Pergamon

Learning and Instruction. Vol. 7, No. 2, pp. 161–186, 1997

0959–4752/97 $17.00 + 0.00

S0959-4752(96)00015-1

SELF-REGULATED LEARNING: A NEW CONCEPT EMBRACED BY RESEARCHERS, POLICY MAKERS, EDUCATORS, TEACHERS, AND STUDENTS

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Abstract

In the past decade self-regulated learning (SRL) has been studied extensively. It has been defined as a complex interactive process involving not only cognitive self-regulation but also motivational self-regulation. An increasing body of knowledge attests that cognitive self-regulation can be taught and that students who use these self-regulatory skills obtain better grades in the content domain to which these skills apply. However, students who self-regulate on one occasion may not self-regulate their studying on another occasion, despite the acknowledged benefits. It is argued that self-regulated learning can be domain-specific or domain-transcending, and that competent performers in a specific domain rely on different types of prior knowledge related to that domain.

In this paper a conceptual review on self-regulated learning is offered on. Four major points will be addressed. First, six types of prior knowledge will be described. Second, it is documented that SRL can be a complex, demanding and deliberate activity, but also a simple, habitual and automatic activity. Third, it will be argued that we have covered some ground demonstrating that cognitive self-regulation can be taught. Fourth, motivational self-regulation will be addressed in an attempt to clarify its position in the six component model of self-regulated learning. Finally, our intervention program will be briefly described in an attempt to demonstrate how the various design recommendations given in the previous sections can be put to the test.

A Major Goal in Education: Teaching Students Self-regulatory Skills

Many educators and policy makers currently defend the view that a major goal of formal education should be to teach students self-regulatory skills. These skills are viewed as vital, not only to guide one's own learning during formal schooling, but also to educate oneself and up-date one's knowledge after leaving school. All actors involved in education have raised hopes that psychological knowledge about how students become self-regulated learners and about successful instruction will help us bridge the gap between teaching students disciplinary knowledge and allowing them to acquire strategic knowledge.

Currently, most teachers do not seem to have difficulties in identifying self-regulated learners or describing the attributes of students who fail to regulate their learning. Additionally, there seems to be consensus among researchers that self-regulated learners differ in many aspects from those who need a large amount of external regulation. For example, they rely on internal resources (internal regulation) to govern their own learning process, beginning a learning activity by setting goals for extending knowledge and bolstering motivation. They also seem to be aware of what they know and feel about the domain of study, including which general cognitive and motivation strategies are (less) effective to attain the learning goals, how easy or difficult it is to gain mastery in that domain, and whether they have the capacity and the motivation to invest the necessary resources.

Many influential educational psychologists have proposed theoretical models and have set up longitudinal studies to produce theoretical and pragmatic information about self-regulated learning, and about the environments in which this type of learning can be most successfully acquired (Gardner, 1991; Resnick, 1987; Scardamalia & Bereiter, 1986; Weinert & Helmke, 1995). There seems to be consensus, at least at the descriptive level, of what is meant by self-regulation. For example, Schunk and Zimmerman (1994) defined it as "the process whereby students activate and sustain cognitions, behaviors, and affects, which are systematically oriented toward attainment of their goals" (p. 309). On the other hand, researchers struggle with the concept at the explanatory level, the main reason being that SRL is located at the junction of several research fields. This implies that investigators have the tendency to reinvent the wheel, adapting and extending their emerging theories, instead of borrowing existing conceptual frameworks from neighboring fields. Social scientists have been notoriously poor in such integrative attempts.

It is therefore implied that educational psychology will be faced with a challenging task at the turn of this century. Policy makers and teachers are ready for massive school reform, inviting researchers to come into the classroom in order to decide together on the next plan or strategy. Yet, researchers realize that most classrooms are still populated with students who are not self-regulating their learning, and that most teachers are not yet equipped to turn students into self-regulated learners. In most cases, teachers are still steering and guiding the learning process, a situation which does not invite students to use or develop their cognitive or motivational self-regulatory skills. Usually, students are expected to reproduce and apply the new information that the teacher has presented or made available.

Indeed, most tasks set to students in formal schooling can be characterized as "outcome-based practice sessions". Teachers are considered to be experts. Their task is to model the new skills. Students, on the other hand, are indiscriminately viewed as novices and requested to observe the model, then imitate and practise the skills in order to accommodate in the future. This instructional model assumes (1) that most students will be successful in activating or generating the cognitive strategies that will produce a satisfactory solution in the time allotted by the teacher, (2) that transfer will materialize spontaneously during the practice sessions, and (3) that students will gradually become independent of their teachers' guidance and control. Furthermore, it is assumed that students will be able to control their effort expenditure and manage their emotions.

Yet, there is abundant evidence that transfer, or the skill to generate context-sensitive strategies at the point of application, does not occur spontaneously, and that students do not become self-regulated learners overnight. Indeed, it has become clear, that for self-regulated learning to develop, teachers must create a powerful learning environment, in which students are allowed and inspired to design their own learning experiments. This implies that students should be motivated to actively participate (experiment and reflect) in the teaching-learning processes organized by the teacher and construct their own knowledge base on the basis of direct and indirect learning experiences (cf. The Cognition and Technology Group at Vanderbilt, 1990).

This paper offers a conceptual review of self-regulated learning, using references from empirical studies briefly to reinforce the discussion at various points. I will address four major points. First, I will argue that different types of prior knowledge are essential and powerful ingredients I SRL. Second, I will document that SRL can be a complex, demanding and deliberate activity, but also a simple, habitual and automatic activity. Third, I will illustrate that we have covered some ground demonstrating that cognitive self-regulation can be taught. Fourth, I will defend the view that cognitive and motivational forms of SRL are interwoven aspects that jointly affect effort expenditure and task performance. These aspects should be taken into account when designing powerful learning environments in which students can acquire strategic knowledge. Each of these four major points will be discussed. Finally, our intervention program will be described briefly. It is an attempt to demonstrate how the various design recommendations can be put to the test.

Prior Knowledge: An Essential and Powerful Ingredient in SRL

Currently, most educational psychologists acknowledge that prior knowledge is a powerful and essential ingredient in SRL. Yet, there is some confusion about what constitutes prior knowledge and about the type of prior knowledge that is necessary for self-regulated learning to occur. I find it informative to use the six component model, depicted in Fig. 1 to illustrate the different types of prior knowledge that students need in order to be able to learn independently. This six component model is meant to be seen as a heuristic device. It is not a summary of empirical findings, which at present would not entirely support such a structure. As can be seen, the model consists of 6 cubes, 3 of which represent cognitive self-regulation (left part of Fig. 1), the other 3 refer to motivational self-regulation (right part of Fig. 1). Three levels can be distinguished, namely the domain-specific level (bottom level) the strategic level (intermediate level) and the goal level (top level). I have selected cubes as a form of representation because of their three dimensional structure. In fact, I suggest that each component represents a specific type of prior knowledge that a student has potentially available at any given time. However, only a subset of that information is accessible and usable given in a specific context. "Availability" and "accessibility" are both visually represented in the model: prior knowledge that is currently on-line at the domain-specific level, as well as prior knowledge that has been made instrumental to that domain at the strategic level, and the goal level is visually represented in the forefront of each cube (lit up). The dark part of each cube represents prior knowledge that is not accessible to the student or cannot be used adequately in the current context.

