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).

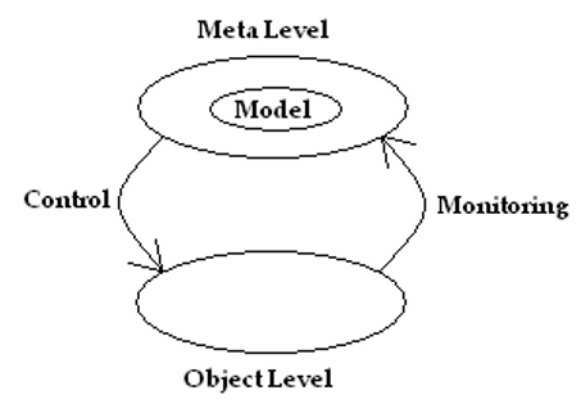

Figure 1: Metacognitive model according to Nelson (1996)

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.

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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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DIDACTICS AND SELF-REGULATED LEARNING IN TECHNOLOGY ENHANCED LEARNING ENVIRONMENTS: A CONTRADICTION?

INTRODUCTION

Didactics is a discipline of pedagogics; in fact, it is sometimes considered to be the pedagogical core discipline. Didactics is often defined as the science of teaching and learning. Didactical models provide sets of criteria which teachers can use to plan, carry out and evaluate their lessons. Although theories and models of didactics do take the learner into consideration, their main focus is on instruction, i.e. on the process of teaching.

Self-regulated learning (SRL) in technology enhanced learning environments (TELEs) is about learners who decide what, when and in which learning environments they want to learn. According to Zimmerman and Schunk (2008), 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" than poor self-regulators (Zimmerman & Schunk, 2008, p.1).

Evidently, theories and models of didactics focus on teaching, while research on SRL in TELEs focuses on the learner. Are these two perspectives not only distinct, but really incommensurable? Will guidelines for teaching and learning derived from theories and models of contemporary didactics not contradict guidelines for teaching and learning derived from research on SRL in TELEs? These questions will be pursued in this contribution.

DIDACTICS

Modern approaches

Didactics as the core discipline of pedagogy has a very long tradition in Europe. In this contribution, I will, however, focus on the relationship between didactics and self-regulated learning as it has manifested itself in German publications.

Discussions about didactics usually come to life when a need for a change in the educational system, in fact, even a need for a change in society is being sensed (Klafki, 1965). This was certainly the case in Germany and in other Western

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countries in the late 1960ies. 1968 was the year when students protested against established ways of learning and teaching, expressing their discontent with the old structures of the universities and with the establishment of society as a whole. The perceived need for a change in the educational system in Germany in the sixties was reflected in the development of new didactical theories and models. Wolfgang Klafki was one of the main proponents for change in didactical thinking.

In his review of classical educational theories[1], Klafki distinguished between two different theoretical approaches to education: one that focused on the content learners were to acquire (content-based education) and one that dealt with formal aspects of learning (formal education). Although he conceded that both approaches had their merits, he claimed that education needed to take into consideration both aspects and he suggested that this could be done in a dialectical manner. In his theory of categorical education (Klafki, 1957, 1963) he proposed that education should support students to develop categories (e.g. concepts, principles, rules, processes) which should open them for understanding the world and, at the same time, open the world for them. To help teachers prepare their lessons in accordance with his concept of categorical education, he suggested the method of didactical analysis (Klafki, 1958, 1963).

Klafki´s didactical thinking and the educational tradition on the basis of which it developed were criticised for a number of reasons (cf. Jank & Meyer, 1991, pp. 165-166). In response to these criticisms, Klafki suggested a new didactical approach which he called critical constructive didactics (Klafki, 1985). He proposed that all teaching should support learners to develop a set of three social competences; i.e. the abilities to be autonomous in decision-taking, to take part in social decision-taking and to demonstrate solidarity. More concretely, he provided teachers with a new analytical framework (perspectives scheme) to help them plan their teaching.

In 1965, a model for the structural analysis of teaching was published by Heimann, Otto & Schulz (1965) who were working at a teachers' college in Berlin at the time. The "Berlin didactics" were primarily intended to be used in teacher education at the college. The model distinguished between six structural aspects of teaching. Two of these (anthropological and socio-cultural pre-conditions) were related to the pre-requisites of teaching, while the other four were related to the indispensable didactical decisions (objective, topic, method and media).

Schulz later revised the Berlin didactics; the revised version was published in 1980 and became known as the "Hamburg didactics" (Schulz, 1980). While the Berlin model was a purely formal model describing the structure of teaching, the Hamburg model again incorporated the idea of education as self-education. Formal aspects are still important in the Hamburg model, as, for instance, in the distinction between different levels of lesson planning (long-term perspective, outlining, planning the process to take place during a lesson and revision of planning). However, the "objective" of teaching is no longer a purely structural category; in

[1] The German term corresponding to education is "Bildung"; in the German pedagogical tradition, the term "Bildung" includes the aspect of self-education.

the Hamburg didactics, the objective is to support the development of competence, autonomy and solidarity.

Although Klafki reformed didactical thinking, his theories and models were still embedded in classical didactical thinking and in the European tradition of education as self-education, a tradition that was largely based on hermeneutical approaches. His didactical ideas gave, however, also rise to approaches in didactics and teaching methods which were more empirically oriented. These include didactics based on system theory (Frank, 1962; von Cube, 1980), didactics based on communication theory (Schäfer & Schaller, 1976; Winkel, 1980), constructivist didactics (Reich, 1996, 2008), pragmatic didactics (Beyer, 2008), media didactics (Issing, 1987; Hüther, 1997) and didactics based on research in neurological processes (Herrmann, 2009). While all of these approaches certainly merit attention, I will only focus on constructivist and media didactics because these seem to be most closely related to the field of technology enhanced learning.

Constructivist didactics

It is probably much too simplistic to speak of constructivism as a single and homogeneous theory. Nonetheless, it seems to me that the basic idea of constructivism is as follows: what we know about reality is the result of mental constructions that we made on the basis of our interaction with the world in which we live. Of course, we do not create idiosyncratic worlds, completely separated from each other. The construction of reality is a social process (Berger & Luckmann, 1966).

In Germany, the idea of constructivist didactics were first espoused by Siebert (1994), Müller (1996), Reich (1996), von Glasersfeld (1996) and Kösel (1997). As Terhart (2003) observed, contemporary ideas on constructivist didactics can be traced back to four different fields of inquiry: (1) radical constructivism (von Glasersfeld, 1996), (2) the neurobiology of cognition (Roth, 1994), (3) systems theory (Luhmann, 1984, 1990) and (4) new conceptions of learning (Weinert, 1996 a,b; Reinmann-Rothmeier & Mandl, 1998). Some of the ideas central to constructivist didactics are (cf. Wolff, 1994; Dubs, 1995; Meixner, 1997):

- Learning is the process of actively constructing knowledge,
- Learning environments and content should be authentic and complex, relating to the experiences of the learner,
- Learning to learn (self-regulated learning) should be encouraged,
- Learning should take place as a collaborative activity,
- Learning does not only involve cognitive processes; it also involves emotional, motivational and identity-related processes.

One of the most elaborated approaches in the field of constructivist didactics is probably the one by Reich (2008). Acknowledging the plurality and ambivalences of the post modern world, Reich wants to acquaint teachers with a point of view which is theoretically well-founded and which offers practical suggestions for coping with teaching and learning situations that have become increasingly complex. From his point of view, didactics have to take into consideration the

dialogical and communicative nature of teaching and learning, a point which is also stressed in communicative didactics. Classes are no longer homogeneous entities; didactics have to take into consideration the diversity of interests and expectations of students. In the political arena, didactics have to be on the side of learners; they have to increase equality of chances for each learner and optimize each individual's opportunities to learn.

As for the practical perspective, according to Reich, didactics are related to actions and learning (learning by doing in the sense of Dewey). One of his basic claims is that every learner should create his own didactics. In the constructivist didactics Reich developed, three perspectives can be distinguished: construction, reconstruction and deconstruction. These three perspectives are then crossed with three types of problem windows (action, method and result window), yielding a didactic reflection window which teachers and students can use to reflect on their teaching-learning interaction.

Theories and models of constructivist didactics have not gone without criticism. Terhard (2003), for instance, remarked that the different approaches in the field of constructivist didactics do not constitute a coherent system and that many of their ideas were already voiced before. This complaint reminds me of the one uttered by Klauer (1999) who criticised the ideas of situated cognition developed by Collins and his colleagues (cf. Brown et al., 1989) labelling them old wine in new bottles because they were not completely new. In both cases, however, the authors (Reich and Collins et al.) expressis verbis acknowledged the influence of authors and ideas on which they based their own thinking (Dewey, for instance).

Media didactics

Media didactics refer to the role and effects of media in teaching and learning processes (Issing, 1987). Theories and models of media didactics started to be developed in the 1960ties. The proliferation of mass media had prompted Heimann et al. (1965) to include media as one of the structural aspects in their "Berlin didactics". This in turn, contributed to the development of media didactics as a pedagogical discipline in its own right. During the first phase, the development was influenced by behaviourist learning theories. Approaches of this first phase were mainly technology-driven. In the second phase, beginning in the early 70ties, media didactics became less technology-oriented; the role of media shifted from teacher support to learner support. The third phase can be dated back to the early 80ties; media didactic became more action-oriented, trying to establish a closer link with the everyday environments of learners (Kron & Sofos, 2003). Correspondingly, Hüther (1997) distinguished between (1) technology-oriented media didactics, (2) emancipatory political media didactics and (3) action and participant-oriented media didactics.

Teaching according to action and participant-oriented media didactics requires, however, also a change in general concepts of teaching. As Hüther pointed out (Hüther & Podehl, 1997, p.124),

- Teaching should allow for open (in the sense of self-regulated) learning,
- Media should be used cooperatively by all the actors in the teaching-learning process,

- Teachers and students should produce their own media content,
- Media should be used to activate thinking and to initiate action,
- Teachers and students should critically reflect their media use and be able to analyse media in the context of society.

According to Kron & Sofos (2003, p.123), there are different uses of media in teaching-learning contexts. They distinguish between (1) teacher-oriented, (2) module-oriented, (3) task-oriented, (4) system-oriented, (5) exploration-oriented and (6) action-oriented media uses. Somewhat in the same vain, Tulodziecki & Herzig (2004, pp.113-118) suggested a classification system for media use where they distinguish between: (1) media to support teaching, (2) media to support learning, (3) media uses as building blocks in teaching-learning sequences, (4) media systems in teaching and learning and (5) media in technology-enhanced learning environments.

More concretely, Prenzel et al. (2000) suggested a set of questions which should be taken into consideration when actually planning a specific lesson or a sequence of lessons:

- Is there an advantage of using digital media instead of traditional teaching?
- Is the digital medium to be used adequate for the learners?
- In which part of the teaching process should the digital medium be used?
- What are the educational goals which are to be supported by the digital medium?
- Does the digital medium support individual and self-regulated learning?
- Does the digital medium support problem-based learning? (Prenzel et al., 2000, p.120).

SELF-REGULATED LEARNING

A short history

Self-regulated learning or learning to learn has a long tradition in European pedagogy. Johann Amos Comenius (1592 – 1679), one of the founding fathers of European pedagogy, may have been thinking of SRL when he wrote in his *Didactica magna*: "The first and foremost goal of our didactics should be to explore teaching methods which enable teachers to teach less and students to learn more and which will lead to less noise, disenchantment and frustration and to more freedom, enjoyment and true progress in school[2]" (Greif & Kurtz, 1996, p.22). Classical German pedagogy propagated the idea that education (Bildung) is to a large extent self-education (Selbstbildung). To educate one-self meant to develop one's own personality, one's own capacities. According to Wilhelm von Humboldt (1767 – 1835), an individual's goal should be the most proportional development of his potentials.

[2] All translations from German into English were done by the author.

An idea akin to that of SRL was developed in Reform Pedagogy (Reformpädagogik), a movement that started in the last decades of the 19th century and extended until the early 1930s. The movement opposed the old and authoritarian drill school; instead, "education originating from the child", the "natural curiosity of the child", "free work" and "self-activity" were important concepts of the time. While the movement was international (John Dewey, 1859 – 1952 in the U.S.A., Maria Montessori, 1870 – 1952 in Italy), it also had quite an impact on German educational thinking and practices. Hugo Gaudig (1860 – 1923) stressed the importance of self-regulation and self-determination in the activities of his students (Müller, 2004). Georg Kerschensteiner (1854 – 1932) proposed the working school, a school that placed much emphasis on practical activities. Unlike the previous text book and drill schools, it resembled a vocational training institution. Self-activity, i.e. an activity that had its origin in the interests and needs of the child, was an important concept for him. It did not only refer to manual activities, but also to mental activities, and Kerschensteiner considered self-activity to be a means of helping children and young people to develop their personality (Kerschensteiner, 1942).

The idea of SRL reappeared in Germany in the late 1970s and early 1980s (Neber et al., 1978; Weltner, 1978, Fischer & Mandl, 1980). In 1982, the German journal "Unterrichtswissenschaft" (Instructional Science) published a special issue on SRL which was introduced by Weinert, the leading researcher in the field of educational psychology, with an article on SRL as a prerequisite, method and objective of instruction (Weinert, 1982). While he cites publications of Anne Brown and Campione on metacognition and learning to learn and of Jean Piaget, who may be considered a truly European researcher, the majority of authors he refers to are German.

In the same issue, Mandl & Fischer (1982) discuss theoretical approaches to the development and enhancement of SRL. They present a number of German contributions regarding theoretical thinking and empirical investigations in the field of SRL. The theoretical framework for discussion is, however, taken from Brown, Campione and Day (1981) and as examples of intervention programs that support SRL, their work as well as that of Weltner (1978) is cited. The issue continues with a presentation by Wang from Pittsburgh on the "Adaptive Learning Environments Model – ALEM" (Wang, 1982) and with a critical discussion by Issing and Hannemann (1982) of SRL as search for information.

Since then, the literature on SRL has grown almost exponentially. After almost two decades of research on SRL in Germany, Friedrich and Mandl (1997) revisited the state of the art and presented a thorough analysis of factors that facilitate SRL, reviewing American as well as German approaches in one of the volumes of the Encyclopaedia of Psychology. One of their main conclusions was that SRL not only involves cognitive, but also motivational and emotional factors.

Results from research on SRL have also been implemented in a number of study guides (cf. Metzig & Schuster, 2003; Witthaus et al., 2003; Metzger, 2004; Konrad, 2008, Ziegler & Stöger, 2009). Metzger's (2004) book on strategies for learning and working contains chapters on motivating oneself, time management, concentrating, coping with anxiety and stress, identifying what is important, processing information, coping with examinations, self-regulation, essay writing

and presenting convincingly. One of the most recent textbook on learning and instruction (Klauer & Leutner, 2007) dedicates a complete chapter to the problem of teaching how to learn to learn.

The concept of self-regulated learning

It is acknowledged that in our European societies, which are often characterised as knowledge societies, life-long learning is becoming increasingly important. It is also expected that the self-regulation of learning will become increasingly important; one reason for this is that learning will increasingly take place outside traditional teaching and training institutions.

The concept of SRL is, however, far from being clearly defined. In discussing SRL, it is helpful 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 – i.e. 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. In a narrow sense, self-regulation of learning refers to a learner's competence to plan, monitor and evaluate his or her learning activities where the learning goals are usually set by a teacher/instructor or at least arise from an instructional setting.

Although many authors refer to SRL in this narrow sense, from a constructivist point of view it could be argued that even in an instructional setting, learning is self-regulated: "From a constructivist point of view, learning is a self-regulated, constructive, cognitive and emotional activity, determined by a person's biography and serving her survival" (Siebert, 2003, p.13).

Another problem is - as Friedrich and Mandl (1977) already pointed out - that there are a number of terms similar to that of SRL: independent study, individual study, self-directed learning, self-education, self-guided learning, self-instruction, self-planned learning, self-teaching, etc. and it is difficult to clearly distinguish between these terms (see also the chapter "A conceptual framework for research on self-regulated learning" by Beishuizen and Steffens, in this book).

But even if we focus on concepts of self-regulation in the narrow sense, there are still very different points of view (Weinert & Schrader, 1997, p.305; Schreiber, 1998, p.15). Many authors assume that SRL is a domain-general competency (e.g. Baumert et al.), while others (a minority) consider self-regulation a domain-specific competency (Weinert & Schrader, 1997, p.306).

Viewing SRL as a domain-general competency, a distinction can be made between self-regulation as a process and components of self-regulation. As far as the process of SRL is concerned, a number of German authors make reference to the cyclic model of Zimmermann (1989, 2000) who considers the self-regulation of learning a process of (1) planning, (2) executing and monitoring and (3) evaluating one's learning activities (e.g. Simmons, 1992; Brunstein & Spörer, 2001; Sindler, 2004; Götz, 2006; Schreblowski & Hasselborn, 2006). With respect to components of self-regulation, some authors refer to variants of Boekaert's (1999) model of

self-regulation, which distinguishes between the regulation of the self, of the learning processes and of the information processing activities (e.g. Baumert et al., without year; Götz, 2006).

