2. Educational effectiveness and constructivism

2.1 Introduction

The first chapter illustrated the growing attention for new learning outcomes. Pupils need to learn metacognition besides the traditional skills. The question is how teachers must structure their instruction when they want to stimulate both metacognition and basic skills.

This chapter starts with a discussion of outcomes of education. Section 2.2 describes both new learning outcomes and the more traditional outcomes. Next, we study two research traditions for answering the question how teacher should structure their instruction, namely educational effectiveness and constructivism. The largest part of this chapter deals with the theoretical background of these two traditions. The focus is on the ideas about instruction within both lines of research.

The first part deals with educational effectiveness and instruction. Section 2.3 starts with a general description of effectiveness research (2.3.1). Educational effectiveness is a research tradition that studies characteristics of schools and teachers that are positively related to achievement of pupils. Within this research, there is a shared view that the largest influences on the achievement of pupils can be found at the classroom level. There is a vast amount of research concerning the relation between characteristics at the classroom level and achievement of pupils. One of the features of effectiveness research is the direct instruction model. Section 2.3.2 describes the characteristics of this model. Research shows that when teachers are trained in using this model, the achievement of pupils improves. The empirical evidence concerning the implementation of this model and the effects on achievement is discussed in section 2.3.3. In conclusion, section 2.3.4 deals with the state of the art of this research tradition.

The second part describes constructivism and its implications for instruction. Section 2.4.1 covers the general principles of constructivism and discusses the consequences for teacher behaviour. Within instruction-psychology, several instructional models were developed that take the constructivist ideas into account. Section 2.4.2 describes the elements of one of these models, the cognitive apprenticeship model. Section 2.4.3 reports on the empirical evidence concerning the implementation of the cognitive apprenticeship model and its effects on metacognition and other outcomes. The final section about constructivism (2.4.4) discusses the state of the art of this line of research.

The third and final part of this chapter (2.5) presents the differences and similarities concerning research and outcomes in both traditions. The section is concluded with the presentation of the research model.
2.2 Educational goals

Education mainly deals with basic domain-specific knowledge and skills. Expertise in a specific domain largely depends on this domain-specific knowledge. Domain-specific knowledge concern facts, concepts, principles and procedures (Boekaerts & Simons, 1993; Verschaffel & De Corte, 1998; Elshout-Mohr & Van Hout-Wolters, 1998). Traditional educational goals refer to this domain-specific knowledge and the effectiveness of education is mostly determined on the basis of this domain-specific knowledge (Van Hout-Wolters, 2000).

As was described in the introduction, politicians, employers and educators do no longer see domain-specific knowledge as the only and most important goal. In addition, students also have to learn how to learn, for which they also need metacognitive, and affective skills (Verschaffel & De Corte, 1998; Bolhuis, 2000; Van Hout-Wolters, Simons & Volet, 2000).

Metacognitive skills are used to regulate and control the cognitive activities. These skills are used to select learning goals and to control learning activities and learning processes. The metacognitive skills can be subdivided in skills that can be used before processing a task, skills that can be used while working on a task and skills that can be used after task completion. Several researchers discern eight metacognitive skills (De Jong, 1992; Boekaerts & Simons, 1993; Vermunt, 1992; 1998). Figure 2.1 provides an overview of these eight skills.
Before starting to work on a task, orientation and planning are important metacognitive skills. Orientation concerns preparing for the learning task by checking the characteristics of the task and the learning goals, by selecting learning materials and cognitive skills, and by considering prior knowledge and skills and the amount of available time. Planning follows orientation. Planning stands for designing the learning process based on the information produced during the orientation. Furthermore, planning implies making predictions about the course of the learning process.

While working on a task, four metacognitive skills can be used, namely monitoring, testing, diagnosing and repairing. Monitoring implies watching whether the learning process runs according to the plan. The learner checks the progress and whether the learning activities contribute in accomplishing the learning goals. Testing concerns more explicitly checking comprehension and learning gains. Monitoring and testing can result in the observation that something goes wrong in the learning process. At that moment, diagnosing can be used to identify what causes the problems in the learning process. When the causes are determined, the learning process can be repaired. Repairing means changing the original planning, for example by choosing other learning activities, by adjusting the learning goals, or by asking for help from others.

After the completion of the task, evaluation and reflection are necessary metacognitive skills. Evaluation stands for judging whether the learning results correspond with the planned
learning goals and to what extent the learning process ran as was planned. The learning process is concluded with reflection on all aspects of the learning process, among which the learning activities, the instruction stage, and the co-operation with other learners. Reflection results in new knowledge and insights that can be used in planning future learning processes. In literature, these metacognitive skills are seen as part of metacognition. Besides the skills, metacognition also consists of metacognitive knowledge. Metacognitive knowledge is the knowledge learners have about the cognitive functioning of themselves and others. The metacognitive knowledge is used in planning the learning process and enlarged by reflection on the learning process (Boekaerts & Simons, 1993).

Finally, the affective skills help pupils cope with feelings that arise while they work on a task. These skills can have a positive, neutral or negative effect on the task completion. Examples of affective skills are motivating, concentrating, self-judgement, valuing, and attributing (Boekaerts & Simons, 1993; Vermunt, 1998).

In conclusion, educational goals concern domain-specific knowledge and skills, metacognition and affective skills. The question is how teachers should structure their instruction when they want to achieve these different goals. Two research traditions are studied to find an answer to this question, namely educational effectiveness and constructivism. The description of these traditions focuses on the ideas about instruction and the empirical evidence about the implementation and effectiveness of these instructional ideas.

2.3 Educational effectiveness

2.3.1 Educational effectiveness and instruction

Educational effectiveness research studies characteristics of schools and teachers that are connected with the achievement of pupils. It addresses the question why one school or one teacher is more effective than another with pupils with similar background characteristics. This is primarily done with correlational and quasi-experimental studies. Effectiveness research shows that the largest part of the variance in achievement can be explained by student characteristics. Student characteristics such as gender, socio-economic status, low family income and ethnicity have proven to be strong predictors of attainment (Sammons, 1999). Next to these characteristics, the prior attainment of the students is very important in the explanation of achievement. Prior attainment of students can be used as a baseline for evaluating the influence of schools and teachers. This is called the value-added approach (Sammons, 1999). Only a small percentage of the variance can be explained by characteristics of schools and teachers. In primary schools, these characteristics explain between 10% and 20% (Creemers, 1994).
Research showed that specific characteristics of schools and teachers can explain differences in the achievement of their students. This resulted in long lists of variables that are connected with student achievement (e.g. Wang & Walberg, 1991). A next, fairly recent step in effectiveness research was the development of comprehensive educational models, causal models of educational attainment that contain explanatory variables at the level of the individual student, the level of classroom teaching, the level of school organisation and the context level (e.g. Creemers, 1994; Scheerens, 1992). From a theoretical and empirical point of view, the classroom is the predominant place in the school where learning and teaching take place (Creemers, 1994; Scheerens, 1992). The school level and the institutional level influence educational outcomes indirectly by influencing the classroom level (Creemers, 1994). Thus, the focus is on the classroom level and the teaching and learning activities that take place within this classroom.

The characteristics of effective instructional teacher behaviour in the comprehensive models are based on process-product research. This line of research studies characteristics of the behaviour of effective teachers. It looks for teaching styles and teaching techniques that predict growth in knowledge and skills. Within this research, the instructional behaviour of teachers was observed in regular classroom and related to the achievement of pupils. With correlational statistics, investigators were able to identify the teacher behaviours that are positively associated with student achievement (Rosenshine 1995). This resulted in long lists of teacher behaviours that are positively related to achievement such as the allocation and use of learning time, classroom management focussed on creating a learning atmosphere, and activities such as structuring content, questioning, evaluation, and feedback (Rosenshine & Stevens, 1986; Brophy & Good, 1986; Walberg, 1991; Creemers, 1994).

The role of these isolated teacher behaviours was not clear, however. Teacher behaviours that were strongly related to achievement in one study sometimes had no relation with test results in another. Consequently, educational researchers tried to find patterns of effective practices. Models were developed with different names, such as explicit, direct, active, and effective teaching (Walberg, 1991). One of the most famous models is the direct instruction model. Based on correlational studies and observational and control-group research, Rosenshine and Stevens (1986) summarised effective teacher behaviours into the model of direct instruction.

2.3.2 The direct instruction model

Rosenshine and Stevens (1986) concluded that effective teachers taught well-structured and expository material by using the following activities:
- Summarising previous learning,
- Explaining goals,
- Providing instruction in small steps with a lot of questions,
- Providing guided practice,
- Providing individual seatwork,
- Monitoring seatwork,
- Providing feedback and a summary.

They further grouped these activities under six teaching functions, together forming the basics for the direct instruction model:
- daily retrospect,
- presentation of new content,
- guided practice,
- individual practice,
- periodical retrospect,
- feedback.

Direct instruction is a form of explicit, stepwise instruction. The model illustrates the transition of the responsibility for the learning process from teacher to student. During the stages of daily retrospect and presentation, the teacher is in control. Before students are able to be responsible for their own learning, they need help and assistance from the teacher. During guided practice, the responsibility gradually shifts from teacher to student. During individual practice the student is responsible (Veenman, 1992).

Effective teachers start their lessons with daily retrospection. The teacher summarises past learning, discusses the (home)work the students made independently, and activates prior knowledge. When students do not have enough prior knowledge, the teacher will have to teach the required knowledge and skills before he starts to present new subject matter. The daily review provides additional practice and overlearning for previous learned materials, and allows the teacher to reteach and to provide corrections in case of misunderstanding. The presentation of new knowledge and skills starts with a description of the lesson objectives. Next, an effective teacher presents the subject matter in small steps, giving several examples and using clear language. During the presentation, the teacher regularly checks whether the students understand the new subject matter. At the end of the presentation, the teacher summarises and stresses the most important parts of the new knowledge and skills. Next, the teacher offers the students sufficient time for practising the knowledge or skill under guidance. The goal of this guided practice is processing the new information through active practising. The teacher gives short and clear assignments, asks numerous questions, keeps all students involved, and makes them feel successful. The phase of guided practice continues until most students understand the new information, and are able to perform new skills. This means that they are ready to work on
assignments independently. These assignments resemble the tasks the students worked on in the guided practise phase. The teacher makes sure that they can start working immediately and work without interruptions. The students are allowed to help each other when they experience problems. The teacher makes clear that their work will be corrected. Preferably this correction takes place as soon as possible for feedback purposes. Periodical retrospect takes place at least once a week. It is necessary to recapitulate new knowledge and skills, because people tend to forget what they have learned. Feedback should take place continuously and frequently. Teachers correct mistakes immediately and explain why answers are right or wrong. It is very important that teachers often reinforce students positively (Veenman et al, 1992; Rosenshine, 1995; Borich, 2000).

2.3.3 Empirical evidence concerning direct instruction

This study focuses on the question how regular teachers must structure their instruction when they want to stimulate both metacognition and basic skills. For answering the question, we need instructional models that teachers can implement in their regular classroom practice. Furthermore, these models must have positive effects on different educational outcomes. This section describes the empirical research into the direct instruction model. We focus on the following questions:
1. Can teachers implement the direct instruction model in regular classroom settings?
2. What are the effects of the direct instruction model on learning outcomes?
3. Can the direct instruction model be used for all kinds of subject matters?
4. Does the direct instruction model have similar effects on all kinds of pupils?

Experimental studies show that teachers can implement the direct instruction model. Rosenshine and Stevens (1986) summarised experimental studies where one group of teachers was trained in specific teaching skills that relate to the direct instruction model and another group did not receive training. Based on these studies, they concluded that trained teachers used more techniques from the direct instruction model in their classrooms than teachers that were not trained. Furthermore, the students of the trained teachers had higher achievement scores and/or engagement rates.

More recent studies also show that teachers can be trained to use the direct instruction model. Roelofs, Veenman and Raemaekers (1993) trained and coached teachers in primary schools in using the direct instruction model. The instructional behaviour of the teachers was observed before and after the training. After the training, the trained teachers had improved the quality and quantity of the use of behaviours from the direct instruction model. Roelofs, Veenman and Voeten (1994) studied the effects of this inservice training and coaching on achievement of pupils in decoding, reading comprehension and arithmetic. The study showed a positive effect of direct instruction on decoding. Direct instruction had a positive effect on
achievement in reading comprehension in grade 6, but a negative effect on reading comprehension skills in grade 3 and 5. Direct instruction did not show effect on arithmetic achievement.

Veenman et al (1993) studied the effectiveness of a training program in direct instruction for students in teacher training. This study also showed that the training program had a positive influence on the instructional behaviour of the student teachers. They showed progress on several aspects of the direct instruction model. The program also had effect on the task-oriented behaviour of the pupils the student teachers taught. This means that the pupils were more involved in the task completion and less distracted. A similar study for student teachers in secondary education also demonstrated the implementation of direct instruction. After the training, trained observers registered significantly more effective instruction. However, this study did not show an effect on pupil engagement rates (Veenman et al, 1998).

The direct instruction model was also used in several school improvement programs. Research into the effectiveness of these programs also proves that teachers are able to implement the direct instruction model. Besides that, it demonstrates that the achievement of pupils improves when their teacher uses the direct instruction model. One of the first improvement programs based on direct instruction was DISTAR, Direct Instruction Systems in Arithmetic and Reading. DISTAR consisted of instructional procedures within curriculum packages for primary schools. Many of the DISTAR programs were quite successful in promoting student achievement for pupils at risk (Rosenshine, 1995). The pupils showed higher scores on arithmetic and self-image (Gersten & Carnine, 1984). At the end of highschool, the pupils that were in the DISTAR-program during the first years of primary school still performed significantly higher on mathematics, reading and language (Veenman, 1998).

Another program that used direct instruction was Success for All (Slavin, 1996; Slavin et al, 1996). This program consisted of externally developed programs with specific materials, manuals and structures. Research showed that the program could be implemented and maintained over considerable time periods. Furthermore, the program increased pupil reading performance. The program also showed large impacts on the achievement of disadvantaged pupils (Slavin, 1996; Slavin et al, 1996). However, the Success for All program consisted of several distinctive elements besides direct instruction such as co-operative learning, reading tutors, pre-school and kindergarten programs, and family support teams. As a consequence, the effects of Success for All cannot simply be attributed to direct instruction.

A Dutch example of the integration of direct instruction within a school improvement program is the project Small-scale Experiment Compensatory Activities (KEA). This project aimed at the improvement of achievement in language and arithmetic of the pupils of four primary schools. The schools were populated with a high percentage of non-native pupils, about 90%. Teachers were extensively trained and coached to use the direct instruction
model. Classroom observations showed that the teachers generally succeeded in implementing this instructional behaviour. A year after the program, the teachers improved the quality of their instructional behaviour even more. The same counts for the achievement of pupils, who scored considerably higher on language and arithmetic tests than the control group of pupils (Hoogendijk & Wolfgram, 1995; Wolfgram, 1999). As a result of the program, the pupils achieved at the average national level, which is exceptional for non-native pupils. This implies that direct instruction can have very positive effect on the achievement of non-native pupils from a low socio-economic background.

More researchers have come to the conclusion that direct instruction is effective for pupils from disadvantaged backgrounds, or students starting from a low level of achievement in a particular subject (Veenman, 1998; Kozloff et al, 2001; Muijs & Reynolds, 2001). In addition, a study of Nelson and Johnson (1996) compared the effectiveness of direct instruction, co-operative learning and independent learning for pupils with behavioural disorders. This study showed higher rates of on-task behaviour and lower rates of disruptive behaviour in the direct instruction condition (Nelson & Johnson, 1996).

The implementation and effectiveness of the direct instruction model was also studied in a Dutch improvement program, which aimed at technical reading (Houtveen et al, 1997). The teachers in the experimental groups showed significant differences with the control group with regard to the use of elements of the direct instruction model. A follow-up observation showed that this development sinks in. The development in the instructional behaviour of the teachers had positive effects on the achievement of the pupils. The pupils in the experimental group scored significantly higher on a test for technical reading, even when the outcomes were corrected for intelligence, socio-economic background, and attitude towards reading. However, the pupils did not retain the higher scores during a follow-up. This study showed that the direct instruction model is suitable for teaching structured subject matters.

Direct instruction was also used to teach reading comprehension skills (Aarnoutse, 1998). Pupils in primary schools received training in for example deducing from a text the cause-effect relation, the main idea, or the intention of the main character. Each training was based on the direct instruction model. After the training the pupils showed significant learning gains on tests concerning the use of the specific skills. However, these effects did not result in higher achievement in reading comprehension in general (Aarnoutse, 1998). This research indicates that direct instruction can also be used to teach separate reading comprehension skills next to basic skills.

Within the KEA-project, however, the learning gains of the pupils in higher grades on tests for reading comprehension and arithmetic based on constructivist principles showed no large improvements nor large differences with the control group (Wolfgram, 1999). This indicates that the direct instruction model is more suitable for teaching structured subject matters, such as technical reading and arithmetic. The project showed that direct instruction has less
positive results when it concerns reading comprehension and arithmetic in context. The direct instruction model is particularly relevant to teach students algorithms they can use to complete well-structured tasks. These kinds of tasks can be broken down into a fixed sequence of subtasks and steps that consistently lead to the same goal. These well-structured tasks are taught by teaching each separate step to the pupils (Rosenshine, 1995). Reading comprehension, writing and study skills are examples of less structured tasks, for which direct instruction is less suitable. For instruction in these kind of tasks other models were developed, among which a direct instruction model for strategic behaviour (Veenman, 1998) or direct instruction in cognitive strategies (Rosenshine, 1995; Pressley, 1998). In these direct instruction models elements from new instruction-psychological models are integrated.

2.3.4 State of the art of direct instruction

This section summarises whether the questions in section 2.3.3 are answered by research concerning the implementation and effectiveness of direct instruction.

The direct instruction model is based on the observation of teacher behaviours of effective teachers. This means that teachers in their regular classroom setting demonstrated the instructional behaviours within the direct instruction model. Quasi-experimental studies show that teachers can be trained to implement the direct instruction model in their regular classroom settings. In most studies, the pupils outperformed the control group, whose teacher did not use the direct instruction model. In other words, the direct instruction model can be used in regular classrooms and positively influences the achievement of pupils. Direct instruction primarily results in higher achievement in technical reading, language, arithmetic and separate reading comprehension skills. It seems to be most appropriate for teaching well-structured tasks that can be broken down into subskills or subtasks. The teacher uses the direct instruction model to instruct these smaller parts, and to provide guided practice and individual practice. It is useful for teaching skills and processes for which there is a clearly defined procedure.

The direct instruction model seems to be less effective for reading comprehension and arithmetic based on constructivist principles, unless it is combined with elements that are based on constructivism such as modelling. We do not know whether direct instruction can be used to teach metacognitive skills.

Furthermore, there is empirical evidence that direct instruction is effective for non-native pupils and pupils from disadvantaged backgrounds. However, it was not explicitly studied whether direct instruction is only effective for these groups of pupils and less effective for pupils from less deprived backgrounds. In short, we do not know whether direct instruction has differential effects.
2.4 Constructivism

2.4.1 Constructivism and instruction

Although there are many definitions of constructivism, three principles are common among most constructivist approaches.

The first principle is that learning is a process of active knowledge construction. This means that learning occurs not by recording information but by interpreting it. Students actively process information, using prior knowledge, skills, and strategies (Resnick, 1989). More specifically, effective learning depends on the intentions, self-monitoring, elaborations, and representational constructions of the individual learner. The intentions of the learner are important, not the goals of the teacher. Therefore, student goals should be consistent with the instructional goals. The concept of active knowledge construction leads to instruction that places the learner’s constructive mental activity at the heart of any instructional exchange (Resnick, 1989).

This first principle implies that teachers cannot simply transfer knowledge to the learners. Instead, teachers have to involve the learners in a process in which they can actively deal with the information. Teachers have to encourage and accept student autonomy and initiative (Brooks & Brooks, 1993; Savery & Duffy, 1994). The teacher’s role is to challenge student thinking, not to dictate or attempt to proceduralise that thinking. The teacher must assume the roles of consultant and coach. Besides this, teachers have to provide students with knowledge and skills with which they can build their own understandings. Education in knowledge is not enough, students need to be equipped with skills and strategies that help them construct understanding. Motivation and self-regulation also play a pivotal role in this process. As a starting-point for learning, teachers have to solicit problems from students and use these as a stimulus for learning activities. They can also establish a problem that students will readily adopt as their own (Savery & Duffy, 1994). Furthermore, the constructivist teacher stimulates and supports reflection on both the content learned and the learning process (Savery & Duffy, 1994).

The second common principle is that learning is regarded as knowledge dependent. Students use their current knowledge and experience to construct new knowledge. New understandings are constructed by synthesising new experiences into previously built understandings. Within constructivist theory, learning is viewed as a self-regulatory process of struggling with the conflict between existing personal models of the world and the discrepant new insights. This leads to the construction of new representations and models of reality. Learning consists of the negotiation of new understandings through co-operative social activity, discourse, and debate (Fosnot, 1996). Learning is a socially situated activity (Harris & Graham, 1994).
The consequence of this principle for teacher behaviour is that teachers should activate the knowledge and skills the students already have before they introduce new knowledge. Doing so, teachers should inquire first the students’ understanding about certain concepts, before they share their own insights in those concepts. Furthermore, teachers have to provide the learners with possibilities to articulate their understandings and compare them with the understandings of fellow students and the teachers themselves. In this way, constructivist teachers encourage students to test their ideas against alternative views. Modelling, dialogue and co-operative learning are teaching methods that facilitate discourse between teacher and students and among students (Brooks & Brooks, 1993).

The third element constructivism stresses is that learning is highly tuned to the situation in which it takes place (Resnick, 1989). Learning is enhanced in functional, meaningful, and authentic contexts (Harris & Graham, 1994). Knowledge and skills are strongly related to the situation in which they are learned. According to constructivist ideas, it is not possible to teach knowledge and skills unattached from the context. The knowledge and skills are embedded in contextual information. This also implies that students cannot simply transfer separate knowledge and skills to different contexts.

This third principle challenges teachers to develop ways of organising learning that permit skills to be practised in the environments in which they will be used (Resnick, 1989). Teachers should provide the students with authentic tasks. Authentic tasks illustrate the applicability of knowledge and skills and motivate students to learn. In an authentic learning environment the cognitive demands are consistent with the demands in the environment for which the students are prepared (Savery & Duffy, 1994). When teachers offer students practice in different authentic contexts, the students separate the knowledge and skills from a specific context. They need sufficient practice in different settings before they can translate and use the knowledge and skills in new situations.

2.4.2 *Constructivist instruction: the cognitive apprenticeship model*

Constructivism has implications for instruction. The previous section described the major concepts of constructivism and how these are translated in teacher behaviour. These concepts do not result in a ready-made instructional model, however. Within instructional theory several instructional models have been developed that take the constructivist principles into account. These models award the pupils with more control over learning experiences, and assign the teacher with a more coaching and facilitating role. The models aim at the development of higher order skills and metacognitive skills. The most important models are reciprocal teaching, procedural facilitation, modelling, and cognitive apprenticeship (Resnick, 1989).

The cognitive apprenticeship model (Collins, Brown & Newman, 1989) is a framework for designing learning environments that is based on instructional principles of the traditional
apprenticeship model. Traditional apprenticeship embeds the learning of skills and knowledge in their social and functional context. Apprentices learn through a combination of observation, coaching, and practice. Collins, Brown and Newman (1989) have adapted this traditional apprenticeship for the teaching and learning of cognitive skills. This so-called cognitive apprenticeship model combines the effective characteristics of several instruction-psychological models, such as reciprocal teaching (Brown & Palincsar, 1989), procedural facilitation (Bereiter & Scardamalia, 1989), and modelling (Schoenfeld, 1985). In fact, these latter models can better be described as teaching techniques, which are integrated in the cognitive apprenticeship model. As a result, cognitive apprenticeship is the most complete model, and thus we use this model in this study.

The cognitive apprenticeship model consists of four dimensions: content, method, sequence and sociology. Concerning the content of learning, an ideal learning environment should focus on domain knowledge, heuristic strategies, control strategies and learning strategies.

Within the cognitive apprenticeship model six teaching methods are distinguished. The first, modelling, involves an expert carrying out a task so that students can observe and build a conceptual model of the processes that are required to accomplish the task. In cognitive domains, this requires the externalisation of usually internal (cognitive) processes and activities, specifically the heuristics and control processes by which experts make use of basic conceptual and procedural knowledge.

The second is coaching. Coaching consists of observing students while they carry out a task and offering hints, scaffolding, feedback, modelling, reminders and new tasks aimed at bringing their performance closer to expert performance. The content of the coaching interaction is immediately related to specific events or problems that arise as the students attempt to carry out a target task.

The third teaching method, scaffolding and fading, refers to the support the teacher provides to help students to carry out a task. These supports can either take the forms of suggestions or help or they can take the form of physical supports, like cue cards. When a teacher provides scaffolding, it requires the teacher to carry out parts of the overall task that the student cannot manage yet. Fading consists of the gradual removal of supports until students are on their own.

The fourth teaching method, articulation, includes any method of getting students to articulate their knowledge, reasoning, or learning processes in a domain. Inquiry teaching is a strategy of questioning students that can be used to lead them to articulate and refine theories. Teachers can also encourage students to articulate their thoughts as they carry out a task. Another example is that teachers provide opportunities for the students to assume the critic or monitor role in co-operative activities and thereby lead students to formulate and articulate their knowledge of learning processes.
The fifth teaching method within the model is reflection. Reflection enables students to compare their own problem-solving processes with those of an expert, another student, and ultimately, an internal cognitive model of expertise.

The last teaching method, exploration, involves pushing students into a mode of problem solving on their own. Forcing them to do exploration is critical, if they are to learn how to frame questions or problems that are interesting and that they can solve.

The first three teaching methods are the core of cognitive apprenticeship, designed to help students acquire an integrated set of cognitive and metacognitive skills through processes of observation and of guided and supported practice. The next two (articulation and reflection) are methods designed to help students both focus their observations of expert problem solving and gain conscious access to (and control of) their own problem solving strategies. The final method (exploration) is aimed at encouraging learner autonomy, not only in carrying out expert problem solving processes, but also defining or formulating the problems to be solved.

Next to content and teaching methods, Collins, Brown and Newman (1989) emphasise the importance of sequencing. Because the learning needs of pupils differ in the different stages of skill acquisition, the sequence and structure of materials and learning activities should support these needs in order to facilitate the development of skills. The dimensions that should guide sequencing are increasing complexity, increasing diversity and global before local skills.

The final dimension in the framework concerns the sociology of the learning environment. One aspect of this dimension is situated learning. Students should carry out tasks in an environment that reflects the use of the knowledge they learn. The second aspect, culture of expert practice, implies stimulating focused interactions among learners and experts. Another aspect of sociology is promoting intrinsic motivation for learning by providing realistic tasks. The fourth aspect is exploiting co-operation, which refers to having students work together. The last aspect is exploiting competition. This refers to the strategy of giving learners the same task and stimulating them to compare learning processes.

2.4.3 Empirical evidence concerning cognitive apprenticeship

This section describes the empirical research into the cognitive apprenticeship model. Similar to the description of empirical evidence concerning direct instruction, we study whether teachers can implement cognitive apprenticeship in their regular classroom practice. Furthermore, evidence concerning the effects of the model is described. The following questions lead the description of research outcomes:

1. Can teachers implement the cognitive apprenticeship model in regular classroom settings?
2. What are the effects of the cognitive apprenticeship model on learning outcomes?
3. Can the cognitive apprenticeship model be used for all kinds of subject matters?

4. Does the cognitive apprenticeship model have similar effects on all kinds of pupils?

An overview of publications shows that the cognitive apprenticeship model in itself has not been studied much (Terwel & Hooch Antink, 1996). Several articles describe the cognitive apprenticeship model from a theoretical perspective, for example in relation to its usefulness for teaching pupils with special needs (Rojewski & Shell, 1994), and for instructional design (Terwel & Hooch Antink, 1996). Furthermore, a number of articles describe the use of cognitive apprenticeship within vocational training, for example in teacher training (Duncan, 1996; Hockly, 2000). Research into the implementation and effectiveness of the model primarily took place in laboratory-settings and in technological learning environments (e.g. Chee, 1995; De Bruijn, 1995, Järvelä, 1995; Shabo, Guzdial & Stasko, 1997; Patel, Kinshuk & Russell, 1999). De Bruijn (1995), for example, operationalised the methods of cognitive apprenticeship in a computer program for teaching arithmetic for adult basic education students. Modelling and coaching were optional parts of the computer program. The study showed that the students make little use of these options. Shabo, Guzdial and Stasko (1997) also implemented several teaching methods of cognitive apprenticeship in their computer program for learning computer graphics. The program was able to communicate the process, to coach the learner and to elicit articulation and reflection. Formative evaluation showed that the college students that worked with the program used both structured exercises and more open-ended assignments.

The study of De Corte, Verschaffel and Schrooten (1990) approximates the use of cognitive apprenticeship in a regular classroom setting. They used the cognitive apprenticeship model for the explicit and systematic instruction in thinking skills within a programming environment called Logo for grade 6 in primary schools. All six teaching methods were used to help pupils acquiring four general (meta)cognitive skills. The teachers modelled the programming skills. Furthermore, the pupils received an auxiliary card with all successive steps of programming with focus points for each step. The role of this aid faded during the learning process. The pupils were coached during the practice time that followed. Articulation and reflection were stimulated by giving assignments that pupils had to work out in pairs or groups. Whole class discussions were also used for eliciting articulation and reflection. Several opportunities for exploration were provided by stimulating pupils to work alone or in groups on projects of their own choice. The study consisted of two experimental groups and a control group with 24 pupils each. The experimental lessons were given by the researchers assisted by the teacher. After the treatment, the pupils in the experimental groups showed subject-specific knowledge and they were able to use thinking skills in a Logo context. In one of the experimental groups the pupils explicitly learned to transfer the use of thinking skills to other situations. However, the pupils in this group were not able to independently use the thinking skills to solve complex mathematical problems. The effect of
the treatments in terms of transfer of thinking skills to other contexts did show positive results (De Corte, Verschaffel & Schrooten, 1990).

Lee (1995) describes another example of cognitive apprenticeship in a regular classroom setting. In this study, senior high school students received literature instruction based on the cognitive apprenticeship model. All students were African American and their experience with a specific form of social discourse in the African American community was used as a scaffold for teaching skills in literary interpretation. Furthermore, small group discussions, sequenced phasing of control from teacher to students and using the students’ prior knowledge were elements of cognitive apprenticeship present in the lessons. The pupils from the experimental group outperformed the pupils from the control group on a reading comprehension test.

An instructional method for teaching reading comprehension, called transactional strategies instruction (Pressley, 1998) can also be seen as a form of cognitive apprenticeship. This instructional model consists of explanation and modelling by the teacher followed by scaffolded practice in small reading groups. Pupils and teacher discuss the meaning of the text, read aloud, model the use of skills, and interpret the meaning of the text together. Mostly, this instruction focuses on skills as predicting, summarising and seeking clarification, which are skills that resemble the metacognitive skills. Research on the effectiveness of this instructional model showed positive results in the achievement in reading comprehension (Pressley, 1998).

The studies do not provide information about the implementation of cognitive apprenticeship in a regular school setting by a regular teacher. In some studies (e.g. Lee, 1995; Pressley, 1998), regular teachers were involved, but their instructional behaviour was not studied explicitly. So far, research did not explicitly study whether regular teachers can use the model in their lessons. The studies did show effects, mostly on higher-order skills, such as metacognition and problem solving. Because the studies mostly took place in laboratory setting, it less clear what the effects are when cognitive apprenticeship is implemented in a regular setting (Terwel & Hooch Antink, 1996). Besides, the studies did not provide evidence about the effectiveness in terms of basic skills.

Isolated elements of the cognitive apprenticeship model were more frequently studied. Reciprocal teaching (Palincsar & Brown, 1989) is one of the most studied models, that shows elements of cognitive apprenticeship. This model focuses on the learning of the cognitive strategies summarisation, question generation, clarification, and prediction through dialogue between teacher and students. Rosenshine and Meister (1994) compared 16 experimental studies concerning reciprocal teaching. These studies showed that reciprocal teaching influences achievement. The effect size on standardised tests was .32 and on experimenter-developed tests .88. This implies that the student could apply the strategies that they learned. The effects on reading comprehension in general were smaller. Furthermore, reciprocal
teaching had less positive effects on the achievement of below-average students. The effect size for these students was .08 on standardised tests. The review contained seven studies in which teachers were trained to use the model. However, these studies hardly dealt with the implementation and the quality of the instructional activities that stem from the reciprocal teaching model. It is not clear to what extent the teachers implemented the reciprocal teaching procedures and what the quality of their behaviour was during the dialogues. Nine studies combined reciprocal teaching with explicit teaching. In these studies, the four strategies were introduced in three to six traditional lessons before the dialogue started. The effects of this combination were significant. The group size ranged from 2 to 23. The majority of the groups consisted of less than 10 students. This leaves it unclear how effective reciprocal teaching is in classrooms, which usually consist of more than 20 pupils. A larger classroom can be divided into smaller groups, but in that case the teacher cannot take part in the discussions in all groups. The effectiveness of studies described in the review is based on group discussions that include a teacher.

Two more recent Dutch studies also concerned the effectiveness of reciprocal teaching in combination with direct instruction. The study of Brand-Gruwel (1995) focused on the effectiveness of reciprocal teaching in reading and listening. Both experimental programs trained pupils in primary schools in using the four strategies. The program that combined reading and listening showed significant effects on the mastering of the four strategies. Furthermore, the program had positive effects on general reading comprehension, metacognitive skills and regulation during the reading process. The program that focused on listening showed significant effects on the strategies pupils use while they are listening. No transfer to reading was found. The program was not taught by regular teachers. Besides, per school small groups of only six pupils were trained outside the classroom. Although the listening-reading program had significant positive effects on reading comprehension and metacognition, it is not clear whether teachers in regular classroom settings can use reciprocal teaching with similar positive results (Brand-Gruwel, 1995, Aarnoutse & Brand-Gruwel, 1997).

In the study of Walraven (1995), regular teachers were trained to use direct instruction and reciprocal teaching in metacognitive strategies. However, the experimental program was used to teach small groups of three pupils outside the regular classroom. Furthermore, it was not observed how teachers used the instructional behaviour that underlied the program. The program showed significant effects on the pupils’ knowledge about strategies but not on reading comprehension (Walraven, 1995).

Kelly and Moore (1994) and Lederer (2000) did study reciprocal teaching in a more regular setting. Kelly and Moore (1994) studied reciprocal teaching by the regular teacher inside the classroom, but only with a small group of pupils. The other pupils worked independently on reading assignments. They did not specifically study to what extent the teacher implemented
reciprocal teaching and the quality of their instructional behaviour. The pupils in the experimental groups showed significant improvements in reading comprehension. The study of Lederer (2000) integrated reciprocal teaching in whole class teaching in social studies. The intervention concerned grade 4, 5 and 6 and lasted between 15 and 17 days. The researcher provided whole class instruction in the reciprocal teaching procedure and scaffolded the discussion between the pupils that were divided into groups of four of five. The results indicate that all students improved their performance in reading comprehension compared with the control group. Although these latter two studies show that reciprocal teaching can also be used in a more or less regular setting, Kelly and Moore (1994) only used reciprocal teaching for a part of the pupils and Lederer (2000) did not use regular teachers for the instruction. This leaves it unclear whether regular teachers can use the model within a regular classroom setting.

2.4.4 State of the art of cognitive apprenticeship

Cognitive apprenticeship is based on constructivist ideas about learning. As a consequence, the cognitive apprenticeship model is connected with ideas about learning. It focuses not so much on basic knowledge and skills, but on the process of learning and on more complex skills and metacognitive skills. The call for these kinds of outcomes also comes from society. Pupils need to be prepared for lifelong learning by teaching them complex skills and metacognitive skills. The research described in section 2.4.3 did not answer all four questions about the implementation and effectiveness of the cognitive apprenticeship model. Although several researchers attribute clear potentials and high expectations to the cognitive apprenticeship model, there is little empirical evidence concerning the implementation and effectiveness in a regular classroom setting. Since it is a theoretical model, cognitive apprenticeship does not consist of concrete descriptions of teacher behaviours that teachers can easily use and that can structure a lesson. Furthermore, research into the effectiveness of the model usually took place in laboratory settings. This means that the treatment took place outside the regular classroom or was carried out by the researcher or a computer environment. This leaves it unclear whether regular teachers can use the cognitive apprenticeship model in their regular classrooms. And thus, it is hardly studied what the effectiveness of the models is in a regular setting. Additionally, it is unclear whether constructivist instruction is appropriate for teaching all kinds of knowledge and skills. The described studies mostly focus on complex skills, such as metacognitive skills, problem-solving skills and reading comprehension skills. This leaves it uncertain whether cognitive apprenticeship is also suitable for more basic skills. Until now, research did not deal with the question whether cognitive apprenticeship is suitable for all pupils. There is no evidence about the ability individual pupils require to
benefit from cognitive apprenticeship (Järvelä, 1996). For example, when pupils have little prior knowledge concerning a specific content matter, it appears to be necessary that the teacher guides the learning and directly instructs the pupils (Veenman, 1998).

2.5 The two research traditions related

This chapter showed that research on direct instruction and cognitive apprenticeship does not provide a clear answer to the question how regular school teachers should structure their instruction when they want to stimulate the development of multiple educational outcomes. Research into the direct instruction model shows that teachers can implement this model in their regular classroom setting. Furthermore, teachers that use the direct instruction model show significant improvements in the achievement of pupils in basic skills. There is no evidence that direct instruction can also be used for teaching metacognition.

The implementation of cognitive apprenticeship by regular teachers was not explicitly studied. Research shows that the model does have positive effects on metacognition. There is no evidence that these effects can also be reached by regular teachers in a regular classroom setting. Furthermore, it is not clear whether cognitive apprenticeship can also positively contribute to achievement in basic skills. Table 2.1 summarises the way direct instruction and cognitive apprenticeship were studied.

Table 2.1 Characteristics of research into direct instruction and cognitive apprenticeship

<table>
<thead>
<tr>
<th>Direct instruction</th>
<th>Cognitive apprenticeship</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation of teacher behaviour</td>
<td>Little implementation studies</td>
</tr>
<tr>
<td>Study relation teacher behaviour-achievement</td>
<td>Little studies relation teacher behaviour-achievement</td>
</tr>
<tr>
<td>Experimental studies in regular classes</td>
<td>Experimental studies in laboratory settings</td>
</tr>
<tr>
<td>Focus on achievement basic skills</td>
<td>Focus on metacognition and complex skills</td>
</tr>
</tbody>
</table>

The summary of characteristics of research shows that the models are studied in very different ways. For answering the question, which of the two models is more effective in terms of basic skills and metacognition, we need to compare the models in one research design. Thus, this thesis links the two research traditions by studying characteristics of direct instruction and characteristics of cognitive apprenticeship and outcomes from both traditions, being achievement in basic skills and metacognition. Figure 2.2 presents the research model in which elements of both traditions are combined.
The figure contains elements from research into direct instruction and from research into cognitive apprenticeship. The three boxes on the top present the elements that traditionally were studied in educational effectiveness research. The two boxes at the bottom show the main focus of research concerning cognitive apprenticeship so far. The arrows between the three boxes at the top and the other two boxes illustrate the new relations that can be studied in the combined design.

Firstly, the influence of direct instruction on metacognition can be studied. Additionally, the effects of cognitive apprenticeship on basic skills can be demonstrated. Besides that, we can take the background characteristics of the pupils into account in determining the general and differential effectiveness of the models. Most importantly, this combined design enables us to compare the effectiveness of both models.

The study focuses on the effects of direct instruction and cognitive apprenticeship in a regular classroom setting. As a consequence, we first study the implementation of the models. Both models need elaboration in order to facilitate the implementation of the models by teachers in a regular classroom setting. The following chapter describes how the models were elaborated into concrete teacher behaviour within a specific subject matter and pictures the choices that were made to facilitate the implementation process. Besides that, it provides a more explicit definition of achievement in basic skills and metacognition.