TECHNOLOGY ENHANCED LEARNING

Self-Regulated Learning in Technology Enhanced Learning Environments

A European Perspective

Roberto Carneiro, Paul Lefrere,
Karl Steffens and Jean Underwood (Eds.)

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SELF-REGULATED LEARNING IN TECHNOLOGY ENHANCED LEARNING ENVIRONMENTS

TECHNOLOGY ENHANCED LEARNING
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Scope
The rapid co-evolution of technology and learning is offering new ways to represent knowledge, new educational practices, and new global communities of learners. Yet the contribution of these changes to formal education is largely unexplored, along with possibilities for deepening our understanding of what and how to learn. Similarly, the convergence of personal technologies offers new opportunities for informal, conversational and situated learning. But this is widening the gulf between everyday learning and formal education, which is struggling to adapt pedagogies and curricula that were established in a pre-digital age.

This series, *Technology Enhanced Learning*, will explore learning futures that incorporate digital technologies in innovative and transformative ways. It will elaborate issues including the design of learning experiences that connect formal and informal contexts; the evolution of learning and technology; new social and cultural contexts for learning with technology; novel questions of design, computational expression, collaboration and intelligence; social exclusion and inclusion in an age of personal and mobile technology; and attempts to broaden practical and theoretical perspectives on cognition, community and epistemology.

The series will be of interest to researchers and students in education and computing, to educational policy makers, and to the general public with an interest in the future of learning with technology.

Self-Regulated Learning in Technology Enhanced Learning Environments

A European Perspective

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ROBERTO CARNEIRO , PAUL LEFRERE, KARL STEFFENS AND JEAN UNDERWOOD

FOREWORD

Self-regulated learning (SRL) subsumes key aspects of the learning process, such as cognitive strategies, metacognition and motivation, in one coherent construct. Central to this construct are the autonomy and responsibility of students to take charge of their own learning. The value of SRL is in its emphasis on the individual as a pivotal agent in defining learning goals and strategies, recognizing as it does how that individual's perceptions of him or herself alongside learning-task characteristics influence the quality of learning that emerges.

Successful self-regulated learners should be able to: *recognise a need to learn* (for example, be able to spot significant current or impending gaps in their knowledge); *make wise choices in relation to that need* (about what to learn; how and when to learn it; and whom to learn it with and from); and *satisfy that need efficiently and affordably* (for example, by obtaining data on the experiences of other learners, then using that data to set and achieve their own study goals). In addition, because learning is effortful, self-regulated learners must be able to sustain their motivation until the 'job' is done.

It has been recognised that the majority of learners need help in achieving a level of self-regulation. The building blocks required to self-regulate are not necessarily available to each and every learner. For example, learners are often unaware of gaps in their own knowledge and skills and are poor at identifying critically important information. These, and other key skills for self-regulation, can be encouraged both directly and indirectly through a range of learning activities. In this book we look specifically at the ways in which technology enhanced learning environments (TELEs) have been used to support self-regulation.

We hope that after reading these contributions you will agree that networked forms of TELEs hold significant promise. For example, by helping learners to acquire new knowledge and skills at an early enough stage in their development to benefit fully from them (which often means before institutionally-accredited courses are available), and to become more agile in thought, in practice and when crossing disciplinary boundaries. In addition, they offer the prospect of helping people to compare ideas and experiences more readily with peers and mentors, and thereby develop the robust independence of mind and collaborative skills needed to cope in turbulent times, and to seek out or create knowledge that may lead to solutions to tomorrow's problems.

WHY WE THINK THIS BOOK IS TIMELY

SRL skills are increasingly needed. Society is in a state of flux and the pace and complexity of change is becoming faster than the ability of curriculum authorities to anticipate and respond to change, bringing the prospect of curricula that are obsolete before they are taught. A potential way for society to obviate this threat is to reduce its dependence on a small cadre of expert teachers ('sage on the stage') and instead to empower learners to do more for themselves, preferably via routes and methods that help them to acquire in-demand skills and insights, more surely and much earlier than is possible through the formal educational system. This can be done by exploiting community-focused technologies such as Web 2.0 and services built upon those technologies, and will be enhanced by ontology-rich and semantic-driven environments typical of Web 3.0. One extension to this, relying on SRL for its effectiveness, is the idea of do-it-yourself higher education (Kamenetz, 2010). While cost-saving was the initial spur for interest in the 'DIY University', we start to see attention being paid to the lasting benefits of SRL and a growing interest in developing TELEs to support this[1].

To illustrate, current European R&D projects in technology-enhanced learning (reported on in the UK chapter) are exploring how learners can augment TELEs (and related Personalized Learning Environments) by adding their own choice of functions and facilities. That choice can include mash-ups of recommender and aggregation services. The result: low-cost/no-cost access to up-to-date information, aggregated from multiple sources (eg, communities of learners, professional communities of practice, libraries, news sites, twitter feeds, and repositories of open educational content). Such projects can help learners to become: better-placed to hear about effective ways to learn to learn; and better able to share experiences, insights and news. Sustainable lifelong learning systems are dependent on the emergence of new generations of competent (i.e., self-regulated) learners.

PURPOSE AND FOCUS OF THIS BOOK

The book provides an overview of recent studies on self-regulated learning (SRL) in technology enhanced learning environments (TELEs) in Europe – a perspective which is new and has not been articulated hitherto. It addresses conceptual and methodological questions as well as practices in technology enhanced learning. While the focus is on European studies, we are aware that much of the groundwork in the field of SRL has emanated from the United States.

The contributions in this book come from authors who first met as partners in a European project on SRL in TELEs[2]. They also were the founding mothers and fathers of TACONET[3], a targeted cooperative network dedicated to conducting research in this field. TACONET organised international conferences in Barcelona (2004), Lisbon (2005, see Carneiro et al. 2005) and Amsterdam (2007, see

[1] Examples include the Peer 2 Peer University (http://p2pu.org) and the Responsive Open Learning Environment (http://www.role-project.eu/).

[2] TELEPEERS – Self-regulated learning in technology enhanced learning environments at university level: a peer review. http://www.lmi.ub.es/telepeers/

[3] http://www.lmi.ub.es/taconet/ and http//www.taconet/org

Beishuizen et al., 2007). If you find this book interesting, you might consider joining the network.

The book is based in part on a survey which the group conducted in the context of a seed project within the KALEIDOSCOPE Network of Excellence "Concepts and methods for exploring the future of learning with digital technologies". However, it not only presents an overview of research conducted in eight European countries, but also discusses and reflects on the concept of SRL and related topics.

ORGANISATION

The book is divided into three parts: (A) Foundations of SRL in TELEs, (B) Empirical studies on SRL in TELEs and (C) SRL in TELEs: perspectives on future developments.

The introductory chapters by Jos Beishuizen and Karl Steffens (chapter 1) and Antonio Bartolomé and Karl Steffens (chapter 2) provide a framework for research on SRL in TELEs. While the first chapter focuses on SRL and related concepts, the second chapter addresses different technologies which may support SRL. In his chapter on Pedagogy and learning with the new media, Karl Steffens links the idea of SRL to pedagogical ideas that were proposed by German educators.

The contributions to the second part of the book present and discuss empirical studies on SRL in TELEs. Chapter 4 (Unfolding the potential of ICT development by Manuela Delfino and Donatella Persico) and chapter 5 (Technology enhanced learning in teacher education by Roberto Carneiro and Ana Margarida Veiga Simão) explore the use of TELEs in teacher education to support SRL. Chapter 6 (Recent developments research on fostering self-regulated learning in technology enhanced learning environments by Jos Beishuizen) identifies the characteristics of TELEs that can support SRL in individual or in groups of students. Dominique Lenné, Marie-Hélène Abel and Philippe Trigano (chapter 7) present technological tools which were designed to facilitate SRL.

The three contributions to the last part of the book, chapter 8 (Technology enhanced learning: some impressions by Paul Lefrere), chapter 9 (Learning platforms: Problems and promises by Jean Underwood, Antonio Bartolomé, Paul Lefrere) and chapter 10 (Self-regulated learning in technology enhanced learning environments in Europe by Jean Underwood and Paul Banyard) summarise the discussion on SRL in TELEs and provide a perspective for future development.

Collectively, these contributions show the breadth of European studies on the topic of SRL in TELEs. Our hope is that this book will not only inform readers about the current state of affairs, but will also provoke further research in SRL in TELEs and encourage the implementation and use of TELEs to support SRL.

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Part A: Foundations of SRL in TELEs

JOS BEISHUIZEN AND KARL STEFFENS

A CONCEPTUAL FRAMEWORK FOR RESEARCH ON SELF-REGULATED LEARNING

INTRODUCTION

In the international community of educational researchers, self-regulated learning has become an important topic in educational and psychological research over the last three decades. One reason for this is that it has been found that the extent to which learners are capable of regulating their own learning markedly enhances their learning outcomes. As Zimmerman and Schunk (2008) point out, research has shown that in comparison to poor self-regulators, good self-regulators "set better learning goals, implement more effective learning strategies, monitor and assess their goal progress better, establish a more productive environment for learning, seek assistance more often when it is needed, expend effort and persist better, adjust strategies better, and set more effective new goals when present ones are completed" (Zimmerman & Schunk, 2008, p.1). It is therefore desirable to study self-regulated learning in order to be able to improve these skills in learners.

The other reason for the rising interest in self-regulated learning is that we live in societies in which lifelong learning is becoming increasingly important. It is to be expected that lifelong learning will in the future occur in informal learning environments to a higher degree than in the past. Informal learning environments are likely to be less instructor- or teacher-oriented and more learner-oriented which means they will require self-regulatory skills to a greater extent (cf. Hofer at al., 1998, p.73), but even in formal education, self-regulatory skills are desirable assets.

Articles on self-regulation began to be published in journals on social psychology and personality in the 1980s, in the United States as well as in Europe, while in the 1990s, contributions to the field were also published in educational, organisational, clinical and health psychology journals which dealt with a wider range of aspects of the concept of self-regulation, including self-regulated learning, self-control and self-management (Boekaerts et al., 2000). Models and different uses of the term self-regulation proliferated. Furthermore, it turned out to be difficult to distinguish the term self-regulation from similar terms like self-management, regulation of the self, metacognition and coping (Zeidner et al., 2000).

R. Carneiro et al. (eds.), Self-Regulated Learning in Technology Enhanced Learning Environments, 3–19.

Although some relatively complex models of self-regulation were proposed (cf. Carver & Scheier, 1998, 2000), most models exhibit a fairly simple structure (Steffens, 2006). In many models, self-regulation is depicted as a cyclic process involving three stages: (1) goal setting, (2) monitoring processes and strategies, (3) self-evaluation. There exist a number of models which were explicitly developed to describe processes of self-regulated learning.

In discussing the concept of self-regulated learning, it is important to distinguish between broad and narrow conceptions. In a broad sense, learning is self-regulated if the learner is free to decide what, when, where and how to learn (Weinert, 1982). This implies that most of the learning in academic settings – in schools and universities – is only partly self-regulated and partly teacher/instructor regulated or regulated by the affordances and requirements of the learning environment of which the teacher/instructor may be a part. As Boekaerts pointed out, an adequate model of self-regulated learning in the broad sense would have to consider how the achievement of imposed goals (related to the demands of the learning environment) as well as the achievement of personal goals is regulated by the individual (Boekaerts, 2002).

In publications on self-regulated learning, there seems to be a tendency to define the concept in a narrow sense, thereby neglecting the personal goals of the learner. Some authors refer to the components which are considered to play an important role in self-regulated learning: "Students can be described as self-regulated to the degree that they are metacognitively, motivationally, and behaviourally active participants in their own learning process" (Zimmerman, 1989a, p.4). Other authors describe the process of self-regulated learning: self-regulated learning "can help describe the ways that people approach problems, apply strategies, monitor their performance, and interpret the outcomes of their efforts" (Paris & Winograd, 2001, p.3).

In spite of the abundance of different approaches, authors agree that self-regulation involves several components: "self-regulation involves *cognitive*, *affective*, *motivational* and *behavioural* components that provide the individual with the capacity to adjust his or her actions and goals to achieve the desired results in light of changing environmental conditions" (Zeidner et al., 2000, p.751).

Models of self-regulated learning

Over the last two decades, a large number of models for self-regulated learning were developed. Most of these assume that self-regulating one's learning activities is performed in cycles of three or four stages. Winne & Hadwin (1998), for example, proposed a model of self-regulated learning which distinguishes four stages: (1) defining the task, (2) goal setting and planning, (3) enacting study tactics and strategies, and (4) metacognitively adapting studying for the future.

Zimmerman (1998b) developed a model which describes how university students who aim at improving their performance self-regulate their learning. According to this model, a cycle in self-regulated learning consists of four steps: (1) self-evaluation and monitoring, (2) goal setting and strategic planning, (3) strategy implementation and monitoring and (4) strategic outcome monitoring.

Zimmerman (1998c, 2000) also suggested a social cognitive model of self-regulated learning which is richer with respect to the processes which are considered at each stage. According to this model, self-regulation is achieved in cycles consisting of (1) forethought, (2) performance or volitional control, and (3) self-reflection. Zimmerman (1998c, 2000) describes the stages as follows:

– *Forethought*. In the forethought phase, task analysis and self-motivation beliefs are important. Task analysis refers to planning processes like goal setting and strategic planning. Self-motivational beliefs comprise a student's self-efficacy beliefs, his outcome expectations, intrinsic interest and goal orientation.
– *Performance or volitional control*. In this phase, the chosen strategy is implemented and monitored by the student. Zimmerman distinguishes between self-control and self-observation. Self-control refers to regulatory processes like self-instruction, imagery, attention focusing and task strategies. Self-observation includes monitoring strategies like self-recording and self-experimentation.
– *Self-reflection*. In the self-reflection phase, the student tries to evaluate the outcome of his efforts.

As mentioned above, self-regulation involves *cognitive*, *affective*, *motivational* and *behavioural* components (Zeidner et al., 2000, p.751). While the Zimmerman model described above does consider motivational aspects, most early models of self-regulated learning referred to the cognitive component of self-regulation only. Only recently has the role of motivation in self-regulated learning received increased attention (Schunk & Zimmerman, 2008).

Self-regulated learning and related concepts

Learning may take place in very different learning environments: in and out of school, with or without instruction, intentionally or incidentally, formally or informally. Apart from that, learning may take place individually, in a small group or in a community of learners. Basically, two learning situations may be distinguished: learning that is guided by instruction (teaching) and learning that takes place without instruction. However, this is probably too simple a distinction. It would be more appropriate to speak of teacher guided versus learner guided learning where there exists a continuum between the two extremes. Independent of the degree of teacher or learner orientation, learners will have to self-regulate their learning activities. This will be more important in situations where there is little teacher orientation.

The fact that learners have to monitor and control their learning activities has been described using a number of different concepts. Self-regulated learning as explained above is one important one, but there exist a number of related concepts: metacognition, self-directed learning, self-organised learning, personalised learning and self-regulated personalised learning.

Metacognition

One of the concepts most akin to that of self-regulated learning is the concept of metacognition (Flavell, 1971). While Flavell distinguished between metacognitive knowledge and metacognitive experience (see also Efklides, 2006), it has become common to distinguish between (1) knowledge about one's cognitive processes and (2) monitoring and regulating these processes (see Hacker, 1998, for an in depth discussion of the concept). This distinction is very similar to one made by Nelson and Narens (1990) and Nelson (1996) (see figure 1).

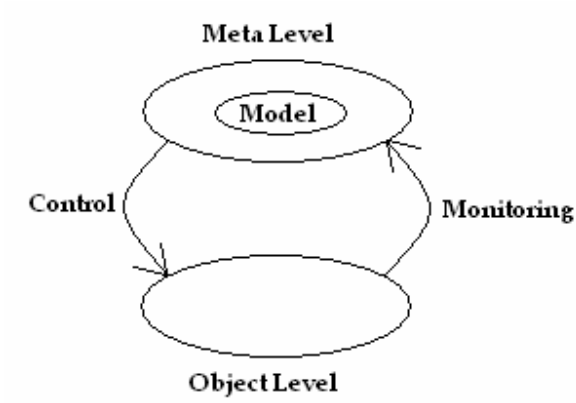

Figure 1: Metacognitive model according to Nelson (1996)

According to these authors, learning always takes place at two levels: at the object level and at the meta-level. The meta-level contains a model of the object level. On the basis of this model, which is continuously updated, the learner monitors the learning process. Moreover, the learner exerts executive control over the learning process. These processes lead to (1) adaptation of the model of the object level, and, consequently, to (2) adaptation of the learning process. Combinations of object level and meta-level can be nested into the object level of a higher control and monitoring loop, leading to recursive cycles of self-regulation activities.

It seems, however, to be difficult to clearly distinguish metacognition from self-regulated learning. Winne and Hadwin (1998), for instance, talk about "metacognitively powered self-regulation" (Winne & Hadwin, 1998, p.278). They present the four-stage model of self-regulated learning mentioned before: (1) task definition, (2) goal setting and planning, (3) enacting study tactics and strategies and (4) metacognitively adapting studying; in their opinion, metacognitive activities can take place in all the four stages. More recently, Azevedo (2009) discussed theoretical, conceptual, methodological and instructional issues in research on metacognition and self-regulated learning. His contribution opens with the statement: "Learning typically involves the use of numerous self-regulatory processes such as planning, knowledge activation, metacognitive monitoring and regulation, and reflection" (Azevedo, 2009, p.87) implying that self-regulated

learning includes metacognitive monitoring and regulation. To us, it would seem to be meaningful to equate the concept of metacognition with the cognitive component of self-regulated learning.

Self-directed learning

As pointed out above, the concept of self-regulated learning is used in a wide and in a narrow sense. Self-regulated learning in a wide sense seems to be equivalent to self-directed learning. As early as 1975, Knowles defined self-directed learning as process "in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating their learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes" (Knowles, 1975, p.18). A rather similar, but more recent definition reads "In self-directed learning (SDL), the individual takes the initiative and the responsibility for what occurs. Individuals select, manage, and assess their own learning activities, which can be pursued at any time, in any place, through any means, at any age." (Gibbons, 2008).

As Gibbons (2002) suggested, enhancing self-directed learning in educational settings would require to customize schooling to the learning needs of individual students and to motivate them to take increasing responsibility for deciding what and how they should learn. This will, of course, be true for any kind of self-regulated learning. Shifting the focus from the learner to the learning environment, the concept of personalisation of learning has come to be of importance.

Personalised learning

Personalisation of learning is part of a much larger campaign that was initiated by the U.K. government in 2001 to personalise public services (Bentley & Wilsdon, 2003; Leadbeater, 2004). While officially it aimed at liberating the individual potential, in effect it put more responsibility (and a greater share of the costs) on the individual citizen. It is therefore not surprising that in talking about personalisation of learning, the more positive aspects of liberating the individual potential are pointed out. According to Halm (2006), personalised learning "meets the needs of the individual learner providing the best method of learning based on their personal interests, learning style(s), motivation and learning objectives". Personalised learning is a form of learning which takes place in a learning environment specifically customised to the individual learner. "Put simply, personalised learning and teaching means taking a highly structured and responsive approach to each child's and young person's learning, in order that all are able to progress, achieve and participate. It means strengthening the link between learning and teaching by engaging pupils - and their parents - as partners in learning." (The Standards site, 2007). Underwood and Banyard (2008) pointed out, however, that in the U.K., managers, teachers and learners understand personalising learning in different ways. They also argue that personalising learning on a large scale will only be possibly using digital technologies (Underwood at al., 2008).

In order to understand how digital technologies may support learners in personalising their learning, they suggest to distinguish between three different spaces: the personal learning space, the teaching space and the school space (Banyard & Underwood, 2009). According to these authors, "the physical characteristics of the personal learning space can still be influenced by teachers and institutions, but the design of that space and the uses of the technology are under the control of the learner" (Banyard & Underwood, 2009, p.11).

The idea of providing learners with technology-enhanced personalised learning environments is also discussed in a series of articles published in the eLearning Papers (Ehlers & Carneiro, 2008; eLearning papers, 2008; Mazzoni & Gaffuri, 2009, a,b).

Self-regulated personalised learning

The concept of self-regulated personalised learning was developed in the iClass project (Aviram et al., 2008,a,b; iClass, 2008). The idea of the project was to develop a web-based learning management system (Intelligent distributed cognitive-based learning system for schools – iClass, see http://www.iclass.info) that promoted self-regulation of learning and intrinsic motivation while allowing learners to personalise their learning environments. Self-regulated personalised learning therefore seems to bear a great deal of similarity with the concept of self-directed learning.

Summing up

It seems that self-regulated learning and similar concepts can be assigned to three different categories: (1) self-regulated learning in the narrow sense and metacognition which focus on the processes in which learners engage when they plan, monitor and evaluate their learning activities, (2) self-regulated learning in the wider sense and self-directed learning which in addition include choice processes (what, when, and where to learn), and (3) the concept of personalised learning which focuses more on the learning environments and its "fit" to the individual student's characteristics.

In the context of this book, the first and narrow concept of self-regulated learning appears to provide the most powerful perspective on the question how to improve self-regulated learning.

TOWARDS A PEDAGOGICAL FRAMEWORK

Although there are a number of studies that show that self-regulated learning can be improved by pedagogical interventions (see, for instance, the collection of studies in Schunk & Zimmermann, 1998, also Boekaerts, 1996; De Corte, Verschaffel, Op't Eynde, 2000; Perels et al., 2005; Rozendaal, Minnaert & Boekaerts, 2005; Schunk, 2005), these do not offer a pedagogical framework that extends beyond the situation analysed in the corresponding contribution. Mooij (2007) suggested that in order to encourage students to develop their skills for self-regulated learning, self-regulation should benefit from the selection of learning

tasks and the coaching and assessment of learning. These three activities may be learner-controlled, but they may also be assisted by teachers or tutors. Two ideas which might be useful in developing a more general pedagogical framework for self-regulated learning are the concept of situated cognition and of cognitive apprenticeship.

Situated cognition and cognitive apprenticeship

In his pioneering article on situated cognition, Collins and his colleagues (Brown, Collins, & Duguid, 1989) argued that in everyday life and in scientific communities, learning is the result of specific activities in specific situations: "The activity in which knowledge is developed and deployed, it is now argued, is not separable from or ancillary to learning and cognition. Rather, it is an integral part of what is learned. Situations might be said to co-produce knowledge through activity." (Brown, Collins, & Duguid, 1989, p.32) In contrast, Collins et al. believed that schools offer knowledge to their students which is abstracted from concrete situations and is therefore not situated. This knowledge can be recalled from memory, but it cannot be put into practice, i.e. it remains inert.

Based on their concept of situated cognition, Collins and his colleagues, in "Cognitive Apprenticeship: Teaching the crafts of reading, writing and mathematics" (Collins, Brown & Newman, 1989) developed a pedagogical model which was based on ideas from traditional apprenticeship. According to Collins et al., teaching and learning in traditional apprenticeship can be described in three phases:

1. the master models the activity in question,
2. he coaches his apprentices as they start to engage in this activity and provides them with scaffolding whenever necessary, and finally
3. he fades from the learning environment, leaving his apprentices to work on their own.

Since this pedagogical model seems to work well in traditional apprenticeship, Collins et al. suggest that schools should adapt it to their needs, making it a cognitive apprenticeship (Collins, Brown & Newman, 1989). To show that this approach might indeed work in schools, they cite publications by Palincsar and Brown (1984) on reciprocal teaching of text comprehension strategies, of Scardamalia and Bereiter (1985) on procedural facilitation of writing skills, and of Schoenfeld (1985) on mathematical problem solving all of which are considered to be good examples of the cognitive apprenticeship approach by Collins et al.

Palincsar and Brown (1984) worked with 5th graders to improve their monitoring of text comprehension. The students were presented with reading strategies that had been observed in expert readers. The training was done in a reciprocal teaching setting, i.e. first the teacher demonstrated the different skills and then teachers and students took turns in actually doing the teaching.

After a three-week training period, students´ reading comprehension scores improved from 15 % correct (pre-test) to 85 % correct (directly after the training). Even after a period of six months, students from the experimental group averaged

60 % correct, and it took only one day of renewed reciprocal teaching to bring them back to their 85 % correct level. Also, effects generalised from the experimental to classroom setting, and there was a clear and reliable transfer to laboratory tasks that differed in surface features from the training task.

In order to help students improve their writing, Scardamalia and Bereiter (1985) developed a number of procedural facilitations in the form of prompts presented on cue cards which aim at facilitating the use of expert-like writing procedures. Similarly, an analysis of goals of the revision process was performed and corresponding prompts were developed. In empirical studies the authors found that their procedural facilitation method did indeed improve students´ writings. It also made them aware that writing is not a linear process, but an iterative one which requires careful planning and revising.

Alan H. Schoenfeld (1985) observed his university students as they solved mathematical problems. He found four factors to be important for successful problem solving: (1) resources, (2) heuristics, (3) control, and (4) belief systems where control refers to the selection and implementation of resources and strategies (planning, monitoring and assessment, decision making, conscious metacognitive acts).

While we agree that the cited publications may be interpreted as examples of cognitive apprenticeship, we also believe that they are good examples of fostering self-regulated learning through instruction. More recent pedagogical intervention programmes which were based on or made reference to the concepts of situated cognition and cognitive apprenticeship have been studied by Jarvela (1995, 1996), Boekaerts (1996), De Corte, Verschaffel, Op't Eynde (2000) and Ghefaili (2003).

Although the work of Collins on situated cognition and cognitive apprenticeship has not gone without criticism (see, for instance, Anderson, et al., 1996, 1997; Greeno, 1997; Klauer, 1999), it did give impetus to the development of Technology Enhanced Learning Environments that seem to have a potential for supporting self-regulated learning (Jarvela 1995, 1996; Ghefaili, 2003). Spiro designed a hypermedia environment based on his cognitive flexibility theory (Spiro et al., 1991). Bransford and his colleagues from the Cognition and Technology Group at Vanderbilt University (CTGV) developed a technology enhanced learning approach (anchored instruction) which is based on the concept of situated cognition. Examples are the Jasper project (CTGV, 1997) and SMART - Scientific and Mathematical Arenas for Refining Thinking (Vye et al., 1998).

More recently, Zimmermann (Zimmerman & Kitsantas, 2005; Zimmerman & Tsikalas, 2005) presented a social cognitive multilevel model of self-regulatory development which shows a high degree of resemblance with the model of cognitive apprenticeship. Like Collins and his colleagues, Zimmerman assumes that at the first level, an expert model is of great importance (observational level). At the succeeding levels (emulation, self-controlled, self-regulated level) the learner becomes increasingly independent of the expert model, improving his self-regulatory skills at each level.

A FRAMEWORK FOR STUDYING SRL IN TELES

In this section, we explore the boundaries of the concept of self-regulated learning, conceived in the narrowest sense as the planning, monitoring and evaluation of learning activities. We view self-regulated learning from the perspective of level of analysis, level of distribution, and level of generalisation.

Level of analysis (low versus high)

Studies in self-regulated learning tend to analyse the performance of learners at the strategic or the behavioural level. Zimmerman (1998c, 2000) suggested a social cognitive model of self-regulated learning which is richer with respect to the processes which are considered at each stage. According to this model, self-regulation is achieved in cycles consisting of (1) forethought, (2) performance or volitional control, and (3) self-reflection. The first and the third cycle encompass strategic activities whereas the second cycle is focused on the behavioural level. However, recently more attention is being paid to the neurological level. Therefore all levels are invoked when students regulate their learning activities. We will subsequently focus on each of the three levels and eventually make a comparison between the various levels of analysis.

Most studies of self-regulated learning focus at the level of strategic processes. For instance, Weinstein's (1996) work on self-regulated learning, particularly the Model of Strategic Learning, relates learning strategies, study skills, motivation, beliefs, and context variables. The same goes for the contributions of Boekaerts (2000), Pintrich (2000), and Zimmermann (1998), discussed above.

At the behavioural level, Koriat, Ma'ayan, Nussinsson (2006) discussed the reciprocal relation between consciousness and behaviour (metalevel and object level in terms of Nelson and Narens, 1990). They provided evidence that task performance is not only regulated by previous planning, but may also influence subsequent planning. For instance, when I have to learn a list of Italian words I may start with estimating the relative difficulty of learning the various word pairs and, subsequently, may allocate rehearsal time according to the expected task difficulty. However, I may experience difficulty in rehearsing particular words and, consequently, adjust my estimate of the level of difficulty of the learning task. This adaptation of the estimated level of difficulty may subsequently determine the way I regulate the learning process. Both causal relationships (planning determines behaviour; behaviour determines planning) appear to occur in self-regulated learning.

Focussing at the neurological level, Shimamura (2000) reported evidence for mid-brain activity during activities like focusing attention, conflict resolution, error correction, inhibitory control, and emotional regulation. Moreover, evidence has been found for frontal lobe activity during selecting, maintaining, updating and rerouting of information in working memory.

Posner and Rothbart (1998) showed that maturation of frontal lobe regions is not completed until the age of 25. Between the ages of 5 and 16 years, the volume of

certain areas in the prefrontal cortex significantly correlates with the performance on cognitive tasks which call upon attentional control. According to Crone (2004), this developmental trend should be taken into consideration when learning arrangements are designed and implemented in which student control is necessary in order to learn. So the presumed advantage of making high school students responsible for their own learning by teaching them how to regulate their own learning has its price: more prefrontal and mid-brain activity is involved in this kind of learning. The required systems should be in place in order to enable the student to bring this kind of learning to a successful end.

As far as the study of self-regulated learning is concerned, all three levels obviously contribute to our understanding of the process of self-regulation. At the neurological level, more important relationships may be revealed. However, the interrelationships between the various levels appear to be very important. We need to know more about the issue of nature and nurture with respect of self-regulated learning. Like intelligence, self-regulation may be determined by both the genetic make-up of the learner and his or her experience.

Level of distribution (individual versus group)

A second perspective on self-regulated learning has to do with the distinction between a focus on individual learning and a focus on the student as part of the community of learners (Brown & Campione, 1994). Most research on self-regulated learning has been focussed on individual student learning. This is not surprising because self-regulated learning is generally considered to be an individual student's characteristic. Zimmerman's (2000) definition of self-regulation as 'self-generated thoughts, feelings, and actions that are planned and cyclically adapted to the attainment of personal goals' (Zimmerman, 2000, p. 14) emphasises this individualised view on self-regulated learning. However, at the classroom level, interesting results have been obtained. Eshel and Kohavi (2003) studied the relationship between teacher control and learner control. Mathematics achievements of 12 to 13-year-old students appeared to be dependent on both high student control and high teacher control. The authors claim that ambitious students may benefit from the "additive effect of high levels of control that are shared by both students and teachers" (Eshel & Kohavi, 2003, p. 259), whereas students aiming for independent learning may flourish under conditions of high student control and reduced teacher control. Apparently, irrespective of the type of students, the development of regulation strategies is related to high levels of student control.

Beishuizen (2008) discussed the potential contribution of the setting of a community of learners to foster the development of self-regulation strategies. He compared two projects in which university students carried out a research task. In one of the two cases, students were involved, as part of their regular bachelor programme in biomedical sciences, in a research programme of the teachers and studied the behaviour of oncogenes in a yeast model. The other case dealt with a software engineering project in which students analysed the introduction of an electronic ticketing system in Dutch public transportation. On the basis of these

two projects, Beishuizen (2008) concluded that the role of the teacher as a model and coach was crucial for the development of self-regulated learning.
It is clear that the focus on individual learning has been predominant in the research on self-regulated learning. We definitely need more evidence as to the contribution of the social environment on both individual development and group development of self-regulated learning.

Level of generalisation (generic versus domain specific)

The third dimension on which we explore the boundaries of the concept of self-regulated learning is the domain within which students develop strategies and skills of self-regulated learning. Most studies focus on a particular domain. For instance, in the Brown, Collins, and Duguid (1989a) paper on cognitive apprenticeship discussed above, three contributions are exposed which focus on the particular domains: text comprehension (Palincsar & Brown, 1984), creative writing (Scardamalia & Bereiter, 1985), and mathematics (Schoenfeld, 1985). Compared to these mono-domain studies, cross domain comparisons are scarce.

Wolters, Yu, Pintrich (1996) asked seventh and eighth grade students to complete the Motivated Strategies for Learning Questionnaire (MSQL, Pintrich & De Groot, 1990) revealing their motivational beliefs and cognitions about the use of cognitive strategies and self-regulation. Students with a mastery or learning goal orientation, valuing the intrinsic value of learning, displayed a positive pattern of motivational beliefs and self-regulation. Students with a performance orientation, motivated by extrinsic goals, showed less positive, more maladaptive motivational beliefs and cognitive strategies. These relationships between goal orientations, motivational beliefs and cognitive strategies were found across the domains of English language, mathematics, and social studies. Interestingly, the authors were able to find distinct effects for two species of performance goal orientation. A so called relative ability goal orientation, aiming at doing better than others, fostered higher levels of self-regulation, whereas an extrinsic goal orientation, associated with test anxiety and fear of failure and looking bad, correlated with a lower degree of self-regulation.

Veenman, Elshout, and Meijer (1997) studied metacognitive skilfulness in three different domains: physics, statistics, and an artificial science domain. High and low intelligent psychology students completed simulation tasks in each of the three domains. Their problem solving behaviour was observed to assess the use of metacognitive strategies. Students showed stable levels of metacognitive performance across domains. Moreover, metacognition and intellectual ability contributed both jointly and independently to the learning process. The authors concluded that metacognitive strategy training makes sense because the training results may be transferable to various domains.

Intra-individual comparisons of self-regulated learning across domains are important for two reasons: to further develop stable insights into the network of concepts elucidating motivation, self-regulated learning and academic performance, and to explore the transferable components of self-regulation

strategies. In this way, these studies may contribute to bridging the gap between laboratory research and school practice.

SITUATING THE CONTRIBUTIONS TO THIS BOOK IN THE FRAMEWORK

While it is the intention of the chapters in the second part of the book to present a European perspective on self-regulated learning (SRL) in technology enhanced learning environments (TELEs), we have to acknowledge that there is no common and unitary European perspective. Instead, there are many different perspectives, not even national ones, but perspective of many European researchers who work in different environments and who have in their research focused on different aspects. We therefore have a diversity of perspectives, but it is this diversity which constitutes something that could be called a European perspective.

Antonio Bartolomé from the University of Barcelona and Karl Steffens from Cologne University first (chapter 2) look at educational technology and its development and then discuss specific technologies and their potential for supporting SRL. Specifically, they present three criteria which they think TELEs should meet in order to be capable of facilitating SRL. These refer to behavioural and strategic aspects of SRL; they focus on the individual learner and they are considered to be domain-general.

Chapter 3 by Karl Steffens discusses whether there is a contradiction between didactics and SRL in TELEs. It is true that classical didactical thinking focussed on teaching and on the perspective of the teacher, and to some extent, this is even true of modern didactics. These approaches leave little room for SRL. Newer approaches in the field of didactics, particularly those of constructivist and media didactics place much more emphasis on the learner and on SRL. They refer to behavioural and strategic aspects of SRL; they focus on the individual learner and they are considered to be domain-general.

Manuela Delfino & Donatella Persico from the Institute for Educational Technology, Italian National Research Council (IDT-CNR) (chapter 4), focus on the development and evaluation of tools to support SRL. They grouped the studies they considered for their review into three categories: (1) studies of metacognitive competencies required or enhanced by the use of Information and Communication Technology, (2) studies aiming to design and implement systems that support the development of SRL and (3) studies aiming to assess and evaluate the potential of different kinds of TELES to support the development of SRL. Their focus is on strategic aspects of SRL and on individual learners, while the level of generalisation varies with the specific study under discussion.

Roberto Carneiro from Universidade Católica Portuguesa and Ana Margarida Veiga Simão from Universidade de Lisboa (chapter 5) look at technology enhanced learning in teacher education. In the first part of their paper, the authors provide an overview of theoretical and empirical studies on SRL in Portugal. In the second section, they describe a study on the impact of a TELE in SRL in the context of a graduate programme of studies offered at the Portuguese Catholic University with a particular focus on motivational profiles of teacher students. The last section provides a brief description of the Digital Portfolio movement in Portugal, a concept that is acquiring momentum among academia and research groups. In this

contribution, the strategic level in individual learners as well as in groups of learners in specific domains is targeted.

Jos Beishuizen from Vrije Universiteit Amsterdam (chapter 6) reports on recent developments in research on fostering SRL in TELEs. The author distinguishes four factors which might influence this process: (1) the student, (2) the teacher, (3) the community of learners and (4) the learning environment. The analysis was based on 26 representative articles from Dutch authors selected from six international and Dutch journals. The author concludes that research has disclosed important relationships between the arrangement of the learning environment, the learning process and the learning outcomes. TELEs seem to be capable of supporting SRL if they provide for adaptability of complexity, interactivity, articulation, and balance. Due to the diversity of studies under scrutiny, almost all levels of analysis, distribution and generalisation are referred to.

Dominique Lenné, Marie-Hélène Abel and Philippe Trigano from Université de Technologie de Compiègne (chapter 7) approach the topic from their own professional perspective which basically is that of a designer of TELEs or, more precisely, a designer of technological artefacts that support SRL. The authors therefore first present some technological tools and environments that can support SRL, then they review recent work on activity tracing and interaction analysis that can provide metacognitive support, and finally they describe a study that evaluated the potential of a TELE in the framework of the TELEPEERS project. Here they look at strategic aspects of SRL, focusing on individual learning in a specific domain (a course on introduction to algorithms and programming).

Paul Lefrere from the Open University in the UK (chapter 8) reports on data gathered in three ways: (1) an impressionistic desk study of education press pieces from 2007, (2) informal and impressionistic interviews of a small number of university teachers in campus-based institutions and (3) a desk study of current UK academic interest and practice in SRL, technology enhanced learning and related areas, as represented by publications by UK researchers, papers accepted by UK editors of journals relevant to technology-enhanced learning and TELEs (primarily the British Journal of Educational Technology) and the type and number of SRL-relevant presentations from UK researchers at major conferences on teaching, learning and TELEs, such as ALT-C. Focus is on the strategic level in individual learners in specific domains.

Jean Underwood from Nottingham Trent University, Antonio Bartolomé from Barcelona University and Paul Lefrere from the Open University (chapter 9), after distinguishing between grand challenges and big issues, discuss the future of learning platforms and their possible impact on SRL as a big issue. Again, emphasis is on the strategic level in individual learners in specific domains.

Jean Underwood and Phil Banyard from Nottingham Trent University (chapter 10) wrote the epilogue to this book. In their contribution, they first reflect on several paradoxes that characterise education in European countries, the first one being that while learners are supposed to be more self-regulating, much more control has been placed on learning and learning outcomes. The second paradox they discuss is that while education is predictable, the future usefulness of this

education is not. The third paradox on which the authors comment is that the present focus on a limited set of basic skills in fact limits a person to that basic set of skills. In the second part of their chapter, they direct their attention to the concept of SRL and to SRL in TELEs. Referring to the preceding chapters, they point out that there seems to be little evidence that the concept of SRL has indeed had an impact on the implementation and use of TELEs. As the authors note, there is, however, also some evidence to the contrary. Jos Beishuizen, in his contribution concludes that Dutch research into SRL in TELEs has disclosed important relationships between the arrangement of the learning environment, the learning process and learning outcomes. So there is hope. But as Underwood and Banyard state "The evidence of the synergy between SRL and TELEs tends still to be confined to the hot-house of research interventions rather than being embedded within the fabric of education."

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TECHNOLOGIES FOR SELF-REGULATED LEARNING

INTRODUCTION

Over the last three decades as Western societies have turned into knowledge societies, self-regulated learning (SRL) has come to be an important topic in educational research. In such societies learning not only takes place in traditional educational institutions, but in the form of lifelong learning far beyond these institutions. In education, the focus is therefore shifting from teaching to learning. This places more responsibility on the individual learner; learners' strategies for self-regulating their learning are therefore becoming more important.

At the same time, technological innovations have made it possible to design powerful technology enhanced learning environments (TELEs) many of which have a potential to foster SRL.

In this contribution, we consider the relationship between these new educational technologies and SRL. In section 1, we shortly reflect on educational technology and its relation to theories of learning and to SRL. In section 2, we present three characteristics which we think any TELE that is to foster SRL should have. In section 3, we investigate whether technologies which are used in TELEs do in fact exhibit these characteristics. In section 4, we introduce connectivism, a new idea on learning in a networked world which stresses the importance of SRL in communities of learners. In section 5, we will present our conclusions including a brief reference to generativism, a learning theory that relates the co-creation and re-creation of new knowledge to human meaning making [1].

TECHNOLOGY AND EDUCATION

Educational technology and learning theories

Theories of learning have been developed under three different paradigms: the behaviourist, the cognitive and the constructivist paradigm. While under the behaviourist paradigm, learning was defined as a change of behaviour due to

[1] We would like to thank Jean Underwood and Roberto Carneiro for their valuable comments on earlier drafts of our contribution.

R. Carneiro et al. (eds.), Self-Regulated Learning in Technology Enhanced Learning Environments, 21–31.

external stimuli, the cognitivist paradigm essentially argued that the "black box" of the mind should be opened and understood. The model of the learner was not of a recipient of knowledge but an information processor. Constructivist while agreeing that learning is related to knowledge about the world stress the fact that this knowledge is constructed by the individual in a social context.

Each of these learning theories has been used to underpin the instructional approach and design of learning software. However, there is one instructional approach, we argue, that is particularly suited for the design of TELEs which have the potential of fostering self-regulated learning: cognitive apprenticeship (Collins, Brown & Newman, 1989). Cognitive apprenticeship was based on the concept of situated cognition which was introduced by Collins and his colleagues (Brown, Collins & Duguid, 1989a). Collins et al. argue that knowledge is always acquired in specific situations; this makes it possible to apply the acquired knowledge in these and similar situations. He believes that schools largely provide their students with abstract knowledge, thereby rendering it inert; inert knowledge may be recalled in examinations but cannot be applied.

According to the cognitive apprenticeship model, an expert serves as a model for the learner in the first phase (modelling). In the second phase, the learner engages in the relevant activities under the supervision of the expert (coaching). In the third phase, the expert gradually withdraws, giving more and more freedom to the learner (fading). Technology enhanced learning environments which are based on the concepts of situated cognition and cognitive apprenticeship were developed by Bransford and the Cognitive Technology Group at Vanderbilt University (anchored instruction, CTGV, 1990, 1997) and by Spiro (cognitive flexibility theory, random access instruction, Spiro et al., 1991).

Educational technology and self-regulated learning

Research on SRL was greatly influenced by the works of Zimmerman and Schunk (Schunk & Zimmerman, 1994; 1998, 2008; Zimmerman & Schunk, 1998, 2008). According to Zimmerman, self-regulation is achieved in cycles consisting of (1) forethought, (2) performance or volitional control, and (3) self-reflection (Zimmerman, 1998, 2000). For a more elaborated presentation of this concept and related ones, see the chapter by Beishuizen and Steffens (Beishuizen and Steffens, in this book).

Zimmerman (Zimmerman & Kitsantas, 2005; Zimmerman & Tsikalas, 2005) also presented a social cognitive multilevel model of self-regulatory development. He assumes that at the first level, an expert model is of great importance (observational level). At the succeeding levels (emulation, self-controlled, self-regulated level) learners become increasingly independent of the expert model, improving their self-regulatory skills at each level. The model very much resembles the cognitive apprenticeship model developed by Collins and his colleagues (Collins, Brown & Newman, 1989) described above. Both models assume that there is an expert in the first stage whose behaviour is to be modelled. In consequent stages, the expert gradually withdraws, giving the learner more and more autonomy.

Technological developments have made it possible to design technology enhanced learning environments which have a rich potential for fostering self-regulated learning, and there is some empirical evidence that they actually do so (Carneiro et al., 2005; Steffens, 2006; Beishuizen et al., 2007). More evidence will be presented and discussed in the remaining chapters of this book.

TECHNOLOGIES FOR SELF-REGULATED LEARNING

Characteristics which a TELE that supports SRL should have

On the basis of the analysis of the relevant literature (e.g. Lepper et at., 1993; Schunk & Zimmerman, 1994; 1998; Zimmerman & Schunk, 1998; Zimmerman & Tsikalas, 2005; Carneiro et al., 2005; Steffens, 2006; Beishuizen et al., 2007; Winters et al., 2008) we identified three criteria which a TELE should meet in order to be capable of supporting SRL. We will first present these criteria and then have a look at some specific technologies to see to what extent they meet these criteria.

(A) Learners should be encouraged to plan their learning activities

Students' skills to plan their learning activities refer to the actual planning of these activities as well as to their time management. They should be encouraged to develop the following skills:

– Planning skills: skills to select between different types of activities, distinguishing between different channels of communication (e.g. written text, spoken communication, multimedia presentation) as well as between different forms of interaction (e.g. documents, tutorials, programs for self-learning, simulations);
– Time management skills: skill to choose the point in time when to actually carry out the activity and the amount of time to dedicate to its execution.

These decisions may be taken according to options given to students by the learning environment or they may be completely open. The extent to which a technology will foster these skills will depend on its capacity to present information in different modes and on its options for interaction.

(B) Learners should receive appropriate feedback so they can monitor their learning

The fact that technology should support students to develop planning skills does not mean that they should be left on their own. It is important that students receive some kind of feedback from the respective learning environments with respect to the activities they are carrying out. This feedback should enable students to draw appropriate conclusions as to the progress of their own learning.

Provision for feedback refers particularly to the communication mechanisms between students and their teachers and peers or the learning environment as a whole. In order for the teacher or the learning environment to provide appropriate feedback, the technology in question should have the capacity to record students' activities.

(C) Learners should be given criteria so they can evaluate their own learning outcomes

After having carried out their activities, students will have achieved specific outcomes. Students should be able to evaluate these outcomes and draw conclusions that will guide future activities. In order to be able to do this, students need to have or to be given some criteria with respect to their original goals or with respect to the competencies they set out to acquire.

Providing criteria requires the existence of an evaluation space which is based on recordings of results, information on criteria and means of communication. Peer participation will be of particular importance.

TECHNOLOGIES AND CRITERIA FOR SRL: DO THEY MATCH?

In the following paragraphs, we will discuss to which extent different technologies meet the aforementioned criteria.

(1) ePortfolios

There exist different kinds of digital portfolios but a characteristic which they all share is the capacity to register and save students' activities and products and the teachers' feedback (B). They do not explicitly foster self-regulated learning (A). Since eportfolios do have an evaluative character, they should help students to evaluate their learning outcomes themselves (C), but not all of the existing models provide for an explicit self-evaluation.

(2) Blogs

Blogs are used in different ways by both teachers and learners. If teachers use blogs to organise their classes to which students may add their comments, this kind of usage hardly meets the three criteria established in the preceding section. However, if blogs are used as personal diaries, they acquire many of the characteristics of eportfolios. In that case, criterion B would be the most important one: recording of activities and of feedback by teachers or peers. With respect to criterion A, blogs may give a greater flexibility to students; blogs may help students to look for resources to support their learning. In this sense, this way of using blogs may foster SRL to a greater degree than most of the eportfolios. This is not true with respect to evaluation (C); blogs do in general not include any options for providing students with criteria for evaluating their own learning.

(3) Office online, Wikis

To create documents in collaboration with others online does not seem to relate to criteria A and C. However, with respect to criterion B, it has to be said that these environments do provide for feedback mechanisms with respect to the work of individual students, either by modifying or correcting their work or by adding comments. It is important that this may be done by different users in real time.

Wikis are somewhat similar in this respect. In both cases, there exist interesting tool which may provide relevant information: the system's history will record the group's interaction and its progress over time.

(4) Virtual environments

Virtual environments contain many tools which in general include resources that will meet criteria A, B and C. This does not mean, however, that these resources will automatically be used to foster SRL. In the European TELEERS project, different technology enhanced learning environments were studied with respect to their potential to foster SRL (see http://www.lmi.ub.es/telepeers/). Instruments to evaluate this potential were developed in the course of the project and can be downloaded from the TACONET web site (http://www.lmi.ub.es/taconet/).

(5) Personal Learning Environments (PLE)

Personal Learning Environments (PLE) have been defined as "consisting of snips, bits and pieces, collections of tools and services which are bundled to individual and/or shared landscapes of knowledge, experiences and contacts" (Ehlers & Carneiro, 2008). This is the first time that individualization of training and learning has actually been achieved. Each student builds his/her own working space, connected with the resources offered from educational institutions, web services and his/her own social network.

PLEs directly relate to criteria A, B, and C. Aviram et al. (2008) suggested the name "Self-Regulated Personalized Learning" (SRPL) to refer to the kind of learning afforded in these kinds of TELEs. The whole conception of PLE is oriented towards SRL: Students have to define their own learning goals, assemble the required resources and organize them in a personal web environment. It is the role of the teacher to guide and coach students and provide criteria for self-evaluation.

(6) Web 2.0

A number of the above tools can also be considered to be resources of Web 2.0. Does this mean that Web 2.0 tools support SRL? This question is by no means trivial. Some characteristics of Web 2.0 seem to meet the three criteria established above; these are collective intelligence, administration of information and social authorship. In many cases, however, these resources are used in educational

programmes where they are adapted to the old learning models thereby eliminating the characteristics related to the criteria we established above.

Recently the British Educational Communications and Technology Agency (BECTA) published its report on Web 2.0 technologies for learning at KS3 and KS4 (11-14 and 14-16 year old students) (BECTA, 2008). In its conclusion, the educational potential of Web 2.0 was acknowledged across the curriculum in many different subject domains. The report also concludes, however, that good practices are only slowly arriving in schools.

Some of the difficulties that BECTA encountered in implementing Web 2.0 in schools were the following:

– filters for different content,
– insufficient band width,
– lack of access to computers in schools as well as at home.

Also, some pedagogical problems are mentioned:

– students do not really create pieces of work on their own;
– in many cases they just "copy and paste";
– student evaluation is not formative nor does it involve several technologies;
– only the teacher and the text book seem to be endowed with authority.

The focal points of Web 2.0 seem to challenge old teaching and learning structures; they are replacing these with open learning environments and open evaluation procedures, with learning achievements based on several media, learning achievements which are creative and which are evaluated in the context of new structures of authority and ownership. These circumstances have given rise to new ideas on technology enhanced learning.

CONNECTIVISM AND SRL

As the Internet has become central to all our lives a new learning paradigm has emerged. In 2005, George Siemens published an article titled “Connectivism: A learning theory for the digital age” (Siemens, 2005). He argued that today we live in a networked world where traditional theories of learning have only limited explanatory power and where the kind of instruction which is still delivered in our schools does not prepare our children to cope with the challenges of the digital age. Therefore, an entirely new approach to learning is needed which is capable of describing learning that is taking place in networks and which redefines the role of educators in a world increasingly defined by network structures (Siemens, 2008).

According to Siemens, “Connectivism is the integration of principles explored by chaos, network, and complexity and self-organisation theories. Learning is a process that occurs within nebulous environments of shifting core elements – not entirely under the control of the individual. Learning (defined as actionable knowledge) can reside outside of ourselves (within an organisation or a database), is focused on connecting specialised information sets, and the connections that enable us to learn are more important than our current state of knowing” (Siemens, 2005, p.5).

Under the connectionist paradigm, learning occurs when individuals who are part of a specific community access knowledge that is available in the community and also feed knowledge into that community. A prototypical example would be a

group of people who share a specific set of interests and who interact with each other and with specific resources through the Internet. Learning then refers to processes of knowledge acquisition at the individual as well as at the community level.

To assess the increased number resources that may be connected, one should have a look at an audiovisual document (networked students) which is based on a class on connectivism which was offered by George Siemens and Stephen Downes in the fall of 2008[2]. Some of the resources that are cited in the video are search engines (Google scholar), shared bookmarks (delicious), blogs and RSS pages (Google Reader), podcasts (iTunes), video conferencing (Skype), wikis (Wikispaces, pgwiki), social networks (facebook, Xing) and many others. These resources may be classified into several groups according to their usage: administration of knowledge, access to information, communication, establishment and maintenance of social networks.

The connectionist point of view also implies a new understanding of knowledge (Downes, 2005; Siemens, 2005). Siemens (2005) states that connected knowledge is emergent and adaptive. Or, as Downes (2007) puts it: "Knowledge is, on this theory, *literally* the set of connections formed by actions and experience. It may consist in part of linguistic structures, but it is not essentially based in linguistic structures … Hence, in connectivism, there is no real concept of transferring knowledge, making knowledge, or building knowledge. Rather, the activities we undertake when we conduct practices in order to learn are more like growing or developing ourselves and our society in certain (connected) ways" (Downes, 2007).

As for the changing role of teachers in a networked world, Siemens (2008) suggests a number of metaphors which in his opinion capture this new role:

- The teacher as a master artist (Brown, 2006) who collaborates with a group of art students thereby introducing them to the culture of artists.
- The teacher as a network administrator (Fisher, n.d.) who helps his students to form connections and create learning networks.
- The teacher as a concierge (Bonk, 2007) who supports his students in finding resources and learning opportunities.
- The teacher as a curator (Siemens, 2007) who as an expert constitutes a source of knowledge in a specific domain and who also serves as a guide who fosters and encourages learner exploration.

Independent of the status we assign to Siemens' ideas, it seems to us that his theoretical approach as well as the examples he cites to characterise the role of the teacher in a networked world both are based on the belief that learners should be given more autonomy in their learning. We ourselves believe that connectivism constitutes a point of view which encourages the development of SRL competences.

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[2] http://www.youtube.com/watch?v=XwM4ieFOotA

Let us examine the three criteria which digital tools need to meet in order to support SRL:

(A) Learners should be encouraged to plan their learning activities.
(B) Learners should receive appropriate feedback so they can monitor their learning.
(C) Learners should be given criteria so they can evaluate their own learning outcomes.

If we look at how digital tools are used from a connectivist point of view, or more specifically, how these tools are used in communities of learners which can be described in terms of connectivism, we find that in general, the ensemble of these tools meets the criteria listed above. Social networks constitute the base for self-monitoring of learning. In an educational context, the teacher's role is to provide criteria which students can use to evaluate their learning outcomes. As for the first point, it is the students who design and construct their own network.

From the point of view of connectivism, we do not look at each resource separately to see if it has a potential to foster SRL; instead, we aim at initiating communities of learners which we provide with a number of web-bases resources (mainly those of Web 2.0 or 3.0) to help them create a network in which SRL can develop.

CONCLUSION

Developments in educational technology and in educational theory and practice are not independent of each other, nor have they ever been. Paradigm shifts in the field of learning theory have facilitated the development of new educational technologies and even new ways of using existing technologies. On the other hand, technological innovations have favoured new uses of technology in education. The creation of TELEs to support self-regulated learning has been facilitated by new approaches in instructional design as well as by new developments in educational technology.

From the literature on self-regulated learning, we extracted three characteristics which we think any TELE that is to support self-regulated learning should exhibit, and we looked at a number of educational technologies to see whether they meet these criteria. By and large and on a very general level, this seems to be the case.

We are under the impression that educational technologies which were designed from a constructivist point of view are particularly apt to promote self-regulated learning. This is why we put some emphasis on the model of cognitive apprenticeship as a base for instructional design, and, as we pointed out, TELEs were indeed designed which made specific reference to the cognitive apprenticeship model.

We also see some resemblance between the cognitive apprenticeship model and Siemens' ideas on connectivism. This seems to be particularly evident when we look at the metaphors he presents for teachers in today's networked world. Brown's metaphor of the teacher as a master artist is directly derived from the cognitive apprenticeship model; in fact, Brown was one of the developers of the cognitive apprenticeship model. However, the cognitive apprenticeship model

depicts the changing relationship between an expert and one learner, while in Siemens' model, the expert and a group of learners constitute a community.

There are also differences between the two models: the cognitive apprenticeship model is explicitly stated as an instructional model while Siemens' connectivist model is a purely descriptive model. And while the cognitive apprenticeship model as an instructional model aims at changing the relationship between expert and learner, making the learner more autonomous, this change is not explicitly considered in Siemens' model. Nonetheless, due to its close relationship with the cognitive apprenticeship model, it comes at no surprise that the connectivist model also places great emphasis on the autonomy of learners and on their capacity to self-regulate their learning.

As for the theoretical status of Siemens' ideas, we doubt – like others (e.g. Kop & Hill, 2008) – that they constitute a theory of learning. They are, however, a good starting point for developing new perspectives on technology enhanced learning which is taking place in a networked world.

One of the most recent perspectives on learning in a networked world was proposed by Carneiro (2010a,b). Carneiro argues that the availability of Open Educational Resources OER) so far has not facilitated the implementation of Open Educational Practices (OEP) on a large scale. In his opinion, the traditional learning theories do not lend themselves to a theoretical underpinning of OEP, but neither do Siemens' ideas on connectivism. Carneiro argues that Siemens' ideas still focus too much on individual learning. What is required, according to Carneiro, are new sets of competences and different ways of enhancing social learning. He himself proposes a point of view which he calls "Generativism" and which might be – after behaviourism, cognitivism, constructivism and connectivism – considered to be a fifth approach to the theory of learning. The basic idea is that learning does not or should not mainly consist of acquiring existing knowledge, but of creating or generating new knowledge. "Generativism lies in the intersection between innovative learning and learning for innovation and addresses the foundations of a creative society. … Generativism understood as a constant co-creation and re-creation of knowledge appeals to the unique human ability to derive new meaning from experience and to build sense out of a shared body of conventional knowledge" (Carneiro, 2010b, p. 19).

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