Prior Knowledge and Cognitive Self-regulation

In the past, researchers tended to cast prior knowledge in terms of conceptual, procedural, and episodic knowledge, and they studied the cognitive strategies for the

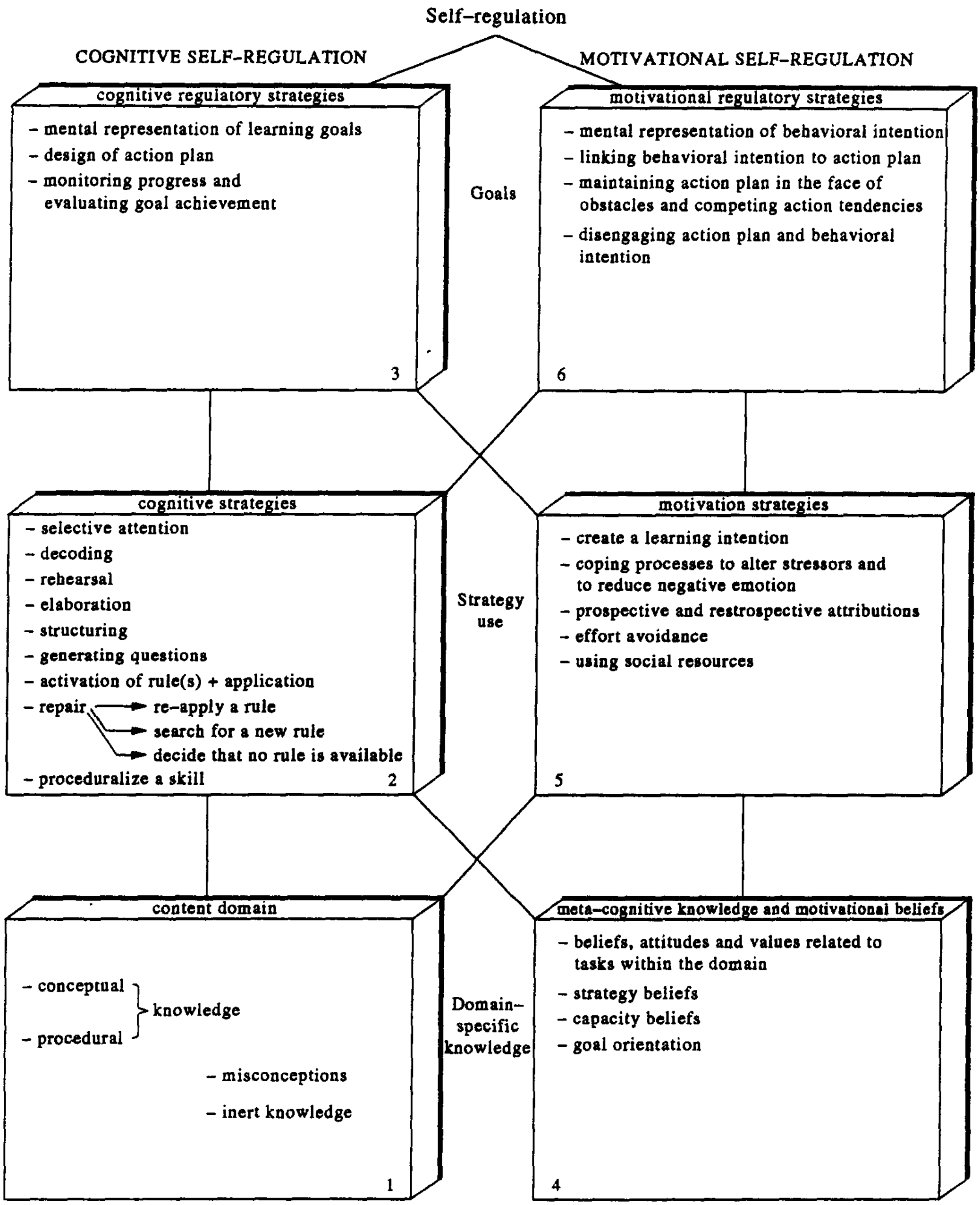

Figure 1. A six component model of self-regulated learning.

acquisition and use of that knowledge. In Fig. 1, conceptual and procedural knowledge that relates to a specific domain is portrayed in Component 1. It consists of the learner's knowledge of ideas, facts and definitions, as well as procedural knowledge such as formulas and rules (Dochy, 1996).

General cognitive strategies necessary for information processing, such as selective attention, decoding, rehearsal, elaboration and organization, are located in Component 2 of the model. There is accumulating evidence (see Ennis, 1990) that some learners are able to apply general cognitive strategies to well-structured as well as to ill-structured domains. But most students need some practice to make their general cognitive strategies instrumental to new domains. Students who have not yet learned to regulate their learning in relation to a domain need external regulation to process and integrate new information. Through explicit transfer inducing instruction and practice, a subset of their cognitive strategies may become attuned to the new domain, acting henceforth as prior knowledge for processing information related to that domain (Ennis, 1990). This instrumentality is visualized in Fig. 2 by the connecting path between Components 1 and 2.

Researchers working in the area of metacognition have argued that effective and successful learners also have access to a third type of prior knowledge, namely metacognitive knowledge. In the beginning, researchers defined metacognitive knowledge in terms of the knowledge a student has about the conditions of effective and ineffective strategy use within content domains (Brown, 1978; Flavell, 1976). Whether or not students have access to metacognitive knowledge was typically assessed with questions such as: "In order to comprehend a text, the best way is to read it more than once." It was established that this type of knowledge facilitates, but does not guarantee appropriate learning or problem solving behavior. Later, Flavell (1987) distinguished between three types of metacognitive knowledge, including knowledge about the self, knowledge about various cognitive tasks, and strategy knowledge. In current research on classroom learning, various indicators of student motivation and beliefs are measured alongside their awareness of effective strategy use. For example, the Michigan group (McKeachie, Pintrich, & Lin, 1985; Pintrich & Garcia, 1993) used the Motivated Strategies for Learning Questionnaire (MSLQ) to measure students' reported cognitive strategy use (e.g., rehearsal, organization strategies, elaboration), their reported self-regulation (e.g., cognitive engagement, time, place and effort regulation), their reasons for engaging in a task (value component) and their beliefs about their own capacity to perform specific strategies and to control the learning situation (expectancy component). Some authors regard motivational beliefs, such as goal orientation, interest, attitudes, and self-concept of ability, as part of metacognitive knowledge. This signifies that the term "metacognitive knowledge" has come to refer to aspects of students' theory of mind, theory of self, theory of learning and learning environments. In my opinion, this inclusion is unwarranted, mainly because it decreases the explanatory power of the various constructs.

I have positioned all knowledge about cognition and motivation, emanating from direct or indirect experiences related to a specific domain, in Component 4 of the six component model. Yet, a distinction is made between metacognitive knowledge and motivational beliefs related to a specific domain. It is assumed that a domain-specific subset of the students' experiential knowledge base is activated when they are confronted with a concrete learning task. This knowledge base (accessible knowledge depicted in the front of the cube) is also sampled when students complete a questionnaire on their study habits or on their conditional knowledge. This subset includes strategy beliefs (e.g., in order to be good in history, you must be able to summarize stories and remember them in your own words), self-referenced cognitions related to the value of tasks and subject-matter areas (e.g., I do not like history because I cannot see why I need to know anything about people who are dead), capacity beliefs (e.g., I am good in history because I have a good memory), control beliefs (e.g., you cannot prepare for a literature exam because they ask you to interpret poems and texts that you have never seen before), and goal orientation (I am interested in history because I like to explore how former cultures were organized and how these people lived).

Metacognitive knowledge allows students to better comprehend, monitor or assess conceptual and procedural knowledge related to a domain, whereas motivational beliefs help them to sustain motivation. Component 4 is positioned at the same level as the declarative knowledge of that domain. The link between Components 1 and 4 visualizes the interaction between the two domain-specific knowledge bases. Pintrich and Garcia (1991) suggested on the basis of their work with university students that there are multiple "pathways" leading from metacognitive knowledge and motivational beliefs (Component 4) to strategy use (Components 2 and 5). For example, students who are extremely low in task value may neither feel capable nor care enough to generate appropriate cognitive strategies when they are required to do so. In a dissimilar vein, students who have no instrumental use of specific cognitive strategies may not be able to complete a task, regardless of their metacognitive knowledge and motivational beliefs.

There is also accumulating evidence (e.g., Chi, Glaser, & Farr, 1988; Wyatt, Pressley, El-Dinary, Stein, Evans, & Brown, 1993) that learners, who are metacognitively aware of what they are doing differ from those who lack this knowledge in their use of so-called metacognitive skills (Component 3). These include orientation, planning, execution, monitoring, reflection, and self-testing. Students who have access to these skills can deliberately activate and use their prior knowledge located at Components, 1, 2 and 4 to mentally represent a learning goal and to design and execute a plan of action. Students who lack prior knowledge in Component 3 (cognitive regulatory strategies) will experience difficulties defining and attaining their own learning goals. There may be many reasons why this is the case, for example, lack of coherent declarative, procedural, or metacognitive knowledge; failure to transform prior knowledge into a strategy for learning or problem solving; or lack of experience in activating and combining various types of prior knowledge (Components 1, 2, 4) in a self-regulated fashion. In order to achieve mastery, these students have to rely on external regulation (e.g., tasks and assignments given by the teacher, or on program control).

Prior Knowledge and Motivational Self-regulation

An increasing number of researchers would agree that the prior knowledge described so far is incomplete for accurate explanation of SRL. Researchers who depict self-regulated learners as learners who have well-organized and easily accessible prior knowledge, located in Components 1–4, ignore that these students also rely on motivation strategies to accomplish learning goals. Hence, analogous to the distinctions made between the various components related to cognitive self-regulation, I have made a distinction between three aspects of motivational self-regulation, including motivational beliefs (Component 4), motivation strategies (Component 5) and motivational regulatory strategies (Component 6). Motivational beliefs, located in component 4, differ from motivation strategies and motivational self-regulatory strategies since they focus on the students' beliefs, rather than on their capacity to regulate motivational and emotional processes before, during and after learning activities. In the past decade, several motivation strategies have been identified, including prospective and retrospective attributions (Weiner, 1986); defensive pessimism (Covington, 1992), coping processes to alter stressors and to deal with negative emotions (Boekaerts, 1993, 1996a), effort avoidance (Rollett, 1987), and creating a learning intention (Boekaerts, 1995). Existing data reveal that this type of prior knowledge can either be domain-specific or domain-transcending (Boekaerts & Otten, in preparation; Pintrich, Garcia, & De Groot, 1994).

There is also evidence that students who have naive models at the level of motivation strategies, must rely on external regulation to sustain their motivation (Boekaerts, 1994; Corno, 1995; Schunk, 1995; Volet, 1994; Xu, 1994). Teachers can help students make their motivation strategies instrumental to learning in different subject-matter areas and assist them in the acquisition of motivational self-regulatory skills, including goal setting and action control. I will discuss motivation strategies and motivational self-regulation in section 4.

Conclusion

So far, I have argued that there are different types of prior knowledge and that novices may have naive models with respect to any of the six components in the model of self-regulated learning. For example, a university professor who exhibits top performance in physics and speaks Spanish, French and English fluently is a novice when she decides to acquire Japanese. The prior knowledge that she has available does not include appropriate declarative knowledge (Component 1 is virtually empty). Although some of the cognitive strategies present in the professor's cognitive repertoire may be applicable to master the Japanese language, deliberate attention should be given to decontextualize these strategies and make them instrumental for the emerging domain-specific component. It may be assumed that the professor, who has already learned a number of foreign languages, is not naive at the level of Components 3, 4, 5 and 6 either. However, it is possible that the metacognitive knowledge and motivational beliefs she has access to are largely invalid for learning Japanese. For example, her strategy beliefs as well as her motivational beliefs concerning time and effort management may be naive. This may imply that the motivation strategies which she usually selects on the basis of these beliefs may be ill adapted and thus in need of elaboration. Specific scaffolds may be necessary to adapt and extend her prior knowledge in Components 4 and 5.

My first design recommendation is:
Teachers should be made aware of the different types of prior knowledge that their students can draw on to give meaning to tasks and assignments. They should invite their students to activate their prior knowledge and make it instrumental to the new domain.

SRL can be a Complex, Demanding, Deliberate, Volitional Activity as Well as a Simple, Habitual and Automatic Activity

Brown and Palincsar (1989) acknowledged that metacognitive knowledge and skills may improve as students increase in age, but emphasized that the acquisition of such knowledge and skills is not part of natural development. Based on a review of the literature, they concluded that deficiencies in metacognition seem to be a problem due to the newness of the task. Developmental psychologists explored whether aspects of self-regulation change with development. It was reported that a child's theory of mind undergoes dramatic developmental changes and that there are large individual differences in self-monitoring and self-reflection at any age level (for review, see Demetriou, Efklides, Kazi, Platsidou, Sirmali, & Kiosseglou, 1996; and Sternberg & Kolligan, 1990).

Educational psychologists mainly compared the metacognitive knowledge and the performance of average and gifted novices of various ages in different content domains, or focused on the performance of experts within a domain of study. On the basis of these studies there is growing consensus that students, who have more metacognitive knowledge in relation to a subject-matter domain, demonstrate superior strategy use and are better problem solvers. For example, Nelissen (1987), reported significant differences in self-monitoring and self-assessment while solving mathematical problems between high-ability and low-ability students from elementary and secondary education. An interesting study by Kurtz and Weinert (1989) also revealed that average 5th and 7th graders differ from their gifted peers since they possess less advanced metacognitive knowledge, independent of age. Further, they are less likely to attribute success to ability, attributing it instead more often to effort. Kurtz and Weinert studied the separate and joint effects of three person variables (viz. intelligence, metacognition, and beliefs about effort control) on the students' strategy use during a word sorting task (novel task) and their recall under time pressure. These authors assessed the students' metacognition with a metamemory questionnaire which consisted of task-related items about the value of clustering strategies, and more general questions about memory tasks and strategies. Causal modelling procedures on the entire sample showed metacognition to be a much stronger predictor of word recall than either effort attributions or scores on traditional intelligence tests. Metacognition influenced recall both directly and indirect via strategy use (i.e., the type of clustering procedures used in the word sorting task). No significant paths were detected from either intelligence or effort control to strategy use and recall performance. This study is especially interesting because separate models were constructed for data from the gifted and average samples. Comparison of these models revealed more of the underlying mechanism linking strategy use to performance. It was found that metacognition remained an important predictor of strategy use in both samples, yet there were interesting differences, as well. For the average students, performance on the recall task was not predicted by strategy use. In this group there was only a direct path leading from metacognition to performance. For the gifted students, there was no direct path from metacognition to performance, but a strong path from strategy use to performance.

The fact that a direct link between strategy use and performance was only evident among the gifted students suggests that these students profited more from their direct interaction with the task (using clustering strategies) than did their average peers. Therefore, I would suggest that simply generating appropriate cognitive strategies at the point of application does not guarantee their efficient use on a later occasion (here: a recall session). Gifted students, more so than their average peers, may be capable of acquiring cognitive strategies directly from their experience with a task *and* integrating them into their repertoire of available strategies. In agreement with this suggestion, Veenman (1993) reported that the rate of progression in novice discovery learning is determined jointly by intelligence measured by traditional tests and by metacognition. His results indicated that efficient use of metacognitive knowledge and skills are stable characteristics of the student across specific domains. Veenman suggested that less intelligent novices acquire different information than their more intelligent peers. The former acquire declaratively encoded rules (e.g., you must always think before you act) which still need to be translated into appropriate strategies. In contrast, the latter seem to acquire strategic behavior directly through their experience with novel tasks.

The line of evidence that pertains to expert performance, e.g., Pressley (1995), clarified that strategic behaviour is tacitly acquired through long experience in a domain of study. This specific type of SRL is habitual, rather than consciously deliberate. It deepens a person's affect about the domain. Pressley referred to an interesting study by Wyatt et al. (1993) who described the extremely rich self-regulated reading of 15 social science professors. They were asked to read self-selected recent journal articles. Wyatt et al., found that these experts had (1) deep and connected conceptual knowledge in their domain of expertise (Component 1, Fig. 2), and (2) had extensive strategic knowledge of reading that type of text (Components 2, 3 and 4). It is the combination of these different types of prior knowledge that results in full-blown constructive responsive reading (a term coined by Pressley & Afferbach, 1995).

The point I want to make is that individuals who have strategic knowledge in relation to a domain of expertise can self-scaffold their knowledge acquisition process, allocating sufficient resources to knowledge extraction and to various monitoring processes. There are many differences between experts and novices, but, as Winne (1995) argued, the ability to fuse information processed and information processing without teacher or text scaffolding sets experts apart from novices. Winne clarified that in the early stages of skill development, students cannot time share among various self-regulatory skills and the learning process per se. He referred to a study by Kanfer and Ackerman (1989) in which this phenomenon was first demonstrated. In this study, adult learners were given a complex skill acquisition task, namely a real time simulation of air-traffic control. On the basis of their extensive research, Kanfer and Ackerman hypothesized that rules for landing aeroplanes are encoded in the form of propositions in the early stages of skill acquisition, but later make the transition to a proceduralized skill. They further assumed that less cognitive resources are needed to run off a proceduralized skill than to consult multiple propositions, strung together by a declaratively encoded rule.

They selected air force personnel unfamiliar with landing aeroplanes and split them into two groups on the basis of their scores on a vocational aptitude battery. Half of the two groups were given a general goal "do your best". The other half was set a more specific goal "acquire 2200 points" which required that they monitored against standards. These authors found that higher aptitudes predicted learning (more planes were landed faster). Moreover, monitoring against a standard began to improve performance between the 5th and the 7th trial. In the early attempts, novices seemed to have trouble sharing time among the learning process per se and monitoring their learning (cognitive self-regulation). This finding suggested that in the beginning of the learning process the processing of action knowledge consumes so much working memory that most of the available resources are expended.

In an additional experiment, Kanfer and Ackerman displayed that giving novices pretraining in action knowledge (making appropriate key-board responses) speeded up proceduralization. More specifically, monitoring goals set early in the skill acquisition process did not hurt learning. However, the negative impact of monitoring instructions was still evident in students who received the same amount of pretraining but without knowing that this training pertained to landing aeroplanes. Winne (1995) warned that instructions to monitor one's learning in the early stages of skill acquisition may hurt learning, particularly in low ability learners and learners with low prior knowledge.

Together, the findings discussed so far add pieces to the puzzle of explaining why non-experts, and I believe most primary and secondary school students fall within that category, cannot regulate their own performance. It is for future research to determine when diverse new skills are fully represented in propositional form and are ready to be proceduralized. At this point, which was in Kanfer and Ackerman's study around the 5th trial, less cognitive resources are needed to activate differing types of prior knowledge and excute a procedural task. When we have information about these transition points we can advise teachers better on the timing of cognitive self-regulation. Until then, it is important to tell teachers that early attempts at self-regulation are characterized as complex and demanding. Even when novices have access to rudimentary forms of prior knowledge located at different components, they lack experience in combining it in a self-regulated fashion. Their SRL is characterized by conscious, deliberate processing, and they depend on external control (provided by teachers, parents or curriculum designers) to regulate their learning (cf. Boekaerts & Simons, 1995; Shuell, 1990). If we want them to proceed beyond this point cognitive self-regulation should be an explicit educational target. This brings me to my third major point.

My second design recommendation is:
Teachers should be made aware that declarative information needs to be proceduralized. They should be trained to create practice sessions which allow students to replace conscious and deliberate processing by more habitual and automatic processing.

Cognitive Self-regulation can be Taught

There is a large body of research that demonstrates that when learners are not (yet) able to regulate their own learning, teachers can compensate for suboptimal self-regulatory skills by providing adequate instructional support (cf. Snow & Lohman, 1984). It is difficult to define the term instructional support, since what is supportive for one group of students may be perceived as low autonomy or pressure by another group (Boggiano, Main, Flink, Barrett, Silvern, & Katz, 1989). Likewise, the type of instructional support required in the initial stages of learning a new skill may be totally different from the support needed in the later stages.

External Regulation vs Scaffolding

Under conditions of direct teaching, teachers traditionally *transmit* new domain-specific knowledge and skills to their students. This one-way interaction process may or may not contain information on efficient strategy use, and it may or may not be followed by guided practice. Eighteen years ago, Durkin (1979) revealed that most reading teachers ask their students a lot of questions, yet do not teach them explicitly how they should go about answering these questions. The same holds for other domains of study. It is in fact strange that teachers who are trained in an education system in which the culture of the "correct answer" is dominant, believe that students acquire the cognitive strategies needed for reading comprehension directly through the reading experience (Aarnoutse, 1990).

In the 1980s, under the influence of theories on guided learning and metacognition, researchers began to prompt teachers to explicitly teach the cognitive strategies that they want their students to use. Evidence to date indicates that students can be taught to execute many discrete cognitive strategies and that their immediate performance can be elevated by explicit practice in the use of these strategies. However, directly teaching discrete strategies does not guarantee either cognitive self-regulation or improved classroom learning in the long-term (Brand-Gruwel, 1995). In an interesting study conducted by Borkowski and Peck (1986) it was demonstrated that the provision of complete strategy instructions lead to comparable post-test performance by gifted and average students. However, the average students' strategy use did not match that of gifted students on a far transfer task. In contrast, when students were given only partial strategy instruction, prior metacognitive knowledge predicted strategy use on both the trained and the far transfer tasks, even when IQ was partialled out.

There is a vast body of research that attests that learning strategies learned in one domain or under specific learning conditions are not generalized to slightly different situations (cf. Brown, Bransford, Ferrara, & Campione, 1983; Paris, Cross, & Lipson, 1984). Several authors (e.g., Blagg, 1991; Derry & Murphy, 1986; Vosniadou, 1992) demonstrated that students do not apply newly acquired conceptual knowledge or cognitive strategies spontaneously, even after they have successfully passed an exam in which that knowledge was tested. An explanation for this phenomenon may be that much knowledge that is explicitly taught to students, remains implicit knowledge. It is not easily accessible, because students have not made their repertoire of cognitive strategies (Component 2) instrumental to that knowledge. In light of this suggestion, researchers have urged teachers to provide learning opportunities in which students explicitly learn to select, combine and coordinate their cognitive strategies in connection to the new knowledge. In addition, they should be prompted to reflect on their strategy use, extending their metacognitive knowledge with strategy and capacity beliefs.

Weinert, Schrader, and Helmke (1989) warned that under conditions of maximal external regulation, there is little room for self-regulatory skills to develop and demonstrate their beneficial effect. This phenomenon was also illustrated by Snow and Lohman (1984) who reported a drop in the correlation between intelligence and achievement when various forms of instructional support were provided. Teachers should realize that students who demonstrate high achievement under optimal external regulation may not perform up to standard under less optimal conditions, e.g., under conditions of high instructional density, in a complex, unstructured or threatening learning environment, or under exam conditions.

In my opinion, it is informative to make a distinction between external regulation and scaffolding. External regulation is a form of support that leaves the learner little autonomy and hardly any responsibility for the learning process. The scaffolding metaphor captures the idea of an adaptable and temporary support system that helps an individual during the initial period of gaining expertise (e.g., training wheels is a good example). This type of support is typical of early skill development and of industrial settings. Vygotsky (1962) introduced the construct "the zone of proximal development" into the developmental literature and used it to refer to the area between a student's actual and potential development. He demonstrated how instruction could foster development. In the literature on apprenticeship and cognitive apprenticeship the construct of expert scaffolding pertains to the process whereby novices are acculturated in an industrial setting by means of modelling, coaching and fading (Collins, Brown, & Newman, 1989). In the early stages of skill acquisition the master is the model and controls the learning process. As students acquire more skill, they are allowed more autonomy and are expected to take over some control. The master then reverts to a coaching role, thus progressively fading support and ceding more responsibility to his or her students.

Several researchers set up intervention studies in which they taught students in the experimental groups one or more cognitive strategies and provided various forms of scaffolding. The intervention programs took as their starting point the finding that experts use strategic behavior tacitly acquired through long experience in a particular field to facilitate their problem solving. They identified the components of strategic behavior used by experts in the field, then taught them to students alongside the problem solving procedures. The basic elements of a cognitive apprenticeship were incorporated in the respective programs. In some studies (e.g., Davey & McBride, 1986; Nolte & Singer, 1985) only one cognitive strategy was taught, namely question generation. In the domain of mathematics, Schoenfeld (1985) taught students a set of strategies that he thought successful mathematical problem solvers used. Larkin and Reif (1976) did the same for physics, Scardamalia and Bereiter (1986) and Englebert and Rafael (1989) for writing, and Palincsar and Brown (1984) and Paris et al. (1984) for reading comprehension. These intervention programs were highly successful on many levels. First, they shifted the teacher role from an expert transmitting declarative and procedural knowledge to that of a coach helping students to acquire the cognitive strategies necessary for operating on domain-specific knowledge. Second, they identified a set of cognitive strategies that experts use when working with domain-specific knowledge. Third, they specified the conditions that foster the acquisition of these cognitive strategies, including proleptic and cooperative learning. In sum, these studies provide evidence that when students are encouraged to solve problems while simultaneously reflecting on their own problem solution process they can acquire metacognitive knowledge and skills, reflected in higher performance on curricular tasks in the same domain.

I would like to digress to the studies on reciprocal teaching, mainly because a recent meta-analysis revealed interesting aspect of the study that may shed some light on the success of the paradigm.

Reciprocal Teaching Dialogue

Brown and Palincsar (1989) formulated a set of conditions that foster cognitive self-regulation for reading narrative and expositionary texts. This set of conditions is generally referred to with the term "reciprocal teaching dialogue". This procedure is defined as a form of instruction whereby learning conditions are arranged in such a way that knowledgeable experts place themselves between the learner and the new environment so that they can experience a particular set of cognitive strategies in the presence of experts and gradually come to perform these functions themselves. Learning is thereby viewed as an active and constructive activity, performed in a social context. In the original design, Palincsar and Brown (1984) taught students four cognitive strategies (clarification, question generation, summarization and prediction) through modelling combined with the Socratic teaching method. That is, in the dialogue between teachers and students, teachers first clarified or demonstrated the target strategies and gave procedural prompts to help students generate the strategies themselves. This scaffolding was gradually faded and replaced by active attempts on the part of the students to illustrate how they used the four central cognitive strategies in order to make sense of a concrete text. Comprehension skills were tested with experimenter-developed comprehension tests. In a later design (e.g., Palincsar, 1987) teachers were instructed to explicitly teach the four cognitive strategies before proceeding with the dialogues (4–20 days of explicit teaching took place).

An important property of the reciprocal teaching procedure is that students are invited to make comments regarding the modelling of the passage and they are provided with guided assistance as they imitate the model in applying the four cognitive strategies. During the course of the dialogues a gradual shift is noted from the teacher doing much of the modeling and explaining, to the students taking over the initiative in the dialogues. Likewise, explicit procedural prompts given by the teacher are substituted by cue cards containing the procedural prompts, or by mental notes of the procedural prompts. The evidence overwhelmingly shows that students in reciprocal teaching groups were superior to control students in reading comprehension skills.

Rosenshine and Meister (1994) reviewed the literature on reciprocal teaching. They compared the experimental and control groups in 16 studies and reported that when experimenter-developed comprehension tests were used a median effect size of .88 was found, whereas the median effect size dropped to .32 when standardized tests were used. Results were equally effective independent of the first or the second design, and there was no instructor effect. No relation was found between the significance of the results and either the number of sessions, the age or size of the instructional groups.

At first glance, two results seem puzzling. First, the results on the standardized tests were non-significant. Comparison between the teacher-designed tests and the standardized tests revealed that in both tests new reading material was used. The latter type of comprehension tests had a median length of 84 words and used multiple-choice questions that required varying degrees of inferencing. The former types of tests had a median length of 400 words usually followed by 8–10 short answer questions or multiple choice questions. Another difference between the teacher made tests and the standardized tests was that the former were pre-structured. Each paragraph started with a topic sentence and the rest of the sentences provided supporting details. This was an important text clue that students learned to exploit in the training sessions. However, these clues were not present in the standardized reading texts. Hence, the students' reading comprehension was assessed with invalid tests (too short and without a topic sentence). The point I am making is that, apparently, the program designers wanted to make students "mindful" to the topic sentence (cf. Salomon & Globerson, 1987). I guess that it was not their intention to make learners independent of this type of scaffolding, otherwise they would have made an attempt to fade these clues before testing the students' reading comprehension.

Second, students in the experimental group did not generate higher level questions than students in the control group. Brown and/Palincsar (1989) suggested that their students learned more than simply generating questions. I would even go further to suggest that increased reading comprehension, without a concomitant increase in the use of one of the supporting cognitive strategies, contributes to the success of the intervention program. Indeed, this finding suggests that students did not think much about how to proceed, they just carried out the task (cf. Veenman, quoted above). It is my guess that the students in these studies used strategic behavior tacitly acquired through the intervention program to facilitate their reading comprehension. I consider this a major breakthrough in applied research.

In sum, the findings reported in Rosenshine et al.s', meta-analysis and many studies not quoted in that analysis documented that cognitive strategies that foster reading comprehension (or mathematical problem solving) can be modelled at school and that students who are given appropriate scaffolds can learn to communicate about the cognitive strategies they apply to a text or problem (see also De Corte, 1995; and Gravemeijer, 1994).

My third design recommendation is:
Teachers should be trained to create powerful learning environments in which students can learn to self-scaffold their learning process.

Cognitive and Motivational Regulatory Strategies are Interwoven Aspects of SRL and Jointly Affect Strategy Use, Effort Expenditure and Task Performance

Set Goals vs Self-defined Goals

At school, students are given tasks and assignments and they have to follow mandatory courses. This implies that they are expected to mentally represent and accomplish these goals. Most learners will strive to accomplish teacher set goals, relying heavily on input, standards, and rules provided by the teacher. It needs to be noted, however, that these teacher set goals may not be congruent with self-defined or self-generated goals. One of the reasons why teacher and student goals are not congruent may be that teachers have a different time horizon than students. They set comprehensive goals for their students (e.g., to know more about x, or to explore y) which are more abstract and distant than the immediate goals and concrete actions students are driven by (e.g., to finish a task as fast as possible, or to get good results on a task). At the moment we have little or no sense of how learning goals are mentally represented by the students, and neither do we know how they fit with students' short-term and long-term goals. Lemos (1996) explored this area. She videotaped 6th grade students' classroom behavior and later asked them to identify on the tape the successive goals they were trying to accomplish. Furthermore, the teachers were asked to reveal which goals they wanted their students to achieve during the videotaped lesson. It was reported that teachers set their students mainly learning and complying goals, whereas students primarily perceived working and evaluation goals.

It seems important that teachers help students to mentally represent learning goals and re-define them in terms of their own short-term and long-term perspectives. On the basis of his extensive research on goal setting, Schunk (1995) advised teacher to set attainable goals and to explicitly teach students the principles of goal setting, encouraging them to use their own standards and monitor against them. He referred to a study by Morgan (1985) who displayed that undergraduates who learned to set proximal goals for reading scored higher on final exams than students in the distal goal condition. They also learned to monitor subgoal progress better and judged intrinsic interest in the course higher.

Volet (1994) conceptualized students' goals for a course in terms of their learning orientation, or direction of study. More specifically, this study examined students' orientation toward a specific university course in terms of their inclination to process material at the surface or at a deeper level. She illustrated that regardless of the way they have been conceptualized, learning orientations have been found to be significantly related to strategy use and performance (Volet & Chalmers, 1992; Volet & Renshaw, 1990), but also to interest (Schiefele, 1992), and to motivation control and effort expenditure (Boekaerts & Otten, in preparation; Volet, 1994).

Effort: Allocating Resources

Most educational psychologists still portray students as being motivated to learn, willing to put in effort and capable of monitoring their own effort. Unfortunately, this is not realistic. Effort is at the heart of self-regulated learning, but researchers do not agree on its conceptualization. Those working within the cognitive framework often claim that effort can be measured by merely observing students and quantifying their responses. They use parameters such as, for example, the number of responses made, the time taken to respond or to study, the length or precision of a response (e.g., Eisenberg, 1992). Over the past decades, several researchers have argued that these quantitative indices of effort may differ greatly from more subjective indices. For example, Alexander (1995) made a distinction between mindful and mindless effort and Weinert et al. (1989) distinguished between qualitative and quantitative effort. The former type of effort refers to the quality of strategy use. This is the extent to which effort is expended to process the material extensively (deep level processing) and in a context-sensitive way. The latter refers to time allocation (e.g., sitting before one's books, or cramming before an exam in a surface level processing style).

Weinert et al. (1989) showed that 6th graders' self-concept of mathematics ability has an indirect effect on their math achievement through effort expenditure and anxiety. Interestingly, students who scored high, either on the pre-test of math ability or on self-concept of math ability, spent high *qualitative* effort. This, in turn, had a positive effect on their math achievement two years later. In contrast, students who scored low on either self-concept of math ability or on the pre-test, spent more *quantitative* effort. This led to more anxiety and to low math achievement. These findings suggest that students who have a low capacity for mathematics (either objectively or subjectively) at the end of primary education are inclined to expend quantitative effort for math tasks. This type of effort is associated with high levels of anxiety and therefore causes poor math performance. It should be noted, that the distinction between mindful and mindless effort and between qualitative and quantitative effort would seem paradoxical from the point of view of cognitive theorists. Within this framework it is held that by its very nature, effort is a sign of activity in the central processor, and is always mindful.

Accumulating evidence emanating from the educational literature attests that motivational beliefs are associated with whether students exert effort and the type of effort they expend. There is a general consensus that students who put in a lot of *effort* are those who believe that effort is a major cause of school success and failure. More specifically, they believe that ability is not a prerequisite for success. It is more important to cleverly exert effort and use one's social support network to acquire new knowledge and skills (Weiner, 1990; Zimmerman, 1995). Other students may not be willing to put in a great amount of effort, particularly those who declare that they are unaware of the causes of success and failure in a particular subject-matter area. The same holds for students who are of the opinion that they are not smart enough to use their personal and social resources to make learning a success.

In the developmental literature, an attempt was made to describe changes over time in students' theories of mind, self-concept of ability, and effort. For example, Harter (1990) described the different subsets of the self in the major periods of life, whereas Paris (1988) and Nicholls (1990) demonstrated that children's theory of effort develops slowly over the middle childhood years. Very young children seem to have a global, often unrealistic concept of ability. It is conceptualized as a skill which is enhanced by practice and effort, but also by good work habits and good conduct. Over the elementary school years, the concepts of ability and effort are further differentiated. Before the age of ten, children believe that putting in effort will always be rewarded, independent of ability. Afterwards, they come to realize that hard work is not sufficient to achieve school success, and that students try to compensate for low ability by putting in a lot of effort. The differentiation between effort and ability is speeded up by social comparisons and by the ability to reflect on one's own actions. In this respect, Demetriou et al. (1996) were able to show that there is a dramatic shift in students' awareness of the content characteristics of a task to the thought processes involved in the task around the age of 12.

In early adolescence, effort and ability are fully differentiated constructs. We found, for example, (Otten & Boekaerts, 1990) that 12-year-olds' self-referenced cognitions in relation to history were largely positive. Students knew what it took to do well on a history exam, but they expressed unfavorable beliefs about literature and text processing, clarifying that they did not know what it took to satisfy the teacher. Their motivational beliefs (Component 4) were reflected in the time spent preparing for the various exams and in their attributions after doing the exams (Component 5). They spent on average 3 hours preparing for a history exam and attributed their outcome significantly more to effort than to ability. The average preparation time for a literature exam was 10 minutes and students attributed their perceived result on the exam significantly more to ability and to external factors than to effort. These results help us to understand why some students invest a lot of effort in a task or course, or spend a long time preparing for an exam, whereas other students do not.

I believe that it is not sufficient to predict students' effort expenditure either on the basis of information about their overall goal structure (short-term and long-term goals), or with their subject-matter related beliefs, interests, and capacity related beliefs in mind. In order to gain insight into students' effort expenditure, domain-specific motivational beliefs should be supplemented by the cognitions and feelings that surface in concrete learning situations. Learning situations, even those that pertain to the same subject-matter area, may differ in the extent to which they trigger personality variables at the general and domain-specific level. This subjective information will affect task-specific cognitions and affects.

Appraisals: Crucial Interface

The "person in situation" view has been documented by Lazarus and Folkman (1984) and their followers, by Snow (1992) and Boekaerts and her colleagues (Boekaerts, 1988, 1992, 1995). Lazarus and Folkman argued that the reactions individuals exhibit at a specific moment in time are affected by "person × situation transactional units". These transactions form the basic units of behavior, and behavioral consistency should be viewed as a function of these units.

Snow (1992) urged researchers to examine both intraindividual continuity and situational specificity. He used the term "aptitudes" to refer to latent or inferred qualities of the learner which make him or her respond differently to current situations. Snow explained that we ought to know students' potential, given specified conditions, in order to be able to design optimal learning environments. Both aptitudes and situation characteristics can be positioned along a continuum ranging from "stable" to "malleable" and "ephemeral". Stability is a matter of degree, since aptitudes or situations can be located more toward the stable or ephemeral end of a continuum. Snow and Swanson (1992) suggested five general categories of aptitudes that need to be considered in any instructional theory, including the learners' conceptual structures, their procedural skills, their learning strategies, their motivational constructs and their self-regulatory or volitional functions. I have used the term prior knowledge to refer to these general categories and I made an attempt to specify the interrelations between these "aptitudes" in my six component model of self-regulated learning.

In other publications (Boekaerts, 1988, 1996b) I argued that when the aim is to explain and predict student behavior in concrete learning situations, it is essential to record the unique ways in which students experience every-day learning opportunities. More specifically, I proposed to study student cognitions, feelings and behavior, *while a learning episode is unfolding*. In that way the person-environment transactional units, that form the basis of goal directed behavior, are allowed to surface. This information will give a dynamic indication of how student characteristics interact with learning tasks and learning environments. Research based on a theory which assumes that cognitive and affective processes are variable across situations and time, can reveal stable and unstable change in behavior. As Krohne (1996) explained, unstable change insinuates random behaviour. It can not be replicated, whereas stable change can. Stable change is an indicator of situation-sensitivity and intraindividual responsiveness to the learning task and its context.

Until recently, most studies that explored the influence of person characteristics on learning used traits to measure person characteristics. These traits, such as achievement motivation, intrinsic motivation and anxiety refer to intraindividually invariable aspects of personality. Research has demonstrated, however, that links between motivational beliefs and learning processes may only be evident in specific age groups, in specific content-areas, or for students with specific personality characteristics (cf. Boekaerts, 1996b; Pintrich & Garcia, 1991). From the results of these findings it can be concluded that theories of learning should also focus on intraindividual continuity and situational specificity.

In our own studies, we made a distinction between personality variables measured at the general level, at the domain-specific level, and at the momentary or situation level. This multi-level motivation approach is used to study the relative impact of motivational beliefs measured at 3 different levels on effort expenditure and learning outcome. First we measure students' motivational beliefs about school tasks in general; second, the value they attach to specific school subjects and their capacity and strategy beliefs in relation to these school subjects; and third, their appraisals of concrete curricular tasks before and after completing them. My model of adaptable learning (Boekaerts, 1991, 1992, 1995) is used to steer and direct this research. This model clarifies the relation between cognitions and affects and links them to two parallel information processing routes, the learning route and the well-being route. A student is said to be learning in an adaptable way when he or she has found the balance between the two processing routes and the basic priorities underlying them. Appraisals have a central position in this model. They steer and direct the students' attention and energy either to adaptive pay-offs (competence, increase in internal or external resources) or the restoration of well-being (prevention of loss of resources). Appraisals and their concomitant emotions may influence upcoming and ongoing cognitive processes. When appraisals are dominantly unfavorable and emotions are intense, they draw the learner's attention away from the learning process which may lead to avoidance behavior.

Together with my co-workers, I developed the on-line motivation questionnaire (OMQ) (e.g., Boekaerts, 1988; Boekaerts & Otten, in preparation; Boekaerts, Seegers & Vermeer, 1995; Crombach, Voeten, & Boekaerts, 1994; Seegers & Boekaerts, 1993) to measure students' cognitions and affects in actual task situations. This questionnaire is administered immediately before a student begins with a learning task or homework assignment and again when it is completed or the student gives up. For the purpose of this paper it is important to know that the OMQ assesses amongst other things the students' appraisals, their affects, and their learning intention before they begin with a curricular task. After completing the task, their effort expenditure, their task assessment, and their attributions and affects are also measured.

Three basic appraisals were identified, two of which reflect the students' self-referenced cognitions on the value of a curricular task, including task attraction and perceived utility. The third appraisal triggered the students' capacity-related beliefs as they pertain to the task. This self-confidence score aggregates the students' self-efficacy judgment expressed in relation to the task, their outcome expectation, and the perceived level of difficulty. It was found that the three appraisals interact and have an effect on effort expenditure and on task performance.

In our studies with children aged 10–16, we found that the value students attach to a curricular task and their self-efficacy determine effort expenditure in a complex way. In the younger age group (end of elementary education, age 10–12) we investigated the effect of appraisals on two types of curricular tasks, mainly mathematics and reading comprehension tasks. It was found (Seegers & Boekaerts, 1993) that both aspects of task value, namely task attraction and perceived importance of the task, were directly linked to learning intention and emotional state. Students who perceived a mathematics task to be attractive and/or important were prepared to invest more effort in completing the task. However, students who found math tasks important, but not attractive, reported a negative emotional state. In this age group, self-efficacy (level of confidence expressed in relation to mathematics tasks) was not directly related to learning intention. It seems that only those students who feel confident that they can accomplish the task and enjoy doing the task are prepared to invest resources (causality pleasure).

Another study conducted by Boekaerts and Otten (in preparation) investigated the effect of the three appraisals on students' learning intention and task performance in relation to four school subjects, including mathematics, history, native language and foreign language learning. Students were in their first year of secondary education. It was found that those students who made favorable judgements of a curriculum task (either expressing that they liked doing the task, found it important, or judged themselves to be competent) were prepared to invest effort. Similar to what was found in the younger age group, perceived importance and perceived competence increased task attraction and learning intention. Unlike what was found in the younger age group, a direct effect of self-efficacy on learning intention was noted.

In our studies with older students (13–16 years olds), we asked participants to maintain a diary in which they completed the OMQ immediately before and after doing homework in 2 school subjects (mathematics and history). We observed that perceived importance was the most dominant appraisal affecting effort for both school subjects. Task attraction did not hold the central position it had in previous studies with younger students while doing seat work. The findings suggest that appraisals of homework assignments, particularly interest (task attraction combined with perceived relevance) play a significant role in allocating resources. Moreover, these appraisals seem to be subject-matter specific.

It is important to note, that teacher control was minimal in the studies involving homework assignments. Indeed, homework can be done in the student's own time which implies that some students allocate sufficient time and resources, whereas other do not. During seatwork, teachers can exert more social pressure and control, while prompting them to spend more time and effort than they originally intended. In this respect, an interesting study was conducted by Volet (1994). She asked undergraduates to complete the on-line motivation questionnaire before and after a semester course. Volet reported that positive appraisals displayed at the beginning of the course were associated with higher levels of effort, better course work and exam performance. These findings, combined with the evidence for a direct link between favorable motivational beliefs, measured at the domain specific level, and appraisals (Seegers & Boekaerts, 1993), led to the following suggestion: students who have positive motivational beliefs (e.g., intrinsic motivation, task orientation, self-concept of ability) are able to generate positive scenarios (a favorable appraisal pattern) when they are confronted with a learning task. This capacity (different from a belief) is considered to be a motivation strategy (Component 5, in Fig. 1). Defined in this way, one could hypothesize that students who lack the skill to generate a positive appraisal pattern (interest, causality pleasure), while being confronted with a learning activity, will need will power to initiate and maintain actions.

Action or Volitional Control

It is easy to imagine that learning situations which entail low effort expenditure without social sanctions will call for motivational self-regulation. In those situations, students need to protect teacher-set learning goals and their own learning intentions from competing action tendencies (see e.g., Corno, 1993, 1995; and Zimmermann & Martinez-Pons, 1986). Kuhl (1984, 1994) referred to will power or volition with the term action control and designed the action control scale to measure this concept. Kuhl's theory of action control provides a detailed explanation of mental processes that link self-referenced cognitions and personal goals to motivational regulatory skills. This theory goes beyond control beliefs, it focuses instead on the individual's sense of personal agency and his or her skill to regulate motivational and emotional processes, rather than on subjective feelings of value and control.

In his action control theory, Kuhl (1984) explained that flexible self-regulation requires a mechanism that discriminates self-defined goals, intentions, wishes and expectations from those defined by others. Individuals who confound their own goal-related beliefs with those of others will predominantly behave according to an external control pattern, encoding the wishes and expectations of others as obligations. Hence, students who score low on action orientation are characterized by a rigid, context-insensitive reliance on the goals, standards, wishes and expectations of others. Such other-related commitments induce cognitions, emotions and affects that are counter productive for self-regulation. Kuhl refers to this mode of control with the term "state orientation". Its debilitating effects on individuals' volitional abilities to plan, initiate and complete intended actions are described and contrasted with the positive effects of another mode of control, termed "action orientation" (Kuhl, 1994). Three behavioral consequences of state orientation are fully described, including failure-related (rumination), decision-related (procrastination) and performance-related (alienation) consequences.

The action control scale measures the most typical and most easily accessible indicators of action orientation. Kuhl constructed this scale to measure a person's disposition to protect behavioral intentions from competing action tendencies. The scale consists of three subscales, which includes initiative, persistence and disengagement. The items relate to a wide variety of daily activities. An example item for each subscale is presented in Fig. 2. Students who score low on the respective subscales are predominantly in a state that reflects "uncontrollable mental activities that are dissociated from and potentially interfering with an individual's current self-generated intention" (Kuhl, 1992, p. 99).

In agreement with the work of Kuhl (1984), Boekaerts (1994, 1995) and Volet (1994)

INITIATIVE (Hesitation)

When I know I must finish something soon:
- I have to push myself to get started (SO)
- I find it easy to get it over and done with (AO)

PERSISTANCE (Volatility)

When I am busy working on an interesting project:
- I need to take frequent breaks and work on other projects (SO)
- I can keep working on the project for a long time (AO)

DISENGAGEMENT (Pre-occupation)

When I have lost something that is very valuable to me and I cannot find it anywhere:
- I have a hard time concentrating on something else (SO)
- I put it out of my mind after a little while (AO)

Figure 2. Example items of the 3 subscales of Action Control.

found that students who are able to activate positive scenarios in relation to a domain of knowledge, reflected in a favorable appraisal pattern, display higher effort and through it better task performance than students with an unfavorable appraisal pattern. Volet predicted and found that the latter students need will power to initiate and maintain actions. She demonstrated that higher levels of effort, but also higher levels of task and exam performance, coincided with favorable appraisals, but also with unfavorable appraisals in the presence of action control. Hence, action control interacted with appraisals to elicit effort. Boekaerts and Otten (in preparation) also found that effort expenditure for history and mathematics assignments (during seat work and at home) was strongly affected by students' interest (aggregated score for task attraction and perceived relevance). Action control had an independent effect on effort, however this effect was subject-matter specific. The interaction effect between interest and disengagement revealed, first, that students who reported low interest in a curricular task and scored high on disengagement showed low effort expenditure. Secondly, students who combined low interest with pre-occupation (low disengagement) displayed significantly higher effort expenditure. Hence, it seems that a minimal degree of concern is necessary to make students put in effort if they are not interested in the task. Motivation strategies (Component 5) and action control (Component 6) jointly affect effort expenditure.

Conclusion

More research is needed to unravel the intricate relations between cognitive and motivational self-regulation and clarify their position in the six component model. I have argued in section three that students who lack prior knowledge in Component 3 are not in a position to self-regulate their learning because they lack the capacity to mentally represent a learning goal. Also, these students are not able to design, execute and monitor an adequate action plan. I concluded that this lack of internal control calls for adequate cognitive scaffolding (in most cases provided by the teacher, but also through better instructional design, or computer supported media). At this point, I would like to emphasize that students who lack prior knowledge in Component 6 are also not in a position to self-regulate their learning. They lack the capacity to discriminate self-defined goals, intentions, wishes and expectations from those defined by others. My conclusion is that these students are in need of *emotional* scaffolding.

This form of scaffolding should be modelled, coached and faded which is similar to the principle of cognitive scaffolding. Teachers and parents should model effective use of resources. They should communicate goals and expectations, allow students to redefine them and formulate their own criteria. They should also scaffold initiative and self-regulated effort. Zimmerman (1995) and Xu (1994) suggested that the context provided by teachers and parents affects SRL. For example, when teachers do not allow for choice of tasks, choice of strategies, and time management, they limit the students' opportunities to become self-regulated learners. In the same vein, it is important that students are stimulated to communicate and reflect on effort allocation. In this respect, Schunk (1995) pointed out that if effort remains constant after practice, students interpret it as a sign of increased task difficulty or as failing capacity. He argued that it is beneficial to students to experience that learning is often hard, even for good students. Such information will help them to elaborate their motivational beliefs and relate them intricately to strategy and capacity beliefs.

My fourth design recommendation is:
Teachers should be trained to design tasks that allow students to ameliorate planning, initiating and completing intended actions.

Connecting the Various Design Recommendations

We set up an intervention program in 4 large vocational schools (students ranged in age from 16–20). Cognitive and motivational self-regulation were explicit educational targets in this intervention program. The design recommendations summarized at the end of each section of this paper were taken as a starting point. In the first phase of the intervention program, 200 teachers were trained to shift their role of being experts transmitting declarative and procedural knowledge to the role of coaches. During the second phase, the trained teachers were used as flywheels, modelling the coaching role for the teacher who participated in the second phase.

Being a coach requires that direct teaching, referred to as "instructional Regime I", is kept to a minimum. We advised them to spend on average 10–15 minutes in Regime I (teacher regulation), mainly to introduce the new topic, model the new skills, and introduce scaffolds and resource materials to the students. After this brief orientation period in Regime I, students were invited to share the regulation process while teachers adopted the coaching role. This implies that teachers should create a learning environment in which students can practise newly acquired skills. Moreover, students should use these practice sessions to increase their self-regulatory skills (Regime II, shared regulation). We trained the teachers to adapt traditional exercises to meet these requirements. In order to be able to work under Regime II conditions, teachers were explicitly trained to design two types of assignments.

The first type of task is a *procedural task* which encourages students to activate declaratively encoded knowledge and proceduralize it (interaction between components 1 and 2). Students worked on the tasks in interactive learning groups. These groups consist of four students who differ in learning style. It is assumed that all students are novices in relation to the new skills at this stage of the learning process. Some may have had some prior experience with the new material, but most of them lack experience in activating and combining their prior knowledge in a self-regulated fashion. The assignments should therefore stimulate them to reflect on the teacher's modelling, consult their notes, use the procedural prompts and the scaffolds provided by the teacher. After some practice, most students' will have replaced conscious and deliberate processing by more habitual and automatic processing. This should be viewed as a signal that they began making their cognitive strategies instrumental for the acquisition and use of knowledge in the new domain. The second type of task invites the students to regulate their own performance.

Cognitive self-regulatory tasks inspire students to time share between the learning process and self-regulation skills. Tasks are designed in such a manner that students have to mentally represent the learning goal, design a plan of action, and monitor their own progress (interaction between Components 1, 2, and 3). It is assumed that students will differ in the way they can self-scaffold their learning process. For example, it is feasible that many students in this age group have access to relevant metacognitive knowledge and skills, but that they cannot make this information instrumental for a new domain. By working in interactive learning groups, they may help each other in making this information available for planning, monitoring and evaluating the problem solving process. Teachers should refrain from giving students explicit help and procedural prompts, providing them instead with resource material and encouraging them to reflect on their own problem solution process. They should also learn to make use of the heterogeneity in the group by prompting students to compare and contrast their problem solving processes with those of their peers. In other words, the second type of assignments should motivate students to make their cognitive strategies instrumental to knowledge acquisition in the new domain. In addition, these tasks should stimulate students to develop their strategy beliefs and to integrate the emerging experiential knowledge meaningfully into the different prior knowledge components (Components 1, 2, 3 and 4). It is important for teachers to realize that they should not reprimand the students when they engage in social talk during group discussions. I believe that this kind of interaction forms a powerful social learning environment for exercising cognitive regulatory skills (Component 3) and discussing strategy and capacity beliefs (Component 4). These beliefs are at the heart of motivational self-regulation which should be practised under Regime III conditions.

We designed a third type of assignment to develop *motivational self-regulation*. These tasks pertain to long-term learning goals and invite students to mentally represent these goals as well as their behavioral intentions. Such demanding tasks should be given under Regime III conditions (student regulation). This implies that the students themselves should be able to ensure maintenance of the behavioral intention. When they are working in Regime III, teachers should refrain from any form of external regulation. Students should be able to formulate proximal and distal goals and design one or more action plans to reach these goals. They should also be able to exert action control geared to initiate the behavioral intention, to ensure its maintenance, and employ self-reinforcement and self-encouragement techniques. Some students are characterized by a rigid, context-insensitive reliance on the goals, standards, wishes and expectations of others (teachers, parents, or peers). These students may learn how to ameliorate planning, initiating and completing intended actions, when they are allowed to work on assignments with peers who have access to motivational self-regulation.

Teachers were trained to administer these different types of assignments and to give differential feedback and support for these tasks. The preliminary results suggest that our intervention program has changed the beliefs and the behavior of teachers and students as regards to their complementary roles. Moreover, the students in the experimental group displayed significantly more deep level processing after a six month intervention program than the students in the control group (cf. Boekaerts, Seegers, & Witteman, 1997).

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