The Austrian authors Ziegler et al. (2003) present an overview of models of SRL. Of the twelve models they describe, four were developed by German authors (Friedrich & Mandl, 1997; Leutner, 1999; Rheinberg et al., 2000; Nenninger & Wosnitza, 2001). These models are also described by the Austrian author Sindler (2004) who in addition presents a model of knowledge management proposed by Reinmann-Rothmeier & Mandl (2000).

Notwithstanding the differences these models exhibit, there are also some communalities. As Ziegler et al. (2003, p. 35) point out, all models assume

– Self-regulated learning involves regulating cognitive as well as motivational strategies,
– Self-regulated learning builds on domain-specific knowledge,
– For self-regulated learning to be successful, it needs to be applied in specific learning environments,
– Self-regulated learning involves three steps: (1) planning (including goal setting, assessment of internal and external resources and selection of appropriate strategies), (2) execution and monitoring (implementation of strategies, monitoring their success, possibly choosing a different strategy) and (3) evaluation (of the learning outcome).

There seems, however, to be a need for further differentiation in concept building and empirical research on SRL. Friedrich & Mandl (1997), for example, suggest to distinguish between (1) structure and processes on the part of the learner and (2) aspects of the learning environment. As for the learner aspects, they refer to a large number of studies that explore structural and process components in the realms of motivation and cognition with respect to SRL. With respect to learning environments, they discuss a number of studies which investigate the potential of specific learning environments to foster SRL. We will address this topic in the next section.

Research on SRL has not gone without criticism, however. Friedrich & Mandl (1997, pp. 274-276) observe the following:

– The theoretical concept of self-regulated learning is not a unitary concept, rather it is multifaceted, with some of the facets not clearly distinguishable;
– In many studies, self-regulated learning is considered to be a disposition or personality trait; little is known about the processes that are involved when a person actually self-regulates his or her learning;
– There is little research considering gender differences;
– There are hardly any longitudinal studies on self-regulated learning;
– Most studies on self-regulated learning have been conducted with high school or university students; little is known about the self-regulation of adult learners in out-of-school and professional environments;
– There is still a need to pay attention to the development of diagnostic instruments,
– Little is known about learning environments that support self-regulated learning.

A more recent criticism was voiced by Leutner & Leopold (2003, 2006). They point out that in empirical studies, correlations between reported cognitive and

metacognitve strategies on the one hand and learning outcomes on the other tend to be low (Baumert, 1993; Baumert & Köller, 1996; Blickle, 1996; Schreiber, 1998).

SELF-REGULATED LEARNING IN TELES

References to SRL in TELEs are often made in publications on learning with the new media. In recent years, a number of books were published on this topic in German (Arnold, 2001; Kerres, 2001; Röll, 2003; Ziegler, Hofmann & Astleitner, 2003; Sindler, 2004; Carell, 2006) all of which address the question of SRL in technology enhanced learning environments (TELEs), but in varying degrees.

New media is a term which is yet to obtain an agreed definition, although when using this term, reference is often made to the digital media or to the use of the new Information and Communication Technologies (Klauer & Leutner, 2007, p.304), or, more precisely, to the use of digital media to present information (Klimsa, 2002) or for communication purposes (Dörr & Strittmatter, 2002). The phrase "learning with the new media" is often considered to be synonymous with expressions like "multimedia learning", "computer-based learning", "telematic learning" and "telemedial learning". Klauer & Leutner (2007, p.304) suggest that when we speak of new media in the context of learning and instruction, we refer to the use of the Information and Communication Technologies (ICTs) for the purpose of learning and teaching. From their point of view, new media share at least one of the following characteristics:

- They use multiple forms of representation (multimedia),
- They allow the learner to interact with the system (interactivity),
- They are capable of adapting to the individual learner (adaptability),
- They provide the learner with the opportunity to communicate with peers and instructors (communication) (Klauer & Leutner, 2007, pp.304-305).

Friedrich & Mandl (1997, p.258) define a learning environment as a specific arrangement of personal (teacher, peers), material (location, learning material, media) and instructional (learning tasks) factors. The term Technology Enhanced Learning Environment therefore refers to learning environments which make use of new digital technologies. It should be pointed out that the term TELEs applies to a wide variety of technology enhanced learning environments: a computer pool where students do their homework, a classroom where students are shown a DVD, a virtual classroom where students collaborate via the Internet using Web 2.0 technologies, a person's private room where he or she works with a CD-based multimedia program to improve his or her Spanish, all these are examples of TELEs (see also the chapter "A technology for self-regulated learning" by Bartolomé and Steffens in this book). While there is evidence that TELEs do have the potential to foster SRL (see Carneiro et al., 2005; Bartolomé & Steffens, 2006; Steffens, 2006; Beishuizen et al., 2007), in the concluding section, I would like to focus on recent publications that either explicitly suggest strategies to foster SRL in TELEs or which could be used to develop guidelines to acquire and improve SRL competencies for learning in TELEs.

Arnold (2001) reports on a study of the didactics and methods of telematic learning and instruction which was part of a project on a Virtual College for Technology, Information and Economics financed by the German Ministry of Education and Research. Broadly speaking, telematic learning alludes to any kind of learning that involves the Internet. More specifically, the term telematic learning refers to ways of learning which are based on new ICTs and which make use of these through networks of multimedia computers (Zimmer, 1997, p.111). Examples from distance learning are therefore the instances of telematic learning that Arnolds describes and analyses.

In order to analyse different examples of telematic learning, Arnold suggests a distinction be made between learning space, learning scenario, learning unit and media representation of learning units. The learning space is a virtual space (a Learning Management System, for instance) where learners can work and communicate with their peers and instructors. The term learning scenario is used to describe the specific temporal and structural organisation of a distance learning course while the term media representation relates to the question of what media are used to represent the content of a specific learning unit. In Arnold's terminology, learning space, learning scenario and media representation are the constituents of what she calls the educational infrastructure. For the evaluation of these learning spaces, she suggests the following criteria (Arnold, 2001, p.39-40):

- Negotiation of learning resources: How does the system handle the management and distribution of learning resources?
- Coordination: How does the system support collaborative learning?
- Monitoring: To what extent does the system provide the learner with feedback, which allows him or her to monitor his or her learning activities?
- Individualisation: What means does the system offer to the learner to customise it to their needs?
- Self-regulation: What support does the system give the learner to organise their learning activities?
- Adaptivity: Is the system easily adaptable to changes in learning concept and learning content?

Kerres (2001), in his book on multimedia and telemedia-supported learning environments, discusses (1) the didactical aspects of teaching with digital media, (2) theoretical approaches to teaching with digital media, (3) conceptual aspects of multimedia and telemedia-based teaching and (4) the development of digital media content. Kerres refers to SRL in the context of discussing the logical structure of learning contents. While in traditional teaching, the learning content is organised by the teacher/instructor with respect to its logical structure as well as with respect to its delivery in time, much of this organising must be done by the learner who uses the digital media. Kerres believes that digital media have a high potential for motivating explorative learning, and it is this kind of learning that requires a great deal of self-regulation. In his opinion, TELEs should, by helping the learner to logically structure the learning contents, facilitate the self-regulation of his or her learning activities and thus increase his or her motivation to explore the learning contents. Consequently, Kerres offers a number of suggestions from the perspective of instructional design as to how the media presentation of learning contents should be organised to support SRL. Basically, these are design elements

that facilitate the learner's orientation and help him or her control their learning activities.

Röll's (2003) book on the "Pedagogy of Navigation" directly addresses the question of support for SRL through new media, however, in a more general and abstract way than the other books. According to Röll, the pedagogy of navigation aims to enable learners to self-regulate their learning, and in his opinion, new media are the means for achieving this aim, provided they allow the learner to experience autonomy, competence and social attachment (Röll, 2003, p.14). His term 'navigation' does not, however, primarily allude to a learner navigating in a specific computer program. Rather, the idea is that the teacher should be a navigator, like a pilot who helps ships in finding their way through shallow or dangerous waters.

Röll provides an abundance of "best practices", i.e. descriptions of TELEs in which children, young people and adults work with great enthusiasm. Basically, it is a call for a new pedagogy and for new didactics. He talks in very positive terms about Reform pedagogy, which he believes places much more emphasis on the learner and his self-activity than the traditional pedagogy of that time. He would therefore like to re-activate the ideas of Reform pedagogy and adapt them to today's ICT-based teaching as he believes new media will help learners to become more self-regulated in their learning activities. "High tech Reform pedagogy aims at creating open and process-based learning structures, which facilitate network-based cooperative learning and foster aesthetic and contextual thinking" (Röll, 2003, p. 365).

The Austrian authors Ziegler, Hofmann & Astleitner (2003) believe that although training of strategies for SRL should be a promising endeavour, this does not occur in the normal classroom very often because teachers simply do not have sufficient time to do so. They therefore suggest that web-based training for SRL might be the solution because it can be conducted much more flexibly and even outside the classroom.

Ziegler et al. propose the idea that students (aged 10 to 14 years) should obtain a "driver's licence" for learning and they suggest that part of a corresponding web-based learning environment should be a module to help students acquire and improve strategies for SRL.

The design they develop for such a web-based module is based on a review of existing models of SRL and empirical research on the topic; it also takes into consideration findings from the field of quality management in eLearning. More specifically, the module incorporates variables that have been found to be of importance in empirical research on SRL:

– Constructive self-monitoring related to specific goals or standards,
– An open learning environment providing support for the learners,
– Small group work,
– Fostering motivational and emotional processes,
– Self-instructive study material,
– High-level criteria for mastery,
– Integration of subject-specific information,

– Multiple modes of intervention (Ziegler et al., 2003, p.104).

Niegemann et al. (2008), in their book on multimedia learning, dedicated a complete chapter to self-regulated learning. They present the model of self-regulated learning proposed by Schiefele & Pekrun (1996) and the one by Zimmerman (2000); the also discuss possibilities to support SRL and they present a multimedia programme which is to foster SRL.

CONCLUSIONS

In the beginning I raised the question whether guidelines for teaching and learning derived from theories and models of contemporary didactics would contradict guidelines for teaching and learning derived from research on SRL in TELEs. At first sight, this might be the case. I am, of course, not talking about a logical contradiction. Rather, I am thinking of a psycho-logical contradiction, much in the way Festinger (1957) defined cognitive dissonance half a century ago. Festinger stated that two cognitive elements are in a dissonant relationship if "considering the two alone, the obverse of one element would follow from the other" (Festinger, 1957, p.13).

Because the term didactics refers to the art of teaching (διδκτική τέχνη), classical and modern theories and models of didactics have placed a strong emphasis on the teaching part. Basically, didactics is about what to teach and how to teach. The different models of modern didactics contain sets of criteria which teachers can use to prepare their lessons and to critically reflect on their teaching. How learners learn is something that is not explicitly discussed although the Berlin model, for instance, encourages teachers to take into consideration anthropological and socio-cultural pre-requites relevant to their teaching.

With constructivist didactics, the situation is different. Emphasis is clearly on learners and on their learning processes. Since learning, i.e. the acquisition of knowledge, is supposed to be a process of construction, constructivist didactics focus on how to organise learning environments which will support knowledge construction. It is therefore not surprising that developers of technology enhanced learning environments and teachers who make these environments available to their students are much closer to the ideas of constructivist didactics than to those of modern didactics. At the level of concrete learning environments, constructivist didactics lend themselves much better to the development of guidelines for their development than modern didactics. Self-regulated learning, from a constructivist point of view, not only refers to the construction of knowledge, but also to the monitoring of the corresponding construction processes.

In as much as learning from the point of view of modern didactics is teacher-controlled, while self-regulated learning in technology enhanced learning is learner-controlled, there exists a certain psycho-logical contradiction with respect to guidelines for teaching and learning that would follow from these two approaches.

However, at a more abstract level, differences between the two approaches do not seem to be so pronounced. Educational goals like the development of abilities to be autonomous in decision-taking, to take part in social decision-taking and to demonstrate solidarity (Klafki) or the development of competence, autonomy and

solidarity (Schulz) point to the importance of the development of personal autonomy, and this educational goal would certainly not be in conflict with the goal to support learners in acquiring and improving their self-regulating competencies in learning.

Also, it has to be acknowledged that since the 1960s, a rich diversity of didactical approaches has been developed. Developments in related fields like cognitive learning theories, situated cognition, systems theories, neurophysiology and constructivism were not independent of each other, and many of the new ideas influenced the development of didactical thinking. While there are certainly differences between post modern didactical approaches, they all place more emphasis on the learner and on conditions which facilitate learning and the self-regulation of learning. There is therefore a clear convergence between the development of didactical thinking and the concept of self-regulated learning.

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Part B: Empirical studies on SRL in TELEs

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UNFOLDING THE POTENTIAL OF ICT FOR SRL DEVELOPMENT

INTRODUCTION

We live in an era of rapid technological change, affecting not only the sphere of work, but also (and perhaps to a greater extent) our social lives, our way to obtain information, our security and our learning. Learning has never been something that could be done once and for all in human life, and the ability to cope with innovation and change has always been important, not only to succeed, but even to survive. So, what's new? Firstly, the speed and the extent of change; secondly, the fact that major changes are taking place not only in what we learn, but also in the tools used for learning. By this, we do not mean merely the technical tools, but the conceptual tools as well.

Indeed, the way we learn is becoming increasingly important; as is the extent to which we are aware of the strategies we use, how we manage our objectives and our flexibility about them. No wonder, therefore, that the cross-curricular skills and competencies required to adapt to the changing nature of learning and knowledge management are regarded as vital by enlightened teachers and school policy makers, and by scientists and enterprise managers. These competencies are not merely cognitive, such as good memory or cleverness; they have to do with personal initiative, self-efficacy, flexibility, intuition, endurance, method, motivation and determination. They do not belong to any disciplinary syllabus, and comprise aspects that, in the past, were not regarded as concerning the scholastic sphere as they involve emotions.

The widespread awareness of the fact that today Life-Long Learning is no longer an option, but a need, and that the learning process must be driven by the individual himself, has determined the increased interest for Self-Regulated Learning, i.e. the way people control their own learning form the cognitive, meta-cognitive, emotional and motivational point of view. Sensitivity to the need for stimulating self-regulated learning attitudes, self awareness and self-evaluation capabilities among learners of all ages is witnessed by the number of international projects, conferences and studies devoted to SRL and to its components, as well as the interest and concern demonstrated by illuminated teachers. In Italy, in particular, the importance of these skills has been stressed by the latest reforms, concerning primary and lower secondary schools.

R. Carneiro et al. (eds.), Self-Regulated Learning in Technology Enhanced Learning Environments, 53–74.

This chapter has been developed after the 2007 KALEIDOSCOPE-TACONET conference organized in Amsterdam and devoted to "SRL in Technology Enhanced Learning Environments (TELEs): Individual Learning and Communities of Learners". For that event, a survey presenting the state-of-the-art in different European countries was presented. This chapter contains a revised version of the of survey concerning Italy.

From the survey emerged that the Italian perspective on the relationship between SRL and TELEs is rather pragmatic, in that it is characterized by a larger diffusion of empirical studies rather than theoretical or experimental research[1].

Much of the work done in Italy in the field of SRL and TELEs stems from the needs emerging from everyday schoolwork, and often does not assume as a theoretical standpoint the work of Zimmerman (1998; 2001), Boekaerts (1999), Boekaerts et al (2000), or Bandura (1997). Often, it addresses aspects of SRL, sometimes without even using the *classical* terminology of the field.

In the following, we have focussed on the most significant studies, grouping them into three categories: studies of the metacognitive abilities involved in the use of Information and Communication Technology, studies aiming to design and implement systems that support the development of SRL and studies aiming to assess and evaluate the potentialities of different kinds of TELEs for SRL development.

INVESTIGATIONS INTO THE METACOGNITIVE COMPETENCES INVOLVED IN THE USE OF ICT

The studies mentioned in this section represent quite a large range of educational applications of ICT, mostly inspired by a constructivist view of learning. This is not a coincidence, of course. In fact, constructivist theories of learning see individuals as active agents building their own knowledge by assimilating and accommodating[2] new information into their own mental schemas. Knowledge construction is the result of the continuous attempt to make sense of experience, and meaningful experience can only take place by interacting with a (learning) environment. A direct consequence of these ideas is that students should be involved in the decisions pertaining to their learning objectives, in planning and assessing their learning; in choosing which learning strategies to use and what tools to employ. In other words, students should be at the centre of the learning process, while the role of the teacher is to provide guidance and support whenever necessary. If these are the principles of constructivist theories, then it appears quite obvious that SRL development goes hand-in-hand with the application of these theories.

The studies mentioned in this section refer to three different kinds of learning environments, which in turn are often associated with different applications of constructivist ideas:

- The first environment is the Web; a relatively new environment, powerful though tricky and difficult to explore, requiring higher order strategies and distinct evaluation abilities to extract information in an effective way. The study in question investigates the abilities needed for Information Problem Solving (IPS) in the Web, where IPS refers to the process of finding

answers to non-trivial questions, which do not have ready-made solutions and require logical reasoning and critical skills to answer[3].

- The second kind of environments is represented by online or blended activities supporting metacognition a competence needed to tackle learning tasks effectively and efficiently. Needless to say, being self-regulated in an online course is an important prerequisite for becoming fully aware of the potential of different tools and different modes of communication. SRL competence is also needed to play different roles within these environments (e.g., as a student and as an online tutor).
- The third kind are simulation environments. These are virtual environments where the learners interact with a scenario incorporating a model (usually a model of a reality, but sometimes it is a model of something that does not exist in the real world). These environments allow students to conduct experiments to study the laws that are behind the model by manipulating variables and parameters, making deductions and inferences, testing their hypotheses and drawing conclusions. Simulations therefore, allow experiential learning, encouraging planning, execution, monitoring and evaluation of one's learning, the main components of SRL.

Web Information Problem Solving

Caviglia and Ferraris (2006) carried out a preliminary study aimed at investigating the process of Web IPS with special focus on the analysis of the cognitive skills and attitudes playing a key role in this intentional learning process. To this aim, they set up an experiment in which seven allegedly proficient Web-users were recorded and observed while solving the same simple information problem. Although almost all the subjects produced acceptable solutions, these solutions differed widely with regard to the cognitive strategies adopted, the attitudes they revealed and the effectiveness of the problem solving process.

The theoretical foundations of this work are rooted in research on Web-searching strategies (Ferraris, 2003), that suggests that IPS on the Web is a complex process requiring integration of ICT-specific skills and cognitive and metacognitive skills generally associated with knowledge building (Scardamalia and Bereiter, 2006) and problem solving (Mayer, 1998).

The basic hypothesis is that, by observing people solving information problems on the Web and analysing the differences in how they complete the task, it is possible to gain a better understanding of the cognitive mechanisms which play a key role in the effectiveness of autonomous knowledge construction processes (e.g., reading strategies, deductive reasoning, question asking, etc.).

This exploratory experiment was conducted with a small number of participants in order to assess whether the method chosen was appropriate and to identify any issues or problems which require revision before a larger scale experiment was conducted. The results revealed that among the factors that influence the

effectiveness of the problem solving process, learning styles, metacognitive skills and self-efficacy have a relevant role.

Further developments of this study prompted the same authors to investigate how people use the Web to solve information problems (Caviglia and Ferraris, 2008). They identified three main competencies that are critical for IPS tasks; asking questions, building hypotheses and recognising trustworthiness. Clearly, these three competencies are essential in non-technological contexts as well, however the Web appears to be a natural and motivating environment in which to foster the development of such competencies, provided that the educational employment of the Web is not seen as a way to expand the quantity of information students are expected to acquire, but rather as an opportunity to learn how to sift through information in a competent way.

METACOGNITION IN ONLINE LEARNING

A review of systems supporting metacognition

The Web as an educational resource and the interest in metacognition as a support to online learning are the focus of a recent paper by Chiazzese et al. (2008). Metacognitive knowledge and skills play a central role in regulatory strategies as they involve awareness of the organization and functioning of the thinking processes.

The authors analyse different computer-based learning environments which include metacognitive support, thus providing an overview on this topic and identifying the following areas for further research:

- studies aiming to integrate cognitive strategies into educational environments, through the development of specific tools designed to monitor and control the metacognitive process;
- studies focused on the cognitive strategies adapted to the new media used during the learning activities;
- studies aiming to use new technologies to support teachers and students engaged in the learning activities

The systems analysed in the paper are organized according to the theoretical background, the metacognitive aspects, the students' role, and the field of application. The authors focus their attention particularly on Gym2Learn, the system they developed to support online text comprehension (see next section).

Metacognitive aims in a blended course

Self-regulation was explicitly targeted and required during a blended course addressed to future online tutors at the University of Macerata in 2004 and 2005. The course was based in four virtual classrooms of approximately 25 students. The model chosen for the course is presented in Rossi et al (2007).

The characteristics of the course include the short duration, the modular structure, the key-role of interactivity, and the coherence between the model and the tools used. The target competencies were:

- social and relational competence, to foster the development of an online community;
- technological competence, to manage a working group in the environment;
- planning and organizational competencies, to manage online activities;
- linguistic competencies (i.e., reading and writing), to foster knowledge construction through activities based on written communication.

The course program comprised four phases: first, a welcoming activity; second, a virtual classroom negotiation aimed at producing a common artefact; third, an instructional design activity in small groups; fourth, a concluding activity where the whole group carried out a final review in order to share objectives and discuss open issues. The last phase also aimed to bridge the gap between individual reflection and the collaborative dimension of the course.

The course evaluation was based both on individual assessment results (course effectiveness) and on qualitative and quantitative data concerning course acceptance. The authors concluded that the model applied was successful as students learnt:

- to be flexible in their choice of communication tools (forum, chat, personal postings) based on fit-to-purpose criteria;
- to alternate between individual and collaborative work;
- to share with others their reflections on the learning experience.

In other words, they learnt how to self-regulate and also how to regulate together the learning processes.

Simulations

Traditional ways of teaching primarily make use of ordinary verbal language and/or mathematical symbols. Even if the introduction of new technologies reinforced the role of multi-media, thus giving a major role to audio, video, and graphics, language maintains its primacy as the main vehicle of knowledge and comprehension. What appear on the computer screen are, above all, linguistic artefacts.

Delogu and Parisi (2006) compare and reflect on two ways of learning, understanding and becoming knowledgeable about reality: learning is achieved in the former through language (i.e., listening, reading and studying the accounts and explanations of other people), and in the latter we can understand and learn through experience (i.e., through observation and interaction with reality). In the first case learning is mediated by words, in the second case learning mostly occurs through senses and actions.

According to the authors, technology has great potential for learning through experience. To evidence this point, they provide examples of where technology facilitates accomplishment and the user gains experience through interaction with computers.

In particular, simulations, which are intended as a way of embedding a scientific theory, model or hypothesis into a software application, allow their users to

manipulate and change that theory, to interact with the model, to test the hypothesis. Simulations are active computer programs: they (re)produce the empirical facts that the theory intends to explain, and they function as virtual experimental laboratories where the user can control and manipulate variables and parameter values (Parisi, 2000). In other words, by definition, simulations put the learners in control of their own learning. Promoting the use of simulations in the learning of different disciplines therefore, involves maintaining that learners should be in control of their learning process, favouring the gradual acquisition of the required skills through an experiential approach.

DEVELOPMENT OF TELES SUPPORTING SRL

This section is devoted to a number of studies that take a very pragmatic approach, aiming to design and implement learning environments that support the practice and development of SRL. Usually, this approach moves from a working definition of SRL, which specifies the actions a learner should take to self regulate, to the implementation of a software system that embodies features allowing or encouraging the learners to carry out such actions. The aim is to experiment with functions that might inform the development of learning environments of the future. In the following, some examples of such systems are provided where different aspects of SRL are addressed.

In DID@Browser, meta-cognitive questions are posed to students while they navigate a hypertext, or a Website, in attempt to foster meta-reflection and therefore improve the cognitive strategies adopted while navigating. The DID@browser metacognitive questions therefore raise awareness of the users' searching abilities.

Gym2Learn is a Web annotation tool based on a metacognitive approach. It was developed to support students in the acquisition of strategies to control and monitor the comprehension of online resources.

Learning Tutor mostly focuses on enhancing student control by providing planning, monitoring and evaluation functions in an e-learning system.

Learning to learn from colleagues alternatively is one of the aims of the LODE system. This is a collaborative environment that combines the socio-constructivist ideas behind Communities of Practice with an extension of the concept of Learning Objects. The gap between the two is bridged by taking into consideration the need to share competence and experience, not just physical resources.

The latter example embraces a whole category of systems; the e-portfolios. Whether "developmental", "reflective" or "showcase" types, these digital archives of multimedia documents recording the authors' achievements are not only a major incentive for self-evaluation, but also a useful tool for planning and monitoring.

The DID@Browser system

As mentioned above, the ability to surf the Web in order to look for specific pieces of information, satisfy a curiosity, solve a problem or at least identify the relevant features seems to be related to a set of skills that have always been important but have now become fundamental to living in the so-called 'knowledge society'.

Learning in the knowledge society does not mean merely accumulating information, but being able to find processes and build new knowledge on this base. To do so, the ability to pose questions is as important as the ability to answer them, and the metacognitive skills that drive these abilities should become the overriding aim of a teacher who aims to empower his/her students. Such metacognitive skills include how to conduct a Web search, how to choose the "right" keywords, how to make and assess hypotheses, how to learn from experience and use skimming and scanning techniques to make sense of what one is reading. If these are the priorities, then the problem is how to support the achievement of these skills and the development of a high degree of awareness in their application.

An attempt to solve this problem is provided by the DID@Browser system, developed by a group of researchers of the Palermo branch of the Institute for Educational Technology of the Italian National Research Council (Chiazzese et al, 2006a; Chiazzese et al, 2006b). In particular, the DID@Browser is based on the hypothesis that students should be supported in the development of metacognitive skills related to Web search by posing to them suitable questions while they navigate. Such questions are supposed to stimulate reflection on the method used to search the Web and they belong to two distinct categories. The first category contains questions related to monitoring the surfing strategy, such as "Why have you clicked this link?", "What information do you expect to find?", "Have you explored the other links on this page?", "Do you intend to return to this page? Why?". The second category contains questions aiming to motivate students to evaluate the results of their activities and the related cognitive strategies, such as "What have you learnt from surfing this site?", "Has your surfing strategy succeeded?". The system records both the students' answers and their surfing paths, and allows a graphical visualisation of the latter.

A pilot study of the effects of DID@Browser was carried out using 27 students from a lower secondary school, who used it for a total of 24 hours, working on Websites and tasks built ad-hoc by the researchers. Besides the tracking facilities embedded in the system, the main tools used to investigate its effectiveness were a final questionnaire and an assessment test. The aim was to elucidate learning results both in terms of contents and in terms of students' awareness of the effectiveness of their own surfing behaviour. The results of the study showed that the strategy of posing questions during surfing did not hinder the learning of content and facilitated self-monitoring by raising awareness of the metacognitive strategies adopted. One drawback reported was that the questions on surfing methods antagonised the subjects due to the apparent irrelevance of the questions.

The Gym2Learn system

The authors of DID@Browser also designed Gym2Learn (see figure 1), an extension of the Firefox browser (Merlo, et al., 2007a; 2007b; Chiazzese et al, 2008). This system supports students in achieving text comprehension skills and encourages them to reflect on their Web surfing strategies. As it may happen in a gym, the gymnastics for learning consists of a series of practical exercises to use

and monitor the strategies required for text comprehension. After this practice, the same strategies are used through a web annotation system. As a result, students are supported both in the training and the execution phase.

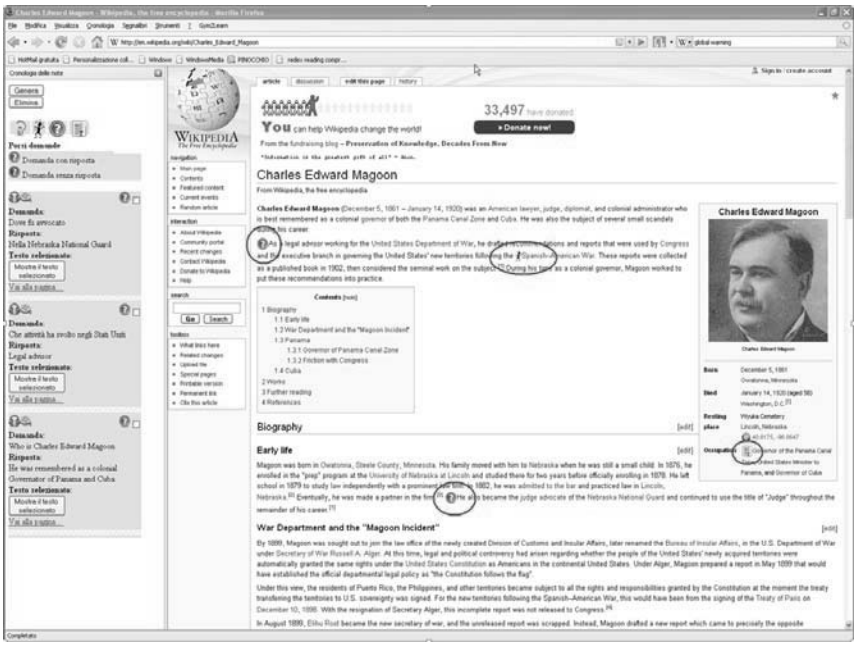

Fig. 1 - A snapshot from Gym2Learn

During the training phase students are stimulated to become aware of the main comprehension strategies and control them. The first training exercises are highly structured, however as the students progress, they are allowed to act autonomously, without relying on support from the system. During the execution phase students have the chance to apply the acquired strategies and use them on the Web.

Gym2Learn provides users with a pop-up menu to access the features necessary to create the notes and a sidebar to view the annotations, review the notes, and modify or delete them. All the annotations made are gathered in a document that can be further elaborated.

The annotations are modelled as a class of metadata which can be ascribed to four different comprehension strategies: recalling previous knowledge; formulating hypotheses which are revised or confirmed during Web-surfing; asking/answering questions to verify text comprehension; and identifying important parts of the text. Among the advantages of this system is the possibility to track the students' notes and to monitor their processes during online quests.

The preliminary results of the use of Gym2Learn are encouraging. According to its developers, the system can be extended to support collaborative learning experiences in order for students to share notes and documents with others.

The LEARNING TUTOR

The work of Pettenati et al (2000) explores the assumption that problems encountered by online students when regulating their learning process are not only cognitive in nature, but also methodological, organisational and emotional. The authors have developed and tested a Web-based authoring system, called Learning Tutor, aimed to support both tutors and students in an online course on broadband communications. The freedom that learners gain when they choose distance learning programs risks being outweighed by a number of difficulties, such as the need to elaborate and fine tune effective working plans, to self-evaluate and monitor progress, to cope with stress and anxiety, to keep up motivation.

Learning Tutor, developed through the MEDIT Environment[4], comprises several complementary and interconnected Web-based tools: the *Course description, Guiding Thread and Agenda*, the *Work Plan and Themes Reviewer* and the *Quizzes*. The first tool, *Course description, Guiding Thread and Agenda*, enables tutors to provide students with a 'guiding thread'; a work plan proposal comprising learning objectives, estimated study time and exercises related to each learning phase. In addition, the tutors usually complete a facility called Agenda, to schedule meetings with their students and where trainees will be able to book face-to-face meetings with each tutor. The second tool, *Work Plan and Themes Reviewer*, was developed for students to organise their own study time on the bases of the tutors' proposal. It is interesting to note that access to the individual work plan and to the results of the self-evaluation tests is restricted to the student unless otherwise specified. As a consequence, the tutors can keep track of students' progress through the different course stages only for those trainees who allowed it. The third tool, the *Quizzes*, allows the tutors to create a set of multiple choice questions, each belonging to a category and featuring a difficulty level. Based on this archive of questions, tests can be generated manually, by the tutor, or automatically, by the system, given the desired difficulty level for each question category.

Learning Tutor addresses the problem of striking a balance between what can be considered the main advantages and disadvantages of online education. Among the strengths is the students' freedom in organising their own learning. This freedom makes learning compatible with other occupations. Among the weaknesses, there is the risk of losing control of the learning process, from a cognitive, metacognitive, emotional and motivational point of view. This risk is regarded as one of the main causes of drop-outs in Italy[5].

The LODE system

The LODE system is a collaborative environment aiming to instigate a Community of Practice (CoP) for teachers using a database of Learning Objects (LOs) which contains not only educational resources but also the pedagogical experience developed through their use. Its developers (Dettori et al, 2007) postulated that, "In a CoP based on such approach to re-use, peers learn from each other and with each other, without external guidance or scaffold. In order for such community to

function effectively and autonomously, therefore, their members should be able to self-regulate their own activity and learning within this context". LODE was therefore designed to encourage SRL and it has been tested in a pre-service teacher training course.

LODE is specifically oriented to share pedagogical experience. To do so, it allows users to create, modify, search and retrieve LOs, create links among them, share reflections about their use, discuss pedagogical and usability issues. The system encourages both individual activity and collaboration with peers, by providing a personalised, easy-to-use interface, endowed with a rich help facility, aiming to maximise the users' autonomy. Facilities encouraging teachers to plan, monitor and evaluate their own learning, as well as provide feedback to peers are also available.

The LODE system was subjected to a two-stage evaluation process. Before using it with trainee teachers, it was evaluated by a team of experts using the TELE-SRL questionnaire, produced during the TELEPEERS project[6]. The evaluation results informed a first revision of the system, and the new release of LODE was used for approximately one month with 120 trainee teachers. The evaluation of this experience was based on qualitative and quantitative data. Information of a qualitative nature was obtained from researcher observation of the trainees' activity and the analysis of their productions. Other qualitative and quantitative data were elicited through an end-of-course questionnaire, aimed at assessing appreciation of SRL related features of the system. The results of the study revealed that students highly valued such features, particularly those which supported communication and feedback exchange among peers. Paradoxically, most of the suggestions made by the trainees to improve the system concerned these features.

In conclusion, LODE appears to be a very promising environment for both pre-service training of teachers and, perhaps to a greater extent, for in-service training. In fact, even if practicing teachers do not seem to be able yet to fully exploit the power of CoPs for their professional development, it is widely recognised that they do need to learn how to learn in such an environment because it is a very powerful way to develop non-procedural, ill defined, empirical competences such as those of experienced teachers.

E-portfolio systems

In Italy, the use of portfolios has a long tradition for education, rooted in the artistic and advertising sectors and in professional training. In effect, these contexts are valued equally to planning, production, analysis, monitoring, evaluation and improvement of tangible and visible artefacts or services that will be judged by customers, users and consumers. Despite this tradition, the term *portfolio* is relatively new in pedagogy. This is due to other words in use for defining portable cases of materials representing a person's work (e.g., *cartella*, *album*, *book* [using the English term], etc.) and because its diffusion in the field of education was delayed as a result of other meanings associated with the word *portfolio* and to its Italian etymology[7].

The word gradually gained recognition at national level when the Language Policy Division of the Council of Europe in Strasbourg developed and piloted the *European Language Portfolio* as a tool to support the development of plurilingualism and pluriculturalism (1998 – 2000)[8]. However, popularity of the term occurred once the laws were approved by the Italian parliament in 2002/2003, as part of the educational system reform. In this context, the portfolio was described as a competence portfolio, an object that includes the description of the student's progress and the documents (assessment test, projects, etc.) he/she produced during the school year. The laws also indicated that the student's portfolio should be compiled and updated by the student's family and teachers, in agreement with the head teacher (Balanskat, 2006).

This definition of portfolio, as an object to be used by students, teachers, and students' families, emphasized the role of portfolios in the learning process, in particular the importance of assessment and self-assessment procedures.

The worth of portfolios is evident from the high number of books by Italian researchers and teachers published after 2003 on the theme of educational portfolios (e.g., Castoldi, 2005; Pasciuti, 2005; Pellerey, 2004; Spinosi, 2004; Varisco, 2004; Comoglio, 2003). However, only a minority of these (e.g., Ajello and Belardi, 2007; Rossi and Giannandrea, 2006) focused also on *digital* portfolios (e-portfolios).

In the following, three exemplary studies on e-portfolios are discussed with reference to their contribution to the field of SRL.

E-portfolio, from theory to practice

The first is a study conducted at the University of Udine (Rossi et al, 2004) in the field of e-learning, assessment and evaluation. The work of these authors starts with a systematic picture of e-portfolio types, objectives, structures and models; a two-year case-study concerning the design and usage of e-portfolios in a university course is then presented, with technological and pedagogical considerations.

According to the authors there are at least six types of portfolio, with differential aims and structures. These are; the documentation portfolio, the showcase portfolio, the record keeping portfolio, the school portfolio, the class portfolio and the teacher portfolio. Their usefulness lies in the opportunities they confer, not only to document the competencies achieved, but also to produce a personal and evolving interpretation of the learning process, emphasizing the student's role in knowledge construction.

Technology has supported the development of tools to create, organize and implement online portfolios, documenting learning achievements over time which are evident in the accumulation of documents, goals and achievements, but mostly through the creation of hyperlinks. The advantages of hyperlinks include easy access (which is guaranteed over time), portability, visibility and flexibility, personalisation opportunities granted, and the ease of sharing information with others.

The second part of the paper details the role that e-portfolios had during the course on "Theories and methods of instructional design" at the University of Udine in the academic years 2002-2003 and 2003-2004. Students taking this course were asked to develop their portfolios according to the model of Danielson and Abrutym (1997) revised by Helen Barrett (2000). This model entails a five-step process for e-portfolio development: collection, selection, reflection, projection/direction and connection.

During the first year, e-portfolios were part of a public space within the online learning environment, developed to support face-to-face lessons; in the second year they were placed in a personal space. In both cases they have been used by lecturers as the starting point of discussions during the students' final summative assessment.

Introducing e-portfolios at institutional level

The second study on e-portfolios was carried out in 2005 at the University of Milano Bicocca. The project was conducted in collaboration with the Vrije University of Amsterdam, and it entailed the implementation of a digital portfolio and a pilot experiment with a small group of post-graduate students in the Sociology department (Dal Fiore and Gui, 2005). The objective was to obtain feedback (such as good and bad practices) so as to extend the innovation on a larger scale.

The main activities for students who implemented the Digital Portfolio within their career were: writing an initial Personal Development Plan (PDP), exchanging feedback and suggestions with peers and tutors, creating a personal archive of relevant material and, finally, reflecting on their development through a Self Reflection Report. The aim of the PDP was to encourage students in setting their learning goals, integrate development scenarios and keep track of their progress and study at university. Writing the PDP entailed three phases over a two year period, during which students were given an online personal repository. All documents, artefacts and other materials were exported at the end of the academic program, which emphasizes the idea that their university career was part of their life-long learning.

The outcomes of the project revealed the need for significant investments to be made in order to introduce and use the Digital Portfolio. The high costs were related to culture, politics, economics, technology and organization. It was for this reason that the following year saw the Digital Portfolio extended to all students enrolled in the faculty, but in a "minimal" version of the service (Gui and Pozzi, 2006) aiming to maintain the advantages of self-reflection.

E-portfolio from the learner point of view

A different perspective is offered by Catherine Blanchard (2006a; 2006b) whose contributions highlight how the author – an apprentice e-tutor - became aware of her professional and personal growth through an analysis of her experience, recorded during its progress in the form of an e-portfolio.

The context of the study is the Masters in "Distance Learning Tutoring" held by the University of Padova in the academic year 2004-2005. Students were asked to keep track of their learning process through an e-portfolio, with a twofold aim: to report the achievements of the assigned tasks, and to reflect on the learning process as it happened. Interestingly, not only is the paper a product of the reflections on the e-portfolio, but its structure is modelled on that of the e-portfolio, with a descriptive narration organized according to the three parts of the training process.

The first part concerned the reflection on the process of construction and description of the competencies to be acquired regarding tutoring styles, contents comprehension and mediation, choice of tools and resources, and online communication. The second part was compiled during a stage in which the students' e-tutors were involved in tutoring practice during an online course. In this phase the considerations on the tutoring process were also based on the "carnet de bord" (log book), a reflection tool compiled by their students. The third part aimed to support the process of construction and definition of the e-tutor profession, reaching a personal point of view on the tutor's roles, methods, tasks and styles.

The e-portfolio was used in a very personal way to carry out the self-evaluation process and accomplish the gradual transition from the role of a higher-education student to the role of an e-tutor. It was also used as a basis to share and discuss with others (i.e., peers, teachers and evaluators) the learning experience, on the assumption that the tutoring profession requires a continuous reflection on the online tutoring practice.

ASSESSMENT OF TELES WITH REGARD TO SRL SUPPORT

This section is devoted to studies aiming to analyse one particular type of TELEs, or sometimes one specific TELE, in order to understand the extent to which they support SRL development, if at all. Many of these studies also seek to identify the features of these environments that are relevant from this perspective. The methodology is widely varied; some researchers employed mixed methods, in order to obtain different types of data and therefore consolidate their findings. In particular, Computer-Supported Collaborative Learning environments were investigated in depth, and the results of these studies are reported in the first part. The second part is dedicated to studies that analysed systems for individual use.

Most of the studies of this section were carried out within the framework of the TELEPEERS Project[9]. For this reason, before we discuss the studies selected for this review, it is useful to summarise the main features of this project.

The aim of TELEPEERS was to evaluate the potential support to SRL provided by TELEs by analysing the features and the way they are used. The TELEPEERS partners belonged to 9 European countries (Germany, The Netherlands, Portugal, Denmark, Italy, United Kingdom, Spain, France and Norway) and focused on various types of TELEs; from offline, self-instructional programs to online, collaborative courses. To guide the analysis of the TELEs, the TELEPEERS team identified a set of features (listed in table 1) that, according to the literature, are desirable when SRL practice and development are among the learning objectives.

The standpoint of this project was that the analysis should focus not only on the software component but also on its mode of use, the rationale being that these two aspects are so intertwined that their effects are difficult to separate. Based on the above mentioned features, TELEPEERS also produced and tested two questionnaires, called the TELE-SRL and the TELESTUDENTS-SRL[10]. The TELE-SRL is meant to be used by teachers and/or SRL experts for an *a priori* evaluation of the TELE's potential, while the TELESTUDENTS-SRL is addressed to the TELE's users and allows an *a posteriori* assessment of the tool and its use. In the following we briefly report the results of the studies carried out by the Italian partner of TELEPEERS, the Institute for Educational Technology of the National Research Council, both during the project and following its conclusion. In addition, we briefly summarise the outcomes of a few other national studies, which concern specific aspects of SRL in connection with Computer Supported Collaborative Learning (CSCL) processes, comprising support to self-efficacy in children and the role of the online tutors.

SRL potential of Computer Supported Collaborative Learning

Table 1 Aspects of TELEs that potentially support the practice of SRL.

General features that support all phases of SRL[11]
• Intuitiveness and homogeneity of the interface
• Possibility to personalise the interface
• Help functions about how to use the software
• Tools to facilitate navigation in the environment
• Functions that support interaction with peers, teachers, tutors, and virtual agents present in the environment
Features that Support planning
• Planning tools: calendars, activity plans, etc.
• Explicit indications of the prerequisites for the assigned tasks
• Suitability of the organization and layout of the internal or external resources available to tackle a task
Features that support task execution and activity monitoring
• Functions that keep track of one's activity within the environment
• Availability of multimedia educational material in different formats
• Possibility to chose between different learning paths within the environment
• Possibility to chose between various difficulty levels for the proposed tasks
• Availability of formative feedback
• Tools to exchange materials and collaborate with other students
• Help functions about how to carry out the task
Features that support self-assessment
• Availability of models of correct task execution
• Possibility to compare one's own work with that of peers
• Self-evaluation tools

The relationship between SRL and online collaborative learning is rather complex as the latter appears to both support, and require the former. The studies described

in the following take two different standpoints: the first focuses on CSCL environments, their features and the way they are used (or can be used), and seek to understand the aspects of SRL that are developed by such environments; the second analyses the role of the tutor in fostering SRL.

Aspects of SRL developed by CSCL environments

Departing from the TELEPEERS project, a team of ITD researchers carried out a number of studies (Dettori and Giannetti, 2005c; Dettori et al, 2005a; 2005b; 2006; Dettori and Persico, 2008a; 2008b; Delfino et al, 2008; Dettori and Persico, in print) to further explore the relationship between SRL and CSCL environments. Some of these studies used the TELE-SRL and TELESTUDENTS-SRL questionnaires to analyse online or blended courses employing a collaborative learning approach. Others used mixed methods, including interaction analysis, in search for evidence of SRL practice and/or development.

The methods employed were also studied. Firstly, a set of SRL indicators for interaction analysis were identified based on the literature of the field (Zimmermann, 1998; 2001; Steffens, 2006) and tested through application (Dettori and Persico, 2008a; 2008b). Secondly, quantitative and qualitative methods were combined and used to compare results. The context of these studies was higher education and the courses analysed usually entailed online collaborative learning and/or blended learning. The results suggest that CSCL techniques, if adequately designed, can encourage and support both SRL practice and its development. In particular, they seem to foster autonomy, both in individual activities and in collaborative activities, encourage social support, help seeking and reciprocal teaching; control and personalisation of the individual workspace, reflection and meta-cognition, development of individual initiative and understanding of different learning styles, planning, monitoring and self-assessment both of individual and team activities. Among the techniques that seem to exploit this potential most effectively, are role-play and peer tutoring. Peer reviews are also helpful.

Another interesting contribution to research in this area comes from studies aiming to provide indications on how to equip CSCL environments in order to support learners and tutors in monitoring and evaluation tasks. For example, some researchers (Calvani et al, 2006; Ligorio and Spadaro, 2005) suggest using the so-called “thinking types” to tag messages in forums. Thinking types are tools present in a variety of online platforms developed on the basis of the socio-constructivist paradigm (e.g., Synergeia, Knowledge Forum) to sustain metacognitive processes, foster reflection and support online discussion.

Thinking types allow and encourage users of collaborative environments to tag their postings with a label indicating the pragmatic function within the structure of the discourse. Despite thinking types usually being chosen from a teacher-defined closed set, they encourage the posting author to reflect on their online exchanges, and to situate them in the message flow, thus guiding readers through the

visualization of their labels. Furthermore, thinking types are useful to analyse the effectiveness of the role taken by the participants.

Ottaviano et al (2004) investigated the effects of online synchronous communication on perceived self-efficacy of primary school children. Self efficacy in a given task is a crucial variable for SRL: learners displaying high self-efficacy are likely to exert more effort and persist longer in the task. Exceptionally high self-efficacy however, may be counterproductive as it can produce lack of preparation in the task. The study also tested improvement of reading comprehension skills by comparing the responses of an experimental group and a control group assigned a learning activity which varied only in the use of online communication tools for which participants collaborate in pairs. The outcomes of the study show a higher dispersion towards the extremes of perceived self-efficacy of the control group of children. In other words, perceived self-efficacy appeared to be either very high or very low after the activity, when interaction was face to face. The authors of the study attribute these results to the fact that teachers could, with the experimental group, devote more attention to each dyad, but they also claim the need for further research in this area.

The role of the tutor in supporting SRL

La Marca and La Monica (2006) analysed a blended course on "Educational Technology" on which 60 students at the University of Palermo were enrolled. The aim of their paper was to draw attention to the e-tutor's role in fostering the metacognitive abilities necessary for students at the beginning of their university experience.

The objectives of the course were to enhance collaborative experiential learning experiences; to strengthen problem solving competence; to encourage self-regulation and self-evaluation capabilities by means of seeking meaning actively, reciprocal learning, critical reflection and progressive mastery. The e-tutors were asked to coordinate the online and face-to-face activities, guiding students in choosing their personal paths in order to acquire a valuable learning method and to solve problems within a community.

The activity presented to students and coordinated by the e-tutors was based on case-studies. Students were asked to: 1) analyse complex situations and draw distinctions between facts and personal opinions; 2) detect the main problem(s) and the relevant facts of the study; 3) formulate and suggest possible solutions, which may involve collaboration with other students; 4) take motivated decisions and discuss with others the possible effects of these; 5) evaluate the decisions taken and reflect on the global situation. Furthermore, students were also asked to express to e-tutors the problems encountered during the activity, in order to find new solutions or think of better alternatives. In this phase the e-tutors may help students by observing, listening, communicating, analysing, reflecting, giving a sense of responsibility, synthesizing and evaluating. To do so, it is essential for e-tutors to identify areas of disagreement, unsolved questions, and neglected aspects; to involve silent students; to direct the group's efforts towards a common aim; to uphold the rules and to help in meeting the deadlines.

The paper concludes by emphasizing the importance of self-regulation capabilities, which are required also of e-tutors if they are to help their students to become self-regulated.

SRL potential of TELEs for individual use

The TELE-SRL questionnaire mentioned at the beginning of this section was also used to analyse some TELEs for individualised learning. Here we summarise the results of two of these analyses. The first focussed on a commercial software called Story Maker 2 and the second on a software environment called Ecolandia (Dettori and Giannetti, 2005a; 2005b).

StoryMaker 2[12] is a Narrative Learning Environment allowing its users (typically, primary school children) to create multimedia stories starting from a rich menu of thematically organised backgrounds, characters, props, sound effects, etc. StoryMaker suits children at varying stages of cognitive development and degrees of technological abilities in that it allows the creation of simple, linear stories but also hyper-media narrations with animations.

Ecolandia[13] is a hypermedia system addressing lower secondary school children. It was developed by Donatella Cesareni in 1994. Its basic assumptions and the evaluation process it underwent are discussed in a book concerning Hypertexts and learning (Cesareni, 1995).

The use of the TELE-SRL with these two software environments produced two types of results. The first is a subjective assessment of the software potential for SRL development, yielded by an expert with the guidance of the questionnaire. The results of the evaluation are arranged along two dimensions: 1) the "process" dimension, where support provided is analysed in terms of planning, execution and monitoring, and evaluation, and 2) the "component" dimension, where SRL is perceived as consisting of cognitive, motivational, emotional and social aspects.

For example, StoryMaker was deemed very powerful from the cognitive point of view, but it was judged to be weaker from the emotional and social point of view. As for the process dimension, StoryMaker appeared to support planning activities far more than execution, monitoring and evaluation. Similarly, Ecolandia's strengths consisted in support to planning, execution and monitoring, while self-evaluation was deemed to be poorly supported. The social, emotional and cognitive aspects were also considered to be fostered more than the motivational aspects.

The secondary level of results produced by this type of study is strictly related to the outcomes of the analyses, and in particular to the weaknesses revealed.

In fact, the TELE-SRL includes a final section entitled "Suggestions for improving the TELE" which requires the evaluator to advise the software developers and/or the teachers/users on how to compensate for such drawbacks. In the case of StoryMaker and Ecolandia, the suggestions provided were very interesting, practical points that could inform further development of the software and/or instructional design detailing its use. So despite the subjectivity of these

evaluations and that many of the software packages analysed were not developed with the aim of encouraging SRL, many useful pieces of advice emerged from this work that could lead both developers and teachers towards a higher degree of awareness of the importance of SRL at all stages of learning development and therefore, to better teaching and learning processes.

CONCLUSIONS

Italy is witnessing an increasing interest in SRL and for the contribution technology can confer to the development of related competencies. The studies analysed in this review cover an extensive range of ICT applications and differ greatly in terms of research objectives, methods and tools used, and educational contexts.

The objectives include:

- the investigation of the very nature of SRL and its relationship with technology, notably the Web and its potential for information seeking and interpersonal communication;
- the design and implementation of new TELEs incorporating innovations from the point of view of SRL sustainability;
- the evaluation of the SRL potential in specific types of TELEs (mostly CSCL Environments or specific software for individual use, etc).

The research methods employed are also very different. As mentioned in the introduction, there is a preponderance of pragmatic approaches, such as case studies and pilot experiments in controlled or natural environments. The evaluation approaches adopted to assess SRL development are usually based on a combination of quantitative and qualitative methods, and data collection techniques range from tracking the learning process in the Web to content analysis of interactions in CSCL environments. Many of the studies have taken place within the framework of the TELEPEERS project or have been informed by its results. In particular, the two questionnaires produced by this project have been adapted and used to assess the SRL affordances of several TELEs before and after use.

Last but not least, the educational contexts of the analysed studies have to do with both formal and informal learning. While much of the European research in the SRL field focuses on academic learning, many of the studies examined here concern the skills needed for informal learning and Life Long Learning or the development of SRL skills in school children.

The scope of the picture provided by this review is, therefore, quite wide, but rather dispersed. However, the studies analysed are only individual data points scattered in the three-dimensional space where the x-axis is the research aim, the y-axis is the research method and the z-axis is the educational context. We need to go deeper with each study, and we also need to be able to draw a picture out of our set of isolated dots. To do so, it appears that there is a need for more concerted efforts, and hopefully for further international action in this direction. The TELEPEERS project has proved that international cooperation in this field can produce solid results and inspire further research, especially if the aim is to elaborate and validate common methodologies and/or tools that are in subsequent studies. The

development of a shared framework for the study of the relationship between SRL and TELEs is, in fact, a necessary condition to obtain a coherent picture.

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NOTES

[1] There are, of course, some notable exceptions. See, for example the work of Pastorelli et al (2001); Albanese et a1 (1995), Albanese et al (2005), Cornoldi et al (2001), just to mention few.
[2] These are the terms used by Piaget (1972), who is considered one of the fathers of constructivism.
[3] A broader definition of IPS is provided by Brand-Gruwel and Gerjets (2008:616), who define it as the ability to "identify information needs, locate information sources, extract and organize information from each source, and synthesize information from a variety of sources".
[4] MEDIT (Multimedia Environment for Distributed Interactive Teaching) is an authoring system for the creation and management of Web-based courses.
[5] Italy is, under this point of view, one of the worst performers among developed countries (Cingano and Cipollone, 2007).
[6] For a short description of the TELEPEERS project and its results, including the TELE-SRL questionnaire, see the next section of this chapter.
[7] Even if the word *portfolio* is derived from the Anglo-Saxon languages, it is a calque of the Italian *portafoglio*, whose first contemporary meaning is "wallet" and etymologically means "to carry paper" (porta-, *to carry*, from Latin portāre; - foglio, *sheet*, from Latin *folium*, *leaf*) - http://www.yourdictionary.com/ahd/p/p0457700.html (consulted on 28th September 2008).
[8] http://www.coe.int/t/dg4/portfolio/Default.asp?L=E&M=/main_pages/welcome.html.
[9] TELEPEERS: "Self-regulated Learning in Technology Enhanced Learning Environments at University Level: a Peer Review", Grant agreement 2003-4710-/001-001 EDU-ELEARN, http://www.lmi.ub.es/telepeers/
[10] Both questionnaires can be downloaded from the Web site of TACONET (http://www.lmi.ub.es/telepeers/), an international association of teachers, scholars and researchers interested in themes stemming from TELEPEERS.
[11] It should be noted that some of these features are desirable for any educational environment, regardless of its aiming to foster SRL. They simply facilitate the users in keeping control of their actions. However, they deserve being mentioned here because of their strong relevance to SRL.
[12] http://www.spasoft.co.uk/demostorymaker.html
[13] Ecolandia is a software package published in Italy by Opera Multimedia in 1994.

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TECHNOLOGY ENHANCED ENVIRONMENTS FOR SELF-REGULATED LEARNING IN TEACHING PRACTICES

INTRODUCTION

The academic community in Portugal has turned to the theme of Self-Regulated Learning (SRL) in Technology Enhanced Learning Environments (TELEs) with a growing interest and increasing energy. This growing interest has emerged because SRL is considered an active and constructive process through which learners establish objectives, monitor, regulate and control their cognition, motivation and behaviour, as they are guided by those same objectives and by contextual specificities that characterize the learning environment (Nicol, 2009; Winters, Greene, & Costich, 2008). The considerable number of PhD and Masters Dissertations with an empirical research focus on SRL is a good indicator of this rising trend. However, there is little evidence of research that has been conducted on the specific topic of SRL in TELEs. This theme of investigation is only now increasing due to the rather recent nature of systematic e-Learning and/or b-Learning activities in formal education, as well as the little training done with teachers on SRL and TELEs in their daily practice. Moreover, the research done on SRL in TELEs has not been thoroughly explored because there is a persistently low awareness of the new technological tools in comparison with the related international agenda.

Nonetheless, the use of Information and Communication Technologies (ICT) in Portugal is constantly evolving and these changes affect all segments of social and academic life. Although the country is experiencing a three year delay in comparison with the average EU indicators, strong developmental trends can be seen in areas of ICT such as e-Government Broadband diffusion and e-Education (Carneiro & Rodrigues, 2007). Furthermore, there is a general understanding that ICT can be a remarkable catalyst for transformations in the educational field. Carneiro (2000, 2007) has delineated seven major potentialities of technology, namely:

– The promotion of an open knowledge system.
– An evolution towards learning technologies, as opposed to the continued use of mere teaching technologies.
– A stimulus that allows each student to become a researcher,

R. Carneiro et al. (eds.), Self-Regulated Learning in Technology Enhanced Learning Environments, 75–101.

– The dissemination of interactive tests that support customized and real time student assessment,
– The formation of distributive networks and virtual learning communities – the new *Agora* of human capital,
– A lever to bring about an effective collapse of the monopolist, mass teaching, centralized education that is typical of the industrial mode of delivery,
– The opportunity to foster intergenerational learning experiences and provide inclusive support to disadvantaged groups.

Suitable use of ICT allows schools to combine *remedial* actions (when necessary) with *enriching* actions (where appropriate) so as to address learning difficulties and/or improve learning outcomes (Andrade & Bunker, 2009; Banyard & Underwood, 2008; Barnard, Lan, To, Osland Paton, & Lai, 2009; Mooij, 2009). In order to accomplish these objectives, the Portuguese government in July 2007 approved a Technology Plan in Education that highlights schools as being the most effective platforms toward universal access to information and knowledge.[1] The Technology Plan involves three components: Technology, Teacher Training, Digital Content. In the context of this Plan each elementary education student (grades 1-4) has been provided with a laptop (Programme Magalhães) and all classrooms have been equipped with broadband connections and smartboards. An identical sweeping investment is being made at lower and upper secondary levels with the aim to reach a 1:2 ratio (computer to student ratio).

Compliant with these sizable ICT investments, the concept of nurturing a competent student finds growing interest among researchers and practitioners, with particular emphasis on higher education (Jardim, 2007). Furthermore, the need to reverse a longstanding situation of high school dropout rates, low professional skills and aggressive lifelong learning policies, makes the demand driven learning agenda come to life and puts high emphasis on individual informal learning paths.

In light of these issues, this paper will address three major concerns related with SRL in TELEs. To specify, we first account for general theoretical and empirical studies done on the impact of SRL on teacher practices in Portugal. Secondly, we describe a study on the impact of a TELE in SRL in a graduate program of studies at the Portuguese Catholic University. This particular study focuses specifically on motivational profiles of teachers and students. Thirdly, we provide a brief description of the Digital Portfolio movement in Portugal - a concept that is acquiring momentum among academia and research groups. Lastly, we provide a summary of general conclusions derived from the insight given in the three core sections mentioned above.

SELF-REGULATED LEARNING AND TEACHING: THEORETICAL AND EMPIRICAL STUDIES COMPLETED IN PORTUGAL

Setting the scene

In the last decade there has been an increase in research concentrating on: i) the understanding of internal and transactional psychological processes which allow individuals to direct their own behaviour in order to achieve objectives and to

control their feelings, thoughts, behaviors and means so as to obtain the desired results; and ii) the understanding of contexts focusing on the beliefs, conceptions and educational practices of parents and teachers.

Lopes da Silva & Sá (2003) have done a review on the national and international research on SRL which identified distinct theoretical approaches and research tendencies. They concluded that the work completed to date allows for a better management of the SRL construct, although it is still necessary to develop more research in this area which allows researchers to elaborate an integrative theoretical body of results from the empirical work and of theoretical reflection.

It was within this framework that the SRL Studies Program[2] (PEAAR, 2005) was created and integrated in the Psychology Research Units and Sciences of Education of the Lisbon University School of Psychology and Educational Sciences. The main objectives of the PEAAR are: a) to stimulate cooperation between researchers from diverse theoretical orientations and different fields of Psychology and Education; b) to give emphasis to the development of research work in these areas; c) and to develop a research network which makes the incorporation of postgraduate students feasible. The PEAAR has gradually integrated the various strands of SRL studies in the areas of Science Education and Educational Psychology as well as the recent ICT inclusion in academic settings. The program was organized by the Faculty of Psychology of the Lisbon University and coordinated by Lopes da Silva and Veiga Simão.

The GT-PA (Working Group-Pedagogy for Autonomy – Moreira, 2002; Vieira, 2002) is another program within these areas that studies learner autonomy and teacher development. The GT-PA group of the University of Minho established its focus around two specific aspects: the role of the learner as an autonomous individual in pedagogy and the role of teachers dealing with learner autonomy in their professional development.

Researchers from both programs have chosen learning and teaching in school settings as principal fields in which to apply self-regulation. They believe that students should be taught to understand and use their personal resources which allow them to reflect on their actions, control their own learning processes and reinforce their learning skills. The researchers also consider it important that teachers stimulate their students to be competent, efficient and motivated when using both learning processes and technological and cultural means. Furthermore, self-efficacy perceptions, conscious and deliberate use of cognitive and motivational strategies, and effort made to achieve educational objectives appear as the foremost specific topics of interest in the multiple theoretical and empirical studies that have been carried out on SRL, although there are differences in the independent variables.

From an extensive analysis of papers, theses and research articles produced, we acknowledge that the prominent theoretical approach is the social cognitive perspective. The identified studies are dominated by national and international scientific knowledge in Educational Psychology and are essentially accomplished, although not exclusively, by psychologists and teachers in postgraduate studies.

The international authors most commonly cited include Bandura, Biggs, Boekaerts, Corno, Deci, Pintrich, Ryan, Schunk, and Zimmerman.

Lopes da Silva, Duarte, Sá and Veiga Simão (2004) as well as Lopes da Silva, Veiga Simão and Sá (2004) for instance, conjugate different models of SRL (Boekaerts, 1996; Pintrich & de Groot, 1990; Zimmerman, 2000) and propose a restructured model detailing phases which integrate the different theories that are intricately connected with the SRL construct. Four phases are distinguished: 1) forethought and setting objectives; 2) strategic planning; 3) monitoring/volitive control; and 4) self-reflection and self-reaction. For each phase, the most relevant processes and metacognitive, motivational, volitional and behavioral variables (thoughts, beliefs, strategies, emotions and expectations), which may influence the path of self-regulation, can be analyzed.

Veiga Simão, Duarte and Costa Ferreira (2008) verified that as a rule, researchers who have dedicated themselves to students' SRL, refer specific characteristics which distinguish SRL as a unique and meaningful process, namely, cognitive regulation, motivational strategies, domain-specific knowledge, specific learning environments and the cyclical phases – planning, execution/monitoring and evaluation (Lajoie, 2008; Rosário 2004; Veiga Simão, 2005a, 2006 Steffens, 2007; Zimmerman, 2000; Zimmerman & Shunk, 2008). Moreover, researchers consider that self-regulation involves a variety of phases and requires different psychological processes (Boekaerts & Niemivirta, 2000; Febbraro & Clum, 1998; Mahoney & Thoresen, 1974; Pintrich, 2000; Zimmerman, 2000). Also, according to the authors, all models defend the learner as an active and constructive participant in creating meanings, constructing learning, managing motivation (Boekaerts & Corno, 2005) and creating opportunities within their educational context. Furthermore, all theoretical models of SRL consider the ways in which learners activate and sustain their behaviour, cognitions and affective functioning. However, in order for this to occur, the way teachers take action, the structure of learning environments, the material available and the social interactions, are all crucial factors for learners' cognitive, metacognitive, emotional and motivational commitment executing tasks. In fact, teachers play a fundamental role because they need to promote different ways of thinking, acting and feeling. Therefore, the authors believe that it is crucial for teachers to consider and reconsider their role in the teaching/learning process.

Frison, Veiga Simão, Costa Ferreira and Duarte (2008) complement this study on SRL by presenting theoretical considerations concerning the potential of SRL. These authors specifically contemplate how motivation and evaluation processes are essential to achieve expertise levels of academic performance. To specify, according to these authors, SRL supports learner motivational involvement and control over their knowledge acquisition cycle in diverse learning environments during different tasks. SRL therefore allows learners to manage personal resources in order to reach objectives; triggers the ability to reflect upon achievements; and develops self-evaluation competencies which permit learners to carry out rectifications or adjustments necessary for goal attainment and strategy enhancement.

Additionally, the authors focus on how this learning process involves both teacher and learner as motivated active participants in generating conditions to

promote successful performance results. Self-regulation impels and stimulates learners to reach self-established goals, but also encourages them to make an effort to reach suggested/mediated objectives by teachers. Motivation is the key to better student understanding of what is expected of them and of what they should expect of themselves. Teacher intervention is permanently implicit in learner guidance and should evolve towards covering educational diversification. Through resource management and methodology planning, teachers can find an array of diverse approaches to stimulate SRL in learners. Inquiry-based teaching for example, can be used as a way of granting learners opportunities to express their thoughts, ideas, interpretations and contemplations. Collective interaction is also critical in this methodological approach because it allows learners to debate, reflect and to self-regulate collaboratively. It also stresses cooperation, interaction and participation as social knowledge constructors (Zimmerman and Schunk; 2008). When students work together, they tend to help each other evaluate better, and consequently, learn better in situations where they share learning experience and expertise (Boekaerts & Corno, 2005). This perspective emphasizes the benefits peers have to offer in terms of regulative and evaluative strategy acquisition and collaborative learning.

This analysis enables the authors to contemplate the existing articulation between the conceptions and strategies that stimulate the SRL process as well as pedagogical practice aspects, namely dealing with evaluation issues. They highlight how self-regulation requires competency development that allows learners to make a realistic diagnosis about what they know, what they need to learn and to organize, plan and develop their learning procedures. Moreover, they view SRL as a process which allows students to determine which objectives and strategies are needed to perform a task. Lastly, SRL implies knowing how to monitor procedures and self-evaluate possibilities, which ultimately lead to expertise levels of active and dynamic academic performance.

GUIDELINES FOR RESEARCH ON SRL

At this stage, we present the general outline of research undertaken in postgraduate studies and research projects in Portugal. These exemplify the direction studies on SRL have taken. One of the main objectives of research conducted in this area is to theoretically and empirically clarify the SRL phases and processes in order to sustain and perfect the proposed theoretical model.

Research outline

We can distinguish two main research outlines: firstly, the study of students' cognitive, metacognitive, motivational and behavioral processes; and secondly, the study of teachers' and parents' beliefs, educational conceptions and practices.

One line of research strives to examine individual or cultural differences in the practice of self-regulation (Jerónimo, 2007), namely, in comparison studies of students in different learning cycles, from pre-school to university (Figueira, 2005) or in change situations, such as the transition between learning cycles (Guerreiro,

2005; Prata, 2006; Sá, 2007). Sá (2007) presents the results of two empirical studies which aim to assess the impact that school transitions have on students' motivation, self-efficacy and performance. In the first study, an analysis of the impact of transition from elementary to secondary school is presented. In the second study, personal variables (gender, age, grades and coping strategies) that promote better adaptation (self-efficacy and performance) to the transition to the university are analyzed. The results emphasize how social and cultural contexts and previous success are important to the development of positive self-efficacy expectations. These are related to more autonomous motivations and to better academic achievement. In this sense, we intend to frame the self-regulation model in a developmental perspective and characterize the affective, motivational, cognitive and behavioral processes which are predominantly relevant at different school levels.

Most research conducted in this area samples university students. The preference for university students is grounded on the facts that they are more autonomous in their academic phase and possess greater responsibility and choice. In the study *Das concepções aos processos - Stress e Coping nos Estudantes do Ensino Superior* [*From Conceptions to Processes – Stress and Coping in University Students*], Figueira and Marques Pinto (2007) study student maladaptation processes at university level using Lazarus and Folkman's (1984) stress and coping model in conjunction with Wells and Matthews' (2001) regulating executive function model. Bessa-Oliveira (2000) and Bessa and Tavares (2000) focus their research on levels of adjustment and self-regulation in university students and highlight the relationship between positive student self-perception and the approaches to learning and self-regulatory strategies.

The different theoretical approaches to learning have inspired many projects in Portugal (Duarte, A. 2002; Ferreira, 2002; Rebelo, 2006; Rendeiro, 2005; Rosário, 1999; Rosário, Núñez, González-Pienda, Almeida, Soares, Rubio, 2005; Valadas & Gonçalves, 2002) that have adopted Biggs' perspective (1993).

Researchers have also investigated the relationship between educational practices and the development of self-regulating competencies in learning. This research also takes into consideration the influence of the type of family (Vidal Paula, 2004; Sousa, 2006) and classroom environment in student self-regulating processes.

Research directed towards intervention processes

Many studies have intervention concerns either in cognitive training (Almeida, 2005) or in establishing how to increase SRL competencies in students. Self-regulating competencies have been specifically highlighted in the field of education. It is fundamental to stimulate the development of such competencies in students and teachers so that all can take advantage of the opportunities and instruments that are available, whether these are internal processes or generated from the modern use of technology (Kaplan, 2008 ;Vrugt & Oort, 2008).

Fragoso de Almeida and Veiga Simão (2007) aimed to elaborate and test intervention programs with the objective of improving teaching and learning strategies and self-regulation in students. This is achieved through the

identification and development of pedagogical support, which promote student strategic knowledge in specific situations, such as homework completion (Cruz, 2006; Duarte, F., 2004; Rosário, Mourão, Soares. Chaleta, Grácio, Simões, Núñez, Gonzalez-Pienda, 2005), reading (Araújo, 2006), history (Teixeira, 2004) or writing practice (Fragoso de Almeida, 2004). This study (with the contribution of primary school teachers) focused on the development of self-regulatory strategies in the writing process, identification of difficulties felt during the teaching of this process, and prevention and remedial activities used.

Araújo (2006) presents a case study in which action research was used to articulate the reflective self-development of the teacher-researcher with pedagogy for autonomy in school. Its objectives were to motivate students towards reading as a communicative practice; to promote self-monitoring of reading and to foster processes of pedagogical self-supervision. The results confirmed that it is possible to develop reading strategies and cooperative work, and that extensive reading may support the development of communicative and learning skills. At a more general level, the study created opportunities for reflection about teaching and the role of professional reflectivity in its transformation.

The study *O Conhecimento Estratégico e a Auto-Regulação do Aprendente*, [Strategic Knowledge and Learners' Self-regulation] by Dias and Veiga Simão (2007) analyses how the development of strategic knowledge can promote self-regulation in first-grade students. Additional objectives of this study include the establishment of pedagogical support in order to develop strategic knowledge - i.e., how developing strategic knowledge can promote student self-regulation and give rise to intervention clues for the participants in education. Homework has become a part of educational practices throughout the last decade and has been the object of research for Duarte and Veiga Simão (2007) in terms of the role it plays in life-long learning and the ways it promotes strategic use of knowledge in fourth-grade students.

In other studies (Costa Ferreira, 2008; Veiga Simão, 2000, 2002a, 2002b) teachers worked with pupils to raise cognitive, metacognitive and motivational strategies. In addition, researchers developed a teacher training procedure in order to stimulate reflective, active and constructive attitudes. The scientific value of this educational project is revealed by validating it in real contexts, which allows us to analyze the meaning of upcoming changes and compare them with the existing scientific knowledge on the subject. This research showed that it is possible to use learning strategies in the classroom within a regular curriculum.

Following this line of thought, Rodrigues (2008) focuses on analyzing students' perceptions related to the importance of teacher feedback as well as self-assessment in promoting self-regulation strategies. This work was based on a case study of 10 students from the sixth grade. Rodrigues concluded from this study that successful students are more aware of the importance of self-regulation strategies in their learning process than students with poor academic performance. Another conclusion was that the students with high academic performance used these strategies correctly in terms of behavioral self-assessment, strategies and the learning process as a whole.

Across this variety of approaches, there are common elements within the different proposals, namely regarding strategic teaching, strategic practice combined with teacher feedback, strategic use of monitoring, possible alterations of monitoring (depending on obtained results), social support provided by teachers and psychologists responsible for the interventions and the consequences of withdrawing this type of support. This work is accompanied by a reflexive practice which aids students in self-evaluating the use and value of adopted strategies and other beneficial results which may be obtained by them.

We highlight a few projects (Lopes da Silva & Sá, 1997; Rosário, 2004; Rosário, Nuñez, & Pienda, 2006) with the objective of improving self-regulation competencies in home study sessions. Zimmerman (1998) emphasizes that studying is a complex activity where components of a distinctive nature inter-relate such as, cognitive, emotional, motivational and behavioral dimensions at different phases of the learning cycle. Lopes da Silva and Sá (1997) reveal a program application to develop study methods in primary and middle school students, which integrates metacognitive, motivational and behavioral variables, while Rosário (2004) presents a program for primary and middle school students which is built on the SRL models and distinguishes three phases which correspond to the three phases of the learning cycle proposed by Zimmerman (1998): the planning phase, the execution phase and the task evaluation phase.

Rosário, Pérez and Pienda (2004) carried out a research program entitled *Stories that show how to study and how to learn: an experience in the Portuguese school system*. SRL is the conceptual framework for the project, called *(Des)venturas do Testas* [*The (Mis)adventures of Testas*]. The innovative nature of the proposal lies in the use of children's literature as a means to convey and discuss study strategies brought to light by a familiar model. *The (Mis)adventures of Testas*, depicts a student that uses different learning strategies to achieve personal and academic goals. This work allows pupils to easily identify answers with proposed solutions that are discussed, as well as transfer competencies discussed in the classroom to other areas of their academic and personal life. Similarly, Guimarães (2006) carried out a study to promote SRL and simultaneously analyze the effects of a psycho-educational project anchored to use narratives as a tool to transmit and discuss learning strategies.

Hence, it is essential that teachers understand and reflect about their own cognitive, metacognitive and motivational processes in order to equate the best way to help their students reflect about their own learning. The cognitive, metacognitive, motivational and volitive knowledge experienced in context constitutes a unique tool for teachers to design and develop learning experiences with their students. If teachers are to help students self-regulate their learning, they should self-regulate their own learning.

Methodological options of the studies

In methodological terms, the developed studies are of a descriptive and differential nature and involve the construction, adaptation and validation of evaluation instruments (Borralho, 2005; Borralho & Lopes da Silva, 2007; Guerreiro, 2005; Lourenço, 2007; Rodrigues, 2005; Vidal Paula, 2004), an intervention evaluation,

and employ quasi-experimental designs, pre and post-tests (Dias, 2004; Duarte, 2004), the use of portfolios (Fernandes, 2005, Veiga Simão, 2005a, 2005b) and case studies (Costa Ferreira & Veiga Simão, 2008; Veiga Simão & Costa Ferreira, 2008).

Rendeiro and Duarte's (2007) study *Concepções de Aprendizagem face à Avaliação em Estudantes do Ensino Secundário* [*Learning Conceptions for the Evaluation of High School Students*], is an example of a qualitative study conducted from a phenomenographic perspective. An empirical taxonomy of learning conceptions was developed in this study to evaluate and verify how the different system categories correspond to the learning conceptions identified by the phenomenographic studies.

Future research should include longitudinal studies which allow us to better understand the development of strategic knowledge and autonomy in learning throughout schooling. The study *Os efeitos da transição para o 10º ano na motivação para a aprendizagem* [*The transition effects of the 10th grade in regards to learning motivation*] by Guerreiro and Sá (2007) is an example of a longitudinal study. This study intended to describe the role of the social cognitive variables in student motivation for learning in the transition from middle school to high school.

As a transversal objective to all studies, the construction, adaptation and validation of evaluation instruments suffice. These instruments are necessary for the empirical study of analyzed variables in each study (Guerreiro, 2005; Lopes da Silva & Duarte, 2001; Rosário, 2001; Vidal Paula, 2004). In a study *A avaliação do ambiente familiar e o seu papel na competência escolar das crianças: adaptação do inventário HOME* [E*valuation of family environment and its role in children's scholastic competency: adaptation of the HOME inventory*], Vidal Paula and Lopes da Silva (2007) adapted an instrument that measures family environment – that is, Bradley, Caldwell, Rock, Hamrick and Harris' HOME Inventory for children (1988) between the ages of six and ten. These researchers explored the role of the family environment in children's academic competency and their perception of what competency is (consequent and feature of SRL, respectively).

Dias (2004) and Duarte (2004) have developed self-report questionnaires, while Veiga Simão and Flores (2007) have elaborated interviews and Laranjeira (2007) observation grids on personal beliefs, self-efficacy expectations, as well as motivational orientations, learning environments, family environments and strategic knowledge. Veiga Simão and Flores (2007) focus specifically on the use of interviews to enhance learning in teacher education. The SRL theory in educational psychology integrates knowledge about cognition, motivation, volition, social interaction, and expertise to explain how academic learning is most effective. However, practitioners have lacked guidance in translating this powerful theory into insightful practice. By using semi-structured interviews within a self-regulation approach, researchers may work with teachers and ask them to explore students' perceptions of their experience of learning in order to access a greater depth of understanding about the process.

An overview of studies on teaching practices involving SRL

The different lines of research have enabled testing of the theoretical model, which accounts for individual differences in self-regulating processes (Lopes, 2007; Laranjeira, 2007; Lopes da Silva, Duarte, Sá, & Veiga Simão 2004) and the implementation of teaching practices favorable to the construction and development of self-regulation in learning (Dias, 2004, Duarte, 2004, Rosário, 2004; Veiga Simão, 2002a). This knowledge will allow us to structure learning environments which permit students to construct knowledge and mobilize resources in order to learn to self-regulate their learning so as to transfer and apply it to their future professional activity.

Nowadays teachers are required to be reflective and proficient in analyzing their own conceptions and practices so as to respond successfully to the demands related to teaching and learning. Thus, they must acquire a thorough understanding of the cognitive and motivational principles and assumptions of teaching and learning (Zohar & David, 2008). In order to achieve this purpose, teacher educators must focus on modeling and promoting student teachers' SRL. SRL entails three main characteristics: thinking awareness, use of strategies, and motivation maintenance. The idea is to mobilize self-regulated ability, associating specific training in learning strategies with teacher activity, which leads to the recognition of reasons, assumptions and meanings of the teacher's options, decisions and outcomes. (Veiga Simão, 2002b, 2004b). If students are to strategically use their resources, teachers need to be able to strategically teach and learn the curriculum content themselves. This is why the use of the SRL construct is advocated in the teacher training process as well as the perspective of learning strategies which imply awareness, intention, context sensitivity, control and activity regulation (Veiga Simão, 2002b).

In order to face the challenge of strategic learning, we need teachers who know how to help their students become more autonomous, strategic and motivated in their learning within an academic context so that they may transfer their efforts and strategies to other contexts (Cho & Jonassen, 2009; Hong, Peng, & Rowell, 2009). This implies purpose development which may be included in teacher training plans (Veiga Simão, 2002b, 2004, 2006). Fernandes and Veiga Simão's study (2007) *O portfolio na Educação de Infância: Estratégia de Reflexão dos Educadores e das Crianças* [*The Portfolio in Pre-School: the Reflection Strategy in Pre-school teachers and Students*] was an attempt to contribute both to the understanding of teacher perceptions with regard to the development of portfolios in a kindergarten context as a reflection, regulation and self-regulation learning strategy and also to the perception of reflexive regulation and self-regulated learning processes which involve portfolio development for children.

To address these concerns, Veiga Simão, (2002b, 2004, 2006) and Veiga Simão and Flores (2007) focus on the importance of quality in teacher preparation. Their findings suggest a number of key issues that can challenge teacher education in general: i) integrating learning strategy teaching throughout the various years of training which may contribute to developing processes of self-regulation in the pre-service teacher; ii) emphasizing student autonomy and control in learning, which promotes self-regulatory attitudes and competency development (behavioral,

metacognitive, motivational and volition). The challenge here is to consider the demands of SRL, namely the integration of teaching strategies in teacher education so that student teachers can change future practices. If teachers are to help their students self-regulate their learning, they must self-regulate their own learning.

Costa and Viseu (2008) also focus on teacher training and have proposed a model which helps teachers construct a personal vision of the potential have when used in academic settings. They believe their model encourages teachers to approach the use of technology as a positive and effective resource to use in their lesson preparation and to guide students in SRL.

Veiga Simão and Costa Ferreira (2008) also focus on the teacher's role in a SRL environment. Specifically, this study, seeks to verify whether introducing SRL skills in a domain-specific learning environment can have an impact on teachers' daily methodology. Additionally, they infer the types of processes and training teachers need to experience in order to teach and develop SRL skills in students. Hence they stress the importance of collaborative work in teachers' daily planning so that SRL skills can be successfully developed in learners. These authors were able to achieve these goals by implementing a case study which provided detailed information on a teacher's reflective learning development during the implementation of a SRL methodology in a fourth-grade ESL (English as a second language) classroom. Using pre-intervention and process monitoring workshops with a teacher and a class observer, the researchers registered and analyzed the process of collaborative work to promote a genuine learning environment. Furthermore, by conducting a semi-structured interview with the teacher, Veiga Simão and Costa Ferreira (2008) captured specific points of view about the process involved in self-regulating teachers' work and consequently, students' learning outcomes. After an analysis of the results of this study, Veiga Simão and Costa Ferreira conclude that SRL skills can create a positive impact on teachers' methodology, as they perceive students to benefit from the competencies they acquire and develop. Lastly, the researchers concluded from this study that, in accordance with many previous studies (Zimmerman, 2000), teachers have specific teacher training needs, such as the development of their own SRL knowledge, skills and collaborative work.

The results of the research completed to date indicate that experienced knowledge of the cognitive/metacognitive, motivational/volitive components, in accordance with the context, constitute a unique tool for students to develop learning experiences, which lead to autonomy. Furthermore, the diversity of themes certifies the complexity and variety the studies on self-regulation may follow in order to contribute to the understanding of the role of mediating or moderator variables that lead to a much needed conceptualization of the self-regulation construct. Additionally, we intend to identify the educational environments and the reciprocal relations between the processes and the adopted procedures by students in managing their academic studies. Another preoccupation in these studies is related to knowing how teachers and students react to interventions intended to improve scholastic performance through different process acquisition (cognitive, metacognitive, motivational and affective) and use strategic

learning. Finally, the design of the study, the research methods and the rehearsal of evaluation measures which help understand, evaluate and explain the diversity of interactions involved in learning regulation, are also concerns of the studies.

ASSESSMENT OF TELES THAT SUPPORT SRL IN TEACHING PRACTICES

An interesting research question examines the extent to which a technology-enhanced learning system provides support to develop and consolidate SRL skills. This area suffers a notorious scarcity of empirical research in Portugal; however, this section presents specific studies concerning SRL in TELEs, as well as introducing current studies in Portugal. We first describe a research project designed to assess the impact of a particular TELE in developing SRL skills in university graduate teacher education. This project was developed in the context of TELEPEERS[3], a European consortium involving partners from 9 European countries that dedicated two years of work to develop a better insight on the theme of SRL in TELEs at University level. In the course of the project, research partners designed, tested and validated two evaluation tools which targeted teachers, administrators (TELE-SRL) and students (TELESTUDENTS-SRL).

The Catholic University of Portugal (UCP – Universidade Católica Portuguesa) conducted the research component in Portugal. In particular, UCP carried out a comprehensive study on school teachers who had enrolled in a technology-enhanced graduate training program. The study features the impact of a distance education environment which is strongly supported by Information and Communication Technologies (ICT), on the motivation profiles of student teachers and the acquisition of self-regulation skills to guide them in their learning path (Carneiro 2006). The inquiry about the impact of a TELE on SRL departs from the assumption that teachers posit higher than average dynamic self-regulation attitudes when acting as learners. This being true, teachers would value settings that are supportive and expressive of a learning culture, and technology environments that sustain active learning skills.

The sample used in this study included 143 teacher-students enrolled in a MA degree in Educational Information Technology and beginning the academic year of 2003-04. Students were allocated to five groups (‘classes’) and were required to take five different subjects of study and complete a dissertation.

The model placed a strong emphasis on group and social learning based on active tutoring and constant stimulation to work in forums and chats. Individual and group online assignments accompanied ongoing appraisal and assessment exercises that were designed to offer stimulating working packages. The choice of both the Learner Management System (LMS) and the complementary software tools was made to promote a TELE that could afford high levels of social interaction and induce meta-motivational gains. Moreover, the empirical research was based on the administration of three time-sequenced, purpose-designed and customized surveys to students who enrolled in the advanced teacher education course in information technology.

Firstly, in January 2004, a baseline survey was administered to student teachers who had enrolled in and were pursuing their first term of graduate studies. A second survey was conducted in the middle of the course (September 2004). This

intermediate survey (66 respondents) was designed to analyze learning motivations and to 'explain' how the TELE could assist students in achieving higher patterns of SRL. Particular attention was given to social and self-evaluative features of the TELE. The third segment of the field work occurred during the final stage of the curricular requirements of the course (March 2005). This involved the administration of the same survey used mid-course to assess consolidation or modification of students' perceptions as they approached the end of the required curriculum (63 respondents).

A limited number (6-8) of in-depth qualitative interviews and discussions in a virtual forum were also conducted. To complement this, the researchers from the UCP distributed TELESTUDENTS-SRL to a limited number of students (11 valid responses). This case study approach proved to be instrumental to further clarify the responses to queries, such as the extensive use of MSN, the preference for personal email use, and the utmost importance given to content availability. Finally, we asked one TELEPEERS partner – the University of Barcelona (UB) – to apply our second survey model to a sample of students from the Audiovisual Communication Course (Digital Video Course – classroom learning with the support of new media). Notwithstanding marked differences in course layout and methodology, some of our findings could be contrasted and compared to the data from Barcelona (15 respondents).

The main conclusions of this research can be clustered around seven findings:

– (1) Teachers sought professional development as their prime motivation to enrol in graduate education[4]. They pursued enhanced gratification through (i) knowledge base expansion especially in quality content and (ii) improved career opportunities.
– (2) Technology can play an essential role in course attractiveness providing for increased accessibility (time and space) and flexibility in learning. The TELE rapidly evolved to become a *natural learning environment* and offered student teachers a gradual shift from process to outcome goals (Zimmerman & Kitsantas, 1997).
– (3) The TELE feature that was most valued by student teachers for their motivation was social learning. Learners appeared to value opportunities supported by simple communication systems that were relevant to both virtual and real community building (instant messaging, email, forum, and face-to-face sessions)[5].
– (4) Self-efficacy beliefs that sustain the intrinsic motivation to learn were highly dependent on the use of self-evaluative and monitoring tools (readily available in the TELE[6]) because teachers' attributions of self-efficacy grew out of hetero-efficacy expectations (related to students) and the TELE served as a reflective tool that acted upon two dimensions that serve the purpose of self-efficacy boosting: self-monitoring (intrapersonal attributions) and peer interaction (interpersonal attributions).[7]
– (5) Teachers revealed a preference for b-Learning models including regular *traditional* sessions that they deemed instrumental to sustain collaborative learning.

– (6) The motivation timeline of students can be described as a U-shaped curve where initial enthusiasm was replaced by an immediate disenchantment, followed by a *resilience* trend in conformity with the development of enhanced skills in future goals management[8].
– (7) No evidence could be found to prove the hypothesis that the TELE *per se* could act as a prime determinant of knowledge acquisition.

Another project worth mentioning is Machado's study (2007) on promoting new technologies as well as narrative writing through "Storyline" in primary school students. This researcher suggests from the results of this study that children benefit from learning with new technologies and narrative writing, in the sense that they acquire more autonomy and show more creativity in solving problems. Veiga Simão, Rodrigues and Cabrito (2007) also corroborate these suggestions in a European project "Early Technical Education" seeks to promote technical education for children, encouraging them in the understanding of scientific-technological phenomena. To this end, it was endeavored to develop children-targeted pedagogical material to be applied in the initial and continuous training of Pre-primary and Primary Education teachers and duly based on teaching-learning methodological approaches that comprise the fields of Education and Technology. As a result, a digital manual was prepared with didactic resources on-line (http://www.earlytechnicaleducation.org).

Current diverse research concerning SRL in TELEs has recently been and is being developed at Lisbon University's Faculty of Psychology in the Research Program on SRL - (PEAAR) (http://autoregulacao.uidce.fpce.ul.pt). One of the studies involves exploring secondary school students' study habits, as well as SRL in problem solving related with searching for information on the Web. Specifically, they aim to study the learning paths of 10th grade students throughout 2 academic years in order to capture their perspectives related with SRL and information gathering by using the Web.

Furthermore, the researchers working on this study have opted to focus on this type of learning environment because of its potential in terms of communication and information acquisition. Moreover, they expect to acquire new data that will allow them to construct and improve new pedagogical and technological tools that will facilitate teaching and learning in academic settings as well as throughout life-long professional contexts.

Another study worth mentioning and that has recently been published (Costa Ferreira, Veiga Simão, Lopes da Silva, Ferreira, & Duarte, 2009) is based on the TELESTUDENTS-SRL Questionnaire provided by TELEs by Steffens (2007). With this study, the researchers examined the opinions of students from a private institution who are working in a TELE and must self-regulate their learning process, namely, knowledge acquisition and study rhythm. Specifically, the aim was to correlate variables such as the duration of each student's course, their age, gender, working status with each student's opinion regarding SRL and details of the TELE, such as the teacher support offered. Another goal is to establish whether the learners' learning environment (TELE), including teachers and colleagues, helped them to regulate and/or organize their own learning. Additionally, the researchers would like to know to what extent different aspects of the learning environment were important for the learners' learning outcome. The psychometric

properties of the questionnaire were also analyzed. We applied the questionnaire to a total of 153 students learning a second language. These students had previous training in how to manage their studies in the TELE they were working with.

Results showed that students revealed in all dimensions of the questionnaire that the TELE helped them with their self-regulation process (mean values vary between 3.84 and 4.17 on a scale of 0 to 5). In terms of the psychometric studies, these showed a factorial structure associated to six distinct dimensions (with 66% of the total explained variance and Cronbach's alphas of .751) that evaluate important phases and components of SRL. As expected, results also showed an absence of significant differences for the social and demographic variables studied. Lastly, the analysis of the results suggests new reflections so as to further develop the questionnaire.

Both aforementioned studies are occurring alongside others that aim to reflect the potential of TELEs and SRL in the near future. Researchers in Portugal expect to continue to develop further studies regarding these learning environments and methodologies in an attempt to improve the ways in which *teachers teach* and *learners learn*.

TEACHING AND LEARNING WITH DIGITAL PORTFOLIOS

The theme of learning portfolios has gained widespread enthusiasm in the Portuguese educational areas (Costa, Rodrigues, Peralta, & Raleira, 2006). Recent European and national policy changes that favor a competence-based curricula in primary and secondary education, led to increased interest in portfolios as a reliable tool to define and measure competencies. Thus, portfolios appear as powerful instruments to monitor specialized skills and also transferable competencies. These key competencies touch upon *soft* domains of SRL which address in particular, meta-learning aptitudes such as *learning to learn* and *knowing to know.* Teacher education reflects this new trend at both curricular and methodological levels.

The research reported below is grounded mostly on evaluation theories and learning models. Moreover, this research departs from a variety of meanings attributed to portfolios, more often described as a product and less frequently appointed as a curriculum model or a specific methodology. Accordingly, the literature on digital portfolios is much more scarce and focused on the higher education sphere.

Field surveys show that the main education publishers in Portugal have seized the market opportunity to offer textbooks and teacher guides displaying portfolios as a key pedagogical novelty (Bernardes & Miranda, 2003; Coelho & Campos, 2003; Nunes, 2000). In addition, the government's initiative Ligar Portugal [Connecting Portugal], designed to boost the Information and Knowledge Society, and proposes the generalization of a student electronic portfolio at the end of compulsory education. This e-Portfolio would register all competence acquisitions and practical skills of the individual (in arts, science, technology, sports and other fields). With this tool, a special emphasis is put on the need to report effective use of ICT in the different school subjects.

The first research results on the use of portfolios describe experiments undertaken in a teacher training course. These reports suggest a high effectiveness of portfolios as a means to create a *new pedagogical culture* (Fernandes, 1997; Cardoso, Barbosa, & Alaiz, 1998). Along similar lines, Sá-Chaves (1998, 2000) studied the impact of portfolios on the initial training of teachers and their supervision activities. The same author proposes the concept of *reflective portfolio* in her later research on teacher education and teaching practice (Sá-Chaves, 2005). Following these determining studies, a number of dissertations revisited the theme of portfolio use in initial training of Biology teachers and in their assessment practices (Batista, 2004; Coelho, 2000; Grilo, 2004; Menino, 2004; Parente, 2004).

Also regarding e-portfolios, the department of Chemistry of the University of Porto (School of Natural Sciences) developed an on-line application called DPF. This tool is currently used by senior students in their project work and also in lifelong learning courses (Norberto et al., 2005a, 2005b).

A number of sites have been constructed to offer information and related tools on the use of portfolios and Weblogs:

– www.mocho.pt
– http://nonio.eses.pt/eportfolio
– http://hemajoro.blogspot.com/
– http://mariatec.blogspot.com/
– www.geografismos.blogger.com.br
– http://portefolios.no.sapo.pt/

The latter site refers to the GT-PA, a research group from the University of Minho that develops work on concepts of reflection and autonomy in teacher training.

The University of Porto (Martins, Correia, Soeiro, 2008) has also implemented a project to promote the use of e-portfolios within its academic community. The main idea of this project is to use the e-portfolio as an assessment tool of the student learning path as well as to show the importance of this reflective work in their academic and professional life. According to the results from this project so far, the portfolio enables students to construct a structured collection of knowledge, skills and competencies.

Tavares, Silva and Albuquerque (2008) describe a case-study of a pilot experiment which involved the use of e-portfolios as a translation training tool. These authors also discuss the role of the e-portfolios as a student-support tool in defining objectives and phases for task execution. They suggest that e-portfolios help students in managing project deadlines, in improving their knowledge regarding the construction and management of translation resources and in increasing learner awareness about the concepts related to the development of e-portfolios.

Lastly, Barbas and Moreira (2008) present the "Web 3.0 Fluids Database: e-portfolio, Life Stories and Second Life" project in which they aim to characterize a society of fluxes. In this study the authors identify two different moments. The first consists of transforming the temporality of fluxes, which lead to the study of life stories. The second relates to the integrative spaces of formal and informal learning which allow the authors to identify the e-portfolios and Second Life. Through the significance of these three forms of support, the authors built a database that is

available to all researchers (post-Doc, PhD, Masters) in the scientific community who wish to use it.

CONCLUSION

The Portuguese scientific community disposes of a sizable research track-record in the general field of SRL studies and is investing on recent work related to SRL in TELEs. Some Schools of Psychology and Science Education such as those belonging to the Universities of Lisbon, Minho and Aveiro have investigated a regular flow of research projects and on-going dissertations in SRL that should guarantee a critical mass of academic focus in SRL related themes for the future. The setting up of the SRL Studies Program (PEAAR) of the Lisbon University represents a significant leap forward in recognizing the importance of this field of studies and in creating a prestigious strand, capable of attracting graduate students. Furthermore, projects developed in the PEAAR have concluded that in order for teachers to have their students self-regulate their learning, they must learn to teach content strategically. Therefore, further efforts must be made in training teachers to use learning and teaching strategies that imply consciousness, intentionality and sensitiveness in controlling and regulating tasks in different contexts.

Six domains appear to offer especially promising prospects in developing action-research as well as in the concrete application of new knowledge generated around topics related to SRL and TELEs:

- Implementation of competence-based curricula in primary and secondary schools linked to the European Qualifications Framework implementation and to Education 2010 objectives.
- Gradual dissemination and uptake of Web 2.0 software (Second Life, Hi5, MySpace, Tribe, Facebook, Podcasting, Wikis, etc.) for improved social learning purposes.
- Readdressing the broad area of teacher education, regarding both initial and in-service training programs and a regular uptake of technology enhanced systems of blended learning.
- The development of personal and social competencies in university students - in particular, the core and transferable competencies, with the objective of combating high failure rates in the first years of university studies.
- Generalization of the Bologna Declaration in higher education institutions, which is expected to lead to a gradual replacement of taught learning models by autonomous and group learning paradigms.
- The new thrusts in lifelong learning, with particular emphasis on the implementation of the European Qualification Framework and the need to boost and accredit personal informal learning experiences.

A survey into the narrower field of SRL in TELEs shows that the research momentum is considerably lagging behind and sparsely documented. There are nonetheless, studies attempting to target faculty and students enrolled in higher education programs that have resorted to e-Learning or b-Learning methods of delivery. The Portuguese Catholic University for example, has done some pilot

research with graduate teacher education in computer sciences. However, the actual research panorama remains irregular and fragmented to a certain extent. This situation mirrors some well known difficulties in mainstreaming ICT-embedded solutions into the realm of the educational establishment.

Sequentially, digital portfolios represent a growing agenda of research. This topic benefits from a synergic combination of information society demands (broadband and virtual campus implementation) and a commensurate supply of technology tools – mostly open source – complemented with support material provided by educational publishers. Furthermore, learning portfolios have attracted the active interest of a wide community of practicing teachers for some years.

One curious note worth mentioning is a spreading interest on the subject on the industry and market players' behalf. This interest was evident during the final phase of TELEPEERS, when the research consortium approached businesses for feedback on the main findings about SRL in TELEs. Indeed, there are encouraging signs that businesses could consider the possibility of undertaking research and development partnerships to further explore some relevant dimensions of SRL in TELEs (Carneiro, Steffens, & Underwood, 2005). Research conducted in traditional business settings – footwear and textile industry – have demonstrated the leverage effect that ICT can have regarding performance levels and productivity gains in the low-skilled labor force (Carneiro & Conceição, 2002).

Traditionally, high drop-out rates from school and a related persistence of low-skilled workers in the labor force pose a formidable challenge to the Portuguese education and training systems. Similarly, upgrading skills and updating strategies for lifelong learning will demand a greater use of ICT and the concurrent development of SRL skills in the bulk of the work force - namely those occupying the lower tier of the skills ladder.

The government policy priority designated by *Novas Oportunidades* [New Opportunities](http://www.novasoportunidades.gov.pt/; http://www.en.anq.gov.pt/) proposes to reverse the lack of human capital investment and provide *new opportunities* for the adult population to acquire advanced skills and achieve a full formal certification. These dimensions will absorb roughly 70% of the total Community Support Framework funds during the next 7 years (2007-2013) and also pose a formidable challenge to the scientific community. Thus, gaining better insights into business community interests and establishing suitable bridges between academics and economic actors will encompass promising possibilities for new research and applied work in the comprehensive area of SRL in TELEs. The first batch of independent research conducted on the data base shows some interesting trends: that accessing advanced skills and achieving formal certification enhances broadband internet penetration from 40% to 70% and makes internet use 2.5 times more likely (Lopes, Cerol & Magalhães, 2009).

NOTES

[1] http://www.escola.gov.pt/docs/me_plano_tecnológico_educação.pdf

[2] http://autoregulacao.uidce.fpce.ul.pt

[3] TELEPEERS: "Self-regulated Learning in Technology Enhanced Learning Environments at University Level: a Peer Review", Grant agreement 2003-4710-/001-001 EDU-ELEARN, http://www.lmi.ub.es/TELEPEERS/

[4] Simons, Vansteenkiste, Lens, & Lacante, (2004). Correlational studies provide empirical evidence on the relationship between usefulness of course and jobs (instrumentality) as a prime motivation factor of task orientation.

[5] Bandura (1986, 1997) posited that social factors are prime determining factors of self-regulation efforts during learning.

[6] This finding is consistent with a triadic cyclical model of self-regulation with particular reference to its third phase where *self-reflection* is strongly contingent on *self-evaluative* practices and reciprocal feedback loops (Zimmerman, 1998, 2000; Zimmerman & Martinez-Pons, 1990).

[7] Learner as "scientist" and learner as "judge" attributions (Tollefson, 2000; Weiner, 2000).

[8] The underestimation of the commitment required by web-based learning is an important cause of early drop-out. The literature on insufficient perceptions of the effort required at the beginning of a TELE course is abundant. For other empirical evidence see for instance Muse Jr. (2003), Persico & Delfino (2004), Delfino, Persico & Sarti (2004).

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JOS BEISHUIZEN

FOSTERING SELF-REGULATED LEARNING IN TECHNOLOGY ENHANCED LEARNING ENVIRONMENTS: EVIDENCE FROM EMPIRICAL RESEARCH

INTRODUCTION

In the Netherlands, computers have been used in education since 1970. Two research projects, funded by the Dutch Foundation for Educational Research, provided a major stimulus. At Leiden University, a project focused on Computer Managed Instruction for primary education and secondary vocational education (Van de Perel, 1979). At the Vrije Universiteit Amsterdam, a research group developed Computer Assisted Instruction, also for primary education and secondary (vocational) education (Dirkzwager, Fokkema, Van der Veer, & Beishuizen, 1984). The latter project included research on the differential effects of learner controlled and program controlled instruction, in which the concept of self-regulated learning already showed up. Bernaert (1977) showed that students tended to adopt a more risky learning strategy, skipping explanations and immediately jumping to assignments and exercises, when they have the freedom to find their own way. They performed worse on learning and transfer tests than students for whom the learning path had been determined by the program in advance. This detrimental effect of learner control turned out more striking for students with low cognitive abilities.

These pioneering projects were soon followed by a lot of various research projects, especially after the introduction of the desktop computer in 1975. The switch from "mainframe" to "microcomputer" meant a major change in the potentials and functionalities of computers. Fokkema, Van der Veer, Beishuizen, and Dirkzwager observed in 1984 that microcomputers were cheap. For less than 5000 Dutch guilders (approx. 2300 Euros) microcomputers with limited capacity were available. For less than 10000 Dutch guilders one could purchase a microcomputer with standard characteristics like 64 kB internal memory, a conventional microprocessor like the Z80 and two external drives for floppy disks. Like other governments, the Dutch Ministry of Education started to provide money to schools to buy equipment and train the teachers. This led once again to large scale research projects, like the Technology-Enriched School Projects (Beishuizen & Moonen, 1993; Beishuizen & Versteegh, 1993). Gradually, computers became less expensive and more advanced, which exponentially increased their use in education. Since 1995, research into the use of computers in education became more specific, focusing on various applications, like simulation and gaming, and integrating the computer as an instrument in a larger learning environment, the Technology Enriched Learning Environment.

R. Carneiro et al. (eds.), Self-Regulated Learning in Technology Enhanced Learning Environments, 103–122.

In this review, we focus on research into the development of self-regulation strategies and skills in technology enhanced learning environments. Steffens (2006) defined three steps in self-regulation: '(1) planning the learning activity, (2) executing and monitoring the execution of the learning activities and (3) evaluating the outcome of the learning activity' (Steffens, 2006). Technology enhanced learning environments can be arranged and equipped in such a way that students are supported to actively regulate their own learning processes. Planning can be supported by providing instruments to choose and sequence learning activities out of a list of learning objectives, assignments to be completed or subjects to be studied. Monitoring the execution of learning activities can be facilitated by keeping a log of all activities to be opened for inspection and review, by displaying progress indicators showing what has been done and what lies ahead of the student, or by checking the assignments completed on a list of all tasks to be done.

In order to describe and characterize recent developments in Dutch educational research into self-regulated learning in technology enhanced learning environment, we distinguished four factors influencing the process of self regulated learning in technology enhanced learning environments: (1) the student, (2) the teacher, (3) the community of learners and (4) the learning environment.

The student

We were interested in the effect of learning styles, expertise, prior knowledge, interest, motivation, age, and cognitive abilities on self-regulated learning.

The teacher

The role of the teacher in technology enhanced learning environments is often underestimated. In this review, we wanted to explore whether Dutch research clarified the contributions of teachers to self-regulated learning in technology enhanced learning environments.

The learning environment

Technology is part of the physical learning environment. Computer programs provide *learning tools* to support self regulation. In a hypermedia environment, an interactive map or table of contents may serve such a purpose. Another example is a progress indicator in an exercise with a number of tasks to complete. However, many programs offer more sophisticated support. Students may use a hypothesis scratchpad to formulate their expectations in a simulation environment. An interactive decision tool may help them to develop a particular learning strategy. These examples all have in common that the learner is in control of the learning process. The learning tools help the learner to regulate the learning process. However, in an environment where the program or the teacher is in charge of learning process, the *learning materials* may be arranged in such a way that students are supported to develop their own regulation strategies. Assignments may be arranged in an order of progressive complexity to keep the cognitive load of

each task at a level which is optimal for this particular student in this particular stage of learning. Various subskills may be trained in a consecutive order to enable the student to gradually compose the target skill.

The community of learners

Recent views on learning as a social and constructive process make clear that peers influence the learning of individual students and that learning itself is often the result of a joint effort to solve a problem or to complete an assignment. Therefore, we explored the results of Dutch research into computer supported collaborative learning in which self-regulation (both individually and group wise) was taken into account.

In this review, we were interested in collecting samples of Dutch research on the role of learning tools and learning materials in fostering self-regulated learning in technology enhanced learning environments. This review had two general questions as its main focus:

– Which research programs have been carried out in the Netherlands during the period of 1997 – 2007 in the area of self-regulated learning in technology enhanced learning environments?
– What are the major outcomes of recent Dutch research into self-regulated learning in technology enhanced learning environments?

These research questions were answered by collecting a number of 20 representative articles from international and national scientific journals in which empirical studies were reported into self-regulated learning in technology enhanced learning environments. We did not include theoretical contributions or review studies. Only original empirical research was included in the sample. We took into account that three major research institutes in the Netherlands are active in the area: (1) the Department of Instructional Technology of the University of Twente (Ton de Jong, Jules Pieters, Tjeerd Plomp, Ard Lazonder, Pascal Wilhelm); (2) the Educational Technology Expertise Centre of the Open University of the Netherlands (Jeroen van Merrienboer, Paul Kirschner, Tamara van Gog, Frans Prins), and (3) the Department of Educational Sciences of Utrecht University (Gellof Kanselaar, Jerry Andriessen, Gijsbert Erkens, Paul Kirschner, Frans Prins). We wanted these three research group to be included in our sample. Therefore, we actively sought for publications from these groups and added them to our sample. We used the four factors influencing the process of self regulated learning in technology enhanced learning environments as a framework to describe and interpret the findings reported in the sample.

METHOD

Sample

In order to compose a representative sample of recent Dutch research papers on self regulated learning in technology enhanced learning environments, we chose six journals to extract the papers from:

- Instructional Science (impact factor 2010: 0.92)
- Learning and Instruction (impact factor 2010: 1.44)
- Journal of Computer Assisted Learning (impact factor 2010: 1.01)
- Computers and Education (impact factor 2010: 2.19)
- Interactive Learning Environments (impact factor 2010: 0.94)
- Computers in Human Behavior (impact factor 2010: 1.77)
- Pedagogische Studiën (Pedagogical Sciences, Dutch journal)
- Tijdschrift voor Hoger Onderwijs (Journal of Higher Education, Dutch journal)

These journals were chosen because of their relevance (Journal of Computer Assisted Learning, Interactive Learning Environments, and Computers in Human Behavior), impact factor (Instructional Science, Learning and Instruction, Computers and Education) or local significance (Pedagogische Studiën, Tijdschrift voor Hoger Onderwijs). Our aim was to find 20 to 30 papers which reported empirical research, and shed light on the topic of this review, self regulated learning in technology enhanced learning environments. We were also careful to include some contributions from each of the three major research institutes on the use of computers in education in the Netherlands: (1) the Department of Instructional Technology of the University of Twente; (2) the Educational Technology Expertise Centre of the Open University of the Netherlands, and (3) the Department of Educational Sciences of Utrecht University. Eventually, 26 papers were selected. Table 1 provides a list of the papers.

Table 1. Overview of the sample

#	Reference	Factor
1	Veenman, M.V.J., Wilhelm, P., & Beishuizen, J.J. (2004). The relation between intellectual and metacognitive skills from a development perspective. *Learning and Instruction, 14*, 89-109.	The Learner: Development of Self-regulative Skills
2	Lazonder, A.W. (2000). Exploring novice users' training needs in searching information on the WWW. *Journal of Computer Assisted Learning, 16*, 326-335.	The Learner: Level of Expertise
3	Rienties, B., Tempelaar, D., Van den Bossche, P., Gijselaers, W., & Segers, M. (2009). The role of academic motivation in computers-supported collaborative learning. *Computers in Human Behavior, 25,* 1195-1206.	The Learner: Level of Intrinsic and Extrinsic Motivation
4	Martens, R.L., Gulikers, J. & Bastiaens, T. (2004). The impact of intrinsic motivation on e-learning in authentic computer tasks.	The Learner: Level of

#	Reference	Factor
	Journal of Computer Assisted Learning, 20, 368–376.	Intrinsic Motivation
5	Prins, F.J., Veenman, M.V.J., & Elshout, J.J. (2006). The impact of intellectual ability and metacognition on learning: New support for the threshold of problematicity theory. *Learning and Instruction, 16*, 374-387.	The Learner: Self-regulative Skills versus Intellectual Ability
6	Fisser, P., & De Boer, W. (1999). A decision support tool for web-supported course design. *Journal of Computer Assisted Learning 15*, 255-256.	The Teacher: Authoring Tools
7	Smeets, E., (2005). Does ICT contribute to powerful learning environments in primary education? *Computers & Education, 44*, 343-355.	The Teacher: Attitudes and Skills
8	De Jong, T., & Van der Hulst, A. (2002). The effects of graphical overviews on knowledge acquisition in hypertext. *Journal of Computer Assisted Learning, 18*, 219-231.	The Learning Environment: Learning Tools
9	Swaak, J., De Jong, T., Van Joolingen, W. (2004). The effects of discovery learning and expository instruction on the acquisition of definitional and intuitive knowledge. *Journal of Computer Assisted Learning, 20*, 225–234.	The Learning Environment: Learning Tools versus Assignments
10	Karassavvidis, I., Pieters, J.M., & Plomp, T. (2003). Exploring the mechanisms through which computers contribute to learning. *Journal of Computer Assisted Learning, 19*, 115-128.	The Learning Environment: Effect of Computer Support
11	Kester, L., & Kirschner, P.A. (2009). Effects of fading support on hypertext navigation and performance in student-centered e-learning environments. *Interactive Learning Environments, 17,* 2, 165-179.	The Learning Environment: Fading Support
12	Van Gog, T., Paas, F., & Van Merrienboer, J., (2004). Process-oriented worked examples: improving transfer performance through enhanced understanding. *Instructional Science, 32*, 83-98.	The Learning Environment: Learning Materials
13	Van Drie, J., Van Boxtel, C., Jaspers, J., & Kanselaar, G. (2005). Effects of representational guidance on domain specific reasoning in CSCL. *Computers in Human Behavior, 21,* 575-602.	The Learning Environment: Learning Tools
14	Veermans, K., De Jong, T., & Van Joolingen, W.R. (2000). Promoting self-directed learning in simulation-based discovery learning environments through intelligent support. *Interactive Learning Environments, 8*, 3, 229-255.	The Learning Environment: Learning Tools
15	De Vries, B., Van der Meij, H., & Lazonder, A.W. (2008). Supporting reflective web searching in elementary schools. *Computers in Human Behavior, 24,* 649-665.	The Learning Environment: Learning Tools

#	Reference	Factor
16	Akkerman, A., Admiraal, W., & Huizenga, J. (2009). Storification in history education: A mobile game in and about medieval Amsterdam. *Computers and Education, 52,* 449-459	The Learning Environment: Learning Tools
17	Manlove, S., Lazonder, A.W., & De Jong, T. (2009). Trends and issues of regulative support use during inquiry learning: Patterns from three studies. *Computers in Human Behavior, 25,* 795-803.	The Learning Environment: Regulation Tools
18	Martens, R., Bastiaens, Th., & Gulikers, J. (2002). Leren met computergebaseerde authentieke taken: motivatie, gedrag en resultaten van studenten [Learning with computer based authentic tasks: Motivation, behaviour and learning outcomes of students]. *Pedagogische Studiën, 79*, 469-482.	The Learning Environment: Students' Appreciation of Authenticity
19	Van der Meij, H. (2000). The role and design of screen images in software documentation. *Journal of Computer Assisted Learning, 16*, 294-306.	The Learning Environment: Learning Materials
20	De Jong, T., Van Joolingen, W.R., Swaak, J., Veermans, K., Limbach, R., King, S., & Gureghian, D. (1998). Self-directed learning in simulation-based discovery environments. *Journal of Computer Assisted Learning, 14*, 235-246.	The Teacher: Authoring Tools The Learning Environment: Learning Tools
21	De Laat, M., Lally, V., Lipponen. L., & Simons, R.-J. (2007). Online teaching in networked learning communities: A multi-method approach to studying the role of the teacher. *Instructional Science, 35*, 257-286.	The Teacher: Role in the Community of Learners
22	Saab, N., Van Joolingen, W.R., & Van Hout-Wolters, B.H.A.M. (2006). Supporting communication in a collaborative discovery learning environment: the effect of instruction. *Instructional Science, 35*, 73-98.	The Community of Learners: Learning Materials
23	Janssen, J., Erkens, G., Kanselaar, G., & Jaspers, J. (2007). Visualization of participation: does it contribute to successful computer-supported collaborative learning? *Computers & Education, 49*, 1037-1065.	The Community of Learners: Learning Tools
24	Kirschner, P.A., Beers, P.J., Boshuizen, H.P.A., & Gijselaers, W.H. (2008). Coercing shared knowledge in collaborative learning environments. *Computers in Human Behavior, 24, 403-420.*	The Community of Learners: Learning Tools
25	Van Eijl, P., Pilot, A., De Voogd, P., & Thoolen (2002). Samenwerkend leren of individueel leren met ICT [Collaborative or individual learning with ICT]? *Pedagogische Studiën, 79*, 482-494.	The Community of Learners: Students'

#	Reference	Factor
26	De Laat, M. & Lally, V. (2004). It's not so easy: researching the complexity of emergent participant roles and awareness in asynchronous networked learning discussions. *Journal of Computer Assisted Learning, 20*, 165-171.	Preferences The Community of Learners: Analysis Tools

RESULTS

The Learner

Various learner characteristics have been related to learning processes and outcomes in technology enhanced learning environments. In the sample of 26 studies we found five relevant studies: Lazonder (2000) on the influence of level of expertise, Martens, Gulikers, and Bastiaens (2004) on the influence of intrinsic motivation, Prins, Veenman, and Elshout (2006), Veenman, Wilhelm, and Beishuizen (2004) on the relationship between self-regulation skills and intellectual ability, and Rienties, Tempelaar, Van den Bossche, Gijselaers, and Segers (2009) on the relationship between academic motivation and contribution to discourse in a problem based learning group.

Lazonder (2000) compared the search behavior of 7 novice and 7 expert users of the World Wide Web. Fourteen fourth graders had to locate particular sites and specific information on those sites. Differences between both groups did show up during the phase of locating sites, not during the phase of locating information on sites. Lazonder (2000) concluded that novice users could be supported by training them to improve their monitoring skills, evaluating the quality of the information on sites, and by supporting them to use advanced search tools, like Boolean operators.

Martens, Gulikers, and Bastiaens (2004) compared the behavior of 33 higher education students with high and low levels of intrinsic motivation in a game-like realistic simulation. Unexpectedly, high intrinsic motivation students did not show greater effort or persistence than low intrinsic motivation students. Rather, high intrinsic motivation students displayed more variation in exploratory behavior. For instance, they more often consulted senior advisers (in the simulation environment) or traced information in the archive or the mailbox. This more diversified exploration behavior did not pay off in increased level of knowledge on a posttest. Both high and low intrinsic motivation students performed equally well on the knowledge test.

The extent to which self-regulation skills and/or intellectual ability determine the learning process and outcomes of novice and advanced learners who explore a computer simulated inductive-learning environment was studied by Prins, Veenman, & Elshout (2006). First year psychology students with low or advanced levels of domain related knowledge explored an optics lab and, following a series of three assignments, tried to find out underlying rules. The authors concluded that

when learners operate at the boundary of knowledge, metacognitive skillfulness is more essential for learning than intellectual ability.

By presenting inductive learning tasks in a computer supported simulation environment to fourth-, sixth-, