 8 presents the results of a cross-tabulation of learning activities and the type of learning environment that the teachers had enjoyed. Learning environment turned out to be significantly associated with the learning activities teachers reported, $\chi^2(8, N = 730) = 17.4, p < .05$. Experimenting was reported mostly by teachers who were learning in collaborative project groups and least by teachers learning informally in the workplace. Considering Own Practice was done mostly by teachers learning informally in the workplace, and least by teachers in reciprocal peer-coaching. Experiencing Friction was reported mostly by teachers learning informally in the workplace and least by teachers learning through reciprocal peer-coaching. This last group relatively often reported Struggling Not to Revert to Old Ways while that was done least by teachers who learned through collaborative project groups. Surprisingly, Getting Ideas from Others was not differentiated in the three types of learning environments.

Finally, eleven cross-tabulations were conducted with type of learning environment as categorical variable and the 11 learning outcomes as dichotomous variables (see Table 9).

Table 7
Cross-tabulations of learning activities and learning outcomes: frequencies (and column %).

Learning activities	Learning outcomes												Total LA	Total LO
	Changes in knowledge and beliefs			Intentions for practice			Changes in practices			Changes in emotions				
	AW	CI	NI	TNP	CNP	CCP	NP	BOP	PE	NE	SU			
Experimenting	45 (32.4)	74 (50.3)	117 (33.1)	7 (10.8)	69 (84.1)	2 (7.4)	2 (16.7)	1 (16.7)	125 (58.4)	46 (24.5)	21 (45.7)	234 (32.1)	509 (39.5)	
Considering own practices	65 (46.8)	48 (32.7)	130 (36.8)	33 (50.8)	10 (12.2)	24 (88.9)	10 (83.3)	3 (50.0)	58 (27.1)	41 (21.8)	6 (13.0)	244 (33.4)	428 (33.3)	
Experiencing friction	15 (10.8)	0 (0.0)	1 (0.3)	1 (1.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	9 (4.2)	80 (42.6)	13 (28.3)	109 (14.9)	119 (9.2)	
Struggling not to revert to old ways	5 (3.6)	12 (8.2)	12 (3.4)	1 (1.5)	3 (3.7)	0 (0.0)	0 (0.0)	2 (33.3)	11 (5.1)	13 (6.9)	3 (6.5)	33 (4.5)	62 (4.8)	
Getting ideas from others	9 (6.5)	13 (8.8)	93 (26.3)	23 (35.4)	0 (0.0)	1 (3.7)	0 (0.0)	0 (0.0)	11 (5.1)	8 (4.3)	3 (6.5)	110 (15.1)	161 (12.5)	
Total	139 (100.0)	147 (100.0)	353 (100.0)	65 (100.0)	82 (100.0)	27 (100.0)	12 (100.0)	6 (100.0)	214 (100.0)	188 (100.0)	46 (100.0)	730 (100.0)	1279 (100.0)	
Avoiding learning	0	5	0	0	0	0	0	0	0	2	1	5	8	

LA = Learning activities; LO = Learning outcomes; AW = Awareness; CI = Confirmed idea; NI = New Idea; TNP = Try new practices; CNP = Continue new practices; CCP = Continue current practices; NP = New practices; BOP = Back to old practices; PE = Positive emotions; NE = Negative emotions; SU = Surprise.

Four of the 11 corresponding χ^2 -tests turned out to be statistically significant, that is, New Ideas, $\chi^2(2, N = 730) = 14.6, p < .001$, Intention to Continue Current Practices, $\chi^2(2, N = 730) = 6.3, p < .05$, Negative Emotions, $\chi^2(2, N = 730) = 22.1, p < .001$, and Surprise, $\chi^2(2, N = 730) = 6.9, p < .05$. New Ideas were reported most by teachers who were learning by collaborative project groups and least by teachers learning informally in the workplace. This last group relatively often reported the Intention to Continue Current Practices, while that was done least by teachers who learned through reciprocal peer-coaching. Negative Emotions were reported by far the most by teachers learning informally in the workplace in comparison with the other two groups of teachers. Surprise was reported mostly by teachers who were learning through reciprocal peer-coaching, while teachers who were learning informally in the workplace reported Surprise the least.

4. Discussion

The present study aimed to conceptualize, identify, and document the various learning activities teachers employ in the context of educational innovation and the learning outcomes associated with them. The first research question regarded the learning activities in which experienced secondary school teachers engage when they are confronted with educational innovations. Six categories of learning activities emerged from the data. “Experimenting” and “considering own practice” were the learning activities teachers reported using most frequently. “Getting ideas from others” and “experiencing friction” were the next most frequently reported categories, followed by the categories “struggling not to revert to old ways” and “avoiding learning”. Teachers reported learning mostly through experimentation and reflection on their own teaching practices. They seem to learn much less by external input like the ideas from others, such as colleagues or authors of professional literature. Yet, there appear to be large individual differences among teachers in the learning activities they employ.

Most of the main categories of learning activities found in earlier research on teacher learning and workplace learning (Kwakman, 2003; Tynjälä, 2008) were also found in the present study. However, as expected (Hypothesis 1a), learning through interaction did not show up as a distinct category because, in essence, all learning activities that were identified could be conducted both individually and in interaction with others. Moreover, besides the categories of learning activities already found in earlier research, new categories of learning activities were found such as experiencing friction, struggling not to revert to old ways, and avoiding learning. All these have to do with the more problematic aspects of teacher learning. Hypothesis 1b was thus verified. Although quite well documented in the literature on student learning (Lindblom-Ylänne, 2003; Meyer, 2000; Richardson, 2000), in existing models of workplace learning to date these more problematic

Table 8
Cross-tabulation of learning activities and type of learning environment: frequencies (and row %).

Learning activities	Type of learning environment			Row totals and %
	Collaborative project groups	Reciprocal peer-coaching	Informal workplace learning	
Experimenting	91 (38.9)	82 (35.0)	61 (26.1)	234 (100.0)
Considering own practice	83 (34.0)	69 (28.3)	92 (37.7)	244 (100.0)
Experiencing friction	32 (29.4)	27 (24.8)	50 (45.9)	109 (100.0)
Struggling not to revert to old ways	8 (24.2)	14 (42.4)	11 (33.3)	33 (100.0)
Getting ideas from others	38 (34.5)	35 (31.8)	37 (33.6)	110 (100.0)
Total	252 (34.5)	227 (31.1)	251 (34.4)	730 (100.0)

aspects of learning are largely absent. The present study has highlighted that in normal, day-to-day professional learning these problematic, stressful aspects of learning seem to play an important role.

The present study has also shed some light on the more covert aspects of teacher learning, namely their learning activities in terms of thought processes during learning (Hypothesis 1c). Teachers differed in the extent to which they used the various learning activities, such as considering own practice, experimenting, and struggling not to revert to old ways, in a more meaning-oriented or performance-oriented way. As expected (Hypothesis 1d), teacher learning at the workplace did not show the time-ordered sequence (forethought, monitoring, control and reflection afterwards) as the main models of SRL describe for academic student learning (Pintrich, 2004; Van Eekelen et al., 2005).

Clarifying and categorizing the types of learning outcomes as reported by experienced teachers was the aim underlying the second research question. In the field of student learning, learning outcomes are mostly conceptualized as students' scores on exams or tests. This kind of conceptualization turned out to be useless in the field of teacher learning. Therefore, we had to develop a new conceptualization of learning outcomes in the case of teacher learning, inspired much more by the literature on workplace learning (Eraut,

2004). As expected (Hypothesis 2), a broad spectrum of learning outcomes was identified encompassing cognitive, affective and behavioural ones (cf. Eraut, 2007; Pintrich, 2004). Learning outcomes were represented by four main categories, that is, “changes in knowledge and beliefs”, “changes in emotions”, “changes in intentions for practice”, and “changes in actual teaching practices”. Each of these main categories could be subdivided into several subcategories.

The teachers mainly reported changes in knowledge and beliefs and in emotions and hardly any changes in teaching practices. However, intentions for practice were often reported, which can be seen as precursors of change in actual practices. Perhaps the teachers did actually change their practice but did not report about it in their next log. Another possibility is that teachers tend to report cognitive changes because they associate learning with knowledge and insights. A third possibility is that behavioural change requires a lot of time and is preceded by multiple changes in knowledge and beliefs. It may also be possible, however, that the teachers' ‘learning environments’ were simply not powerful enough to bring about much change in actual teaching practices (cf. Borko, 2004). Perhaps also teacher professional development requires more time than the scope of the present study allowed for. It must be taken into account that all the teachers studied had teaching experience from three to over 30 years, and maybe a period of one school year is just not long enough to bring about actual change in teaching practices developed over such a long period. However, recent experiences with “new learning” schools show that with a school-wide drastic new pedagogy for students, teacher practices may also change drastically, although there is no hard scientific evidence to support this observation to date.

The third research question regarded the extent to and the way in which teachers' learning activities were related to the types of learning outcomes they reported. Experimenting was associated primarily with the Intention to Continue New Practices, Confirmed Ideas, Positive Emotions, and Surprise. Of all learning activities, “considering own practice” turned out to be associated with the most learning outcomes, especially with Awareness, Change

Table 9
Cross-tabulations of learning outcomes and type of learning environment: frequencies (and row %) (significant relations only).

Learning outcomes	Type of learning environment			Row totals and %
	Collaborative project groups	Reciprocal peer-coaching	Informal workplace learning	
Changes in knowledge and beliefs				
New ideas	137 (38.8)	119 (33.7)	97 (27.5)	353 (100.0)
Intentions for practice				
Continue current practices	8 (29.6)	4 (14.8)	15 (55.6)	27 (100.0)
Changes in emotions				
Negative emotion	51 (27.1)	46 (24.5)	91 (48.4)	188 (100.0)
Surprise	14 (30.4)	22 (47.8)	10 (21.7)	46 (100.0)
Total	252 (34.5)	227 (31.1)	251 (34.4)	730 (100.0)

to New Practices, Intention to Continue Current Practices and Intention to Try New Practices. “Getting ideas from others” mainly yielded new ideas and the intention to do something in practice with those ideas. “Experiencing friction” often was associated with Negative Emotions and Surprise. Finally, “struggling not to revert to old ways” mainly showed associations with Back to Old Practices and Confirmed Ideas. Since the categories of learning activities and outcomes were an important result of the present study, Hypothesis 3 had only predicted some of these associations beforehand.

The significant associations between learning activities and learning outcomes found here point to qualitative differences between the various learning activities (Vermunt, 2007). Comparing the teacher learning activities from the present study with research on student learning (Entwistle & McCune, 2004; Lonka et al., 2004) and student teacher learning (Oosterheert & Vermunt, 2001), it is apparent that meaning-oriented learning (e.g., trying to extend one’s understanding of own practice and of new ideas, try new practices based on that understanding) is an important aspect of both teacher and student learning. Trying to understand why things work as they work is a distinctive learning pattern in both student and teacher learning. A main dimension in student learning, namely reproduction-oriented learning, did not occur in teacher learning. There is a parallel between the performance-oriented learning (e.g., wanting to apply new ideas, experimenting within one’s current understanding), as found in the present study, and application-directed learning (with a focus on applying in practice what one learns) as observed in studies on student learning. In both cases, practical application of ideas is an important drive for learning. The struggling, experiencing friction, negative emotions, and avoiding learning aspects of teacher learning found in the present study, are similar to undirected learning as found in studies on student learning (Vermunt & Vermetten, 2004).

The fourth research question regarded the association of teachers’ learning activities and learning outcomes with the type of learning environment they were in. Teachers in informal workplace learning environments reported relatively often that they considered their practice, experienced negative emotions and continued current (old) practices. They reported little experimenting, surprise, and new ideas compared to the other two groups. Both groups of teachers in organized learning environments (reciprocal peer-coaching and collaborative project groups) reported relatively often that they experimented and got new ideas, and relatively little experience of negative emotions. Besides, teachers participating in reciprocal peer-coaching reported relatively often that they struggled not to revert to old ways and experienced surprise. Thus, as was predicted in Hypothesis 4, organized learning environments (reciprocal peer-coaching, collaborative project groups) did seem to elicit qualitatively better learning activities and outcomes than informal learning in the workplace (Hoekstra et al., 2007; Meirink et al., 2007; Zwart et al., 2007).

4.1. Limitations and implications

Of course, the present study has its limitations. In the absence of much work to build on, the present study has been highly explorative in nature. The digital learning logs that were used turned out to be a rich data source and provided an illuminative insight into teachers’ learning experiences, both learning activities and outcomes. On the other hand, these digital learning logs represent self-reported learning experiences and implicit, nonconscious learning is not likely to be reflected in the logs (cf. Eraut, 2004).

The findings of the present study have significant implications for educational practice. They contributed to our understanding of how teachers learn and this knowledge can be crucial for designing powerful environments to foster teacher learning. Until now, attempts to foster teacher learning or professional development have been characterized by a high degree of “beliefs”. The various institutes and agencies responsible for teacher professional development all believe strongly in their own approaches, while at the same time these approaches are very diverse, varying from traditional, via concern-based, case-based, competency-based, informal, and research-based pedagogical approaches, to learning communities and scholarship programmes. There is only limited scientific evidence to support claims for the effectiveness of any of these different approaches (Grossman, 2005). As in the field of student learning, we are convinced that any theory or model of fostering teacher learning and professional development should be based on research evidence on how teachers learn (cf. Beijaard et al., 2007). The present study aimed to contribute to the scientific knowledge base of teacher learning.

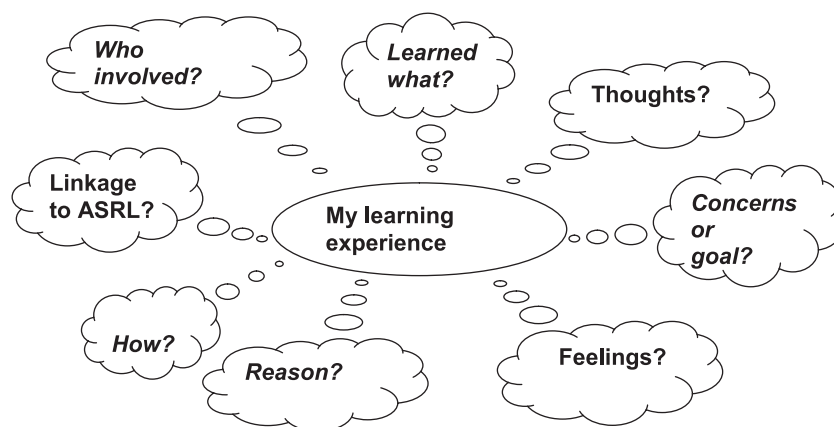
Future research should be directed at further scrutiny of the patterns of teacher learning found in the present study. Future research should also be directed at embedding teachers’ learning activities and outcomes within a broader model that includes, for example, personal and contextual variables, and teachers’ personal theories of teaching and learning. We also need studies directed at testing and further developing pedagogical approaches to foster high quality teacher learning. Developing intervention models, based on scientific evidence that can support and foster teacher learning in the context of educational innovation, and studying the power and effects of these models in bringing about teacher learning, are in our view important tasks for educational research in this field for the years to come.

Acknowledgements

The present study was made possible through a grant of the Dutch National Research Association NWO (no. 411-01-254). We would like to thank especially the Ph.D. students who were part of the research team in this area of special interest: Rosanne Zwart, Jacobiene Meirink, and Annemarieke Hoekstra. Moreover, we owe many thanks to the three anonymous reviewers and the editor of *Learning and Instruction* for their numerous suggestions to improve the first draft of this manuscript.

Appendix A. Aid in writing the digital learning log.

Learning from and for your classroom practice
The digital learning log



Explanation:

Learned what?	What have you learned?
Thoughts?	What thoughts/considerations played a role in this learning experience (before, during or afterwards)?
Concerns or goal?	What did you want to attain?
Feelings?	What did you feel: did you, for example, feel angry, happy, cheerful, hurt, disappointed, etc.?
Reason?	Why did you learn this? Had you sought out the situation? Did it happen spontaneously? Had somebody else told you to do this?
How?	What did you do (or what did others do) that made you learn this?
Linkage to ASRL?	In what way is this learning experience related to students' ASRL?
Who involved?	Were others involved in the situation in which you learned and if so, who were they, for example a colleague, your students, students' parents, etc.?

References

- Alexander, P. A. (2008). Why this and why now? Introduction to the Special Issue on metacognition, self-regulation, and self-regulated learning. *Educational Psychology Review*, 20, 369–372.
- Beijaard, D., Korthagen, F., & Verloop, N. (2007). Understanding how teachers learn as a prerequisite for promoting teacher learning. *Teachers and Teaching: Theory and Practice*, 13, 105–108.
- Berliner, D. C. (1988). Implications of studies of expertise in pedagogy for teacher education and evaluation. In J. Pfeleiderer (Ed.), *New directions for teacher assessment* (pp. 39–67). Princeton, NJ: Educational Testing Service.
- Boekaerts, M. (2002). Bringing about change in the classroom: strengths and weaknesses of the self-regulated learning approach – EARLI presidential address, 2001. *Learning and Instruction*, 12, 589–604.
- Boekaerts, M., & Corno, L. (2005). Self-regulation in the classroom: a perspective on assessment and intervention. *Applied Psychology: An International Review*, 54, 199–231.
- Bolhuis, S., & Voeten, M. J. M. (2004). Teachers' conceptions of student learning and own learning. *Teachers and Teaching: Theory and Practice*, 10, 77–98.
- Borko, H. (2004). Professional development and teacher learning: mapping the terrain. *Educational Researcher*, 33(8), 3–15.
- Brown, A. L. (1978). Knowing when, where and how to remember: a problem of metacognition. In R. Glaser (Ed.), *Advances in instructional psychology, Vol. 1* (pp. 77–165). Hillsdale, NJ: Erlbaum.
- Cicchetti, D. V. (1976). Assessing inter-rater reliability for rating scales: resolving some basic issues. *British Journal of Psychiatry*, 129, 452–456.
- Clarke, D., & Hollingsworth, H. (2002). Elaborating a model of teacher professional growth. *Teaching and Teacher Education*, 18, 947–967.
- Collins, A., Brown, J. S., & Newman, S. E. (1989). Cognitive apprenticeship: teaching the crafts of reading, writing and mathematics. In L. B. Resnick (Ed.), *Knowing, learning and instruction – Essays in honor of Robert Glaser* (pp. 453–494). Hillsdale, NJ: Erlbaum.
- De Kock, J. (2004). Arranging learning environments for new learning. Unpublished doctoral dissertation, Radboud University Nijmegen, The Netherlands.
- Dignath, C., & Büttner, G. (2008). Components of fostering self-regulated learning among students. A meta-analysis on intervention studies at primary and secondary school level. *Metacognition and Learning*, 3, 231–264.
- Efklides, A. (2006). Metacognitive experiences: the missing link in the self-regulated learning process. *Educational Psychology Review*, 18, 287–291.
- Ellis, R. A., Goodyear, P., Calvo, R. A., & Prosser, M. (2008). Engineering students' conceptions of and approaches to learning through discussions in face-to-face and online contexts. *Learning and Instruction*, 18, 267–282.
- Entwistle, N., & McCune, V. (2004). The conceptual bases of study strategy inventories. *Educational Psychology Review*, 16, 325–346.
- Entwistle, N., McCune, V., & Scheja, M. (2006). Student learning in context: understanding the phenomenon and the person. In L. Verschaffel, F. Dochy, M. Boekaerts, & S. Vosniadou (Eds.), *Instructional psychology – Past, present, and future trends: Sixteen essays in honour of Eric De Corte* (pp. 131–148). Amsterdam: Elsevier.
- Eraut, M. (2004). Informal learning in the workplace. *Studies in Continuing Education*, 26, 247–273.
- Eraut, M. (2007). Early career learning at work and its implications for universities. *British Journal of Educational Psychology Monograph Series II*, 4, 113–134.
- Fenstermacher, G. (1994). The knower and the known: the nature of knowledge in research on teaching. *Review of Research in Education*, 20, 3–56.
- Flavell, J. H. (1979). Metacognition and cognitive monitoring. *American Psychologist*, 34, 906–911.
- Glaser, B., & Strauss, A. (1967). *The discovery of grounded theory: Strategies for qualitative research*. Chicago: Aldine.

- Grossman, P. (2005). Research on pedagogical approaches in teacher education. In M. Cochran-Smith, & K. M. Zeichner (Eds.), *Studying teacher education – The report of the AERA panel on research and teacher education* (pp. 425–476). Mahwah, NJ: Erlbaum.
- Hoekstra, A., Beijaard, D., Brekelmans, M., & Korthagen, F. (2007). Experienced teachers' informal learning from classroom teaching. *Teachers and Teaching: Theory and Practice*, 13, 191–208.
- Inspection of Education. (2003). *Tweede fase vierde jaar. Een overzicht van de stand van zaken vier jaar na invoering van de Tweede Fase Havo/vwo. [Second phase fourth year. An overview of the state of affairs four years after introduction of the Second Phase Upper Secondary Education]*. The Hague, The Netherlands: Ministry of Education, Culture and Science.
- Korthagen, F. A. J. (2001). *Linking practice and theory: The pedagogy of realistic teacher education*. Mahwah, NJ: Erlbaum.
- Kwakman, C. (2003). Factors affecting teachers' participation in professional learning activities. *Teaching and Teacher Education*, 19, 149–170.
- Lieberman, A., & Pointer Mace, D. H. (2008). Teacher learning: the key to educational reform. *Journal of Teacher Education*, 59, 226–234.
- Lindblom-Ylänne, S. (2003). Broadening an understanding of the phenomenon of dissonance. *Studies in Higher Education*, 28, 63–78.
- Little, J. W. (2002). Locating learning in teachers' communities of practice: opening up problems of analysis in records of everyday work. *Teaching and Teacher Education*, 18, 917–946.
- Little, J. W. (2007). Teachers' accounts of classroom experience as a resource for professional learning and instructional decision making. In P. A. Moss (Ed.), *Evidence and decision making. 2007 NSSE Yearbook, Vol. 106, Issue 1* (pp. 217–240). Boston: Blackwell Synergy.
- Lohman, M., & Woolf, N. (2001). Self-initiated learning activities of experienced public school teachers: methods, sources and relevant organizational influences. *Teachers and Teaching: Theory and Practice*, 7, 59–74.
- Lonka, K., Olkinuora, E., & Mäkinen, J. (2004). Aspects and prospects of measuring studying and learning in higher education. *Educational Psychology Review*, 16, 301–324.
- Meirink, J. A., Meijer, P. C., & Verloop, N. (2007). A closer look at teachers' individual learning in collaborative settings. *Teachers and Teaching: Theory and Practice*, 13, 145–164.
- Meyer, J. H. F. (2000). An empirical approach to the modelling of dissonant study orchestrations in higher education. *European Journal of Psychology of Education*, 15, 5–18.
- Oosterheert, I. E., & Vermunt, J. D. (2001). Individual differences in learning to teach: relating cognition, regulation and affect. *Learning and Instruction*, 11, 133–156.
- Pintrich, P. R. (2004). A conceptual framework for assessing motivation and self-regulated learning in college students. *Educational Psychology Review*, 16, 385–407.
- Putnam, R. T., & Borko, H. M. (1997). Teacher learning: implications of new views of cognition. In B. J. Biddle, T. I. Good, & I. F. Goodson (Eds.), *International handbook of teachers and teaching* (pp. 1233–1296). Dordrecht, The Netherlands: Kluwer.
- Randi, J. (2004). Teachers as self-regulated learners. *Teachers College Record*, 106, 1825–1853.
- Richardson, J. T. E. (2000). *Researching student learning*. Buckingham, UK: Open University Press and SRHE.
- Shulman, L. S., & Shulman, J. H. (2004). How and what teachers learn: a shifting perspective. *Journal of Curriculum Studies*, 36, 257–271.
- Tynjälä, P. (2008). Perspectives into learning at the workplace. *Educational Research Review*, 3, 130–154.
- Van Eekelen, I. M., Boshuizen, H. P. A., & Vermunt, J. D. (2005). Self-regulation in higher education teacher learning. *Higher Education*, 50, 447–471.
- Vermunt, J. D. (1995). Process-oriented instruction in learning and thinking strategies. *European Journal of Psychology of Education*, 10, 325–349.
- Vermunt, J. D. (2005). Relations between student learning patterns and personal and contextual factors and academic performance. *Higher Education*, 49, 205–234.
- Vermunt, J. D. (2007). The power of teaching-learning environments to influence student learning. *British Journal of Educational Psychology Monograph Series II*, 4, 73–90.
- Vermunt, J. D., & Verloop, N. (1999). Congruence and friction between learning and teaching. *Learning and Instruction*, 9, 257–280.
- Vermunt, J. D., & Vermetten, Y. J. (2004). Patterns in student learning: relationships between learning strategies, conceptions of learning, and learning orientations. *Educational Psychology Review*, 16, 359–384.
- Volet, S., Summers, M., & Thurman, J. (2009). High-level co-regulation in collaborative learning. *Learning and Instruction*, 19, 128–143.
- Weinstein, C. E., Husman, J., & Dierking, D. R. (2000). Self-regulation interventions with a focus on learning strategies. In M. Boekaerts, P. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 727–747). San Diego, CA: Academic.
- Zimmerman, B. J. (2008). Investigating self-regulation and motivation: historical background, methodological developments, and future prospects. *American Educational Research Journal*, 45, 166–183.
- Zwart, R. C., Wubbels, T., Bergen, T. C. M., & Bolhuis, S. (2007). Experienced teacher learning within the context of reciprocal peer coaching. *Teachers and Teaching: Theory and Practice*, 13, 165–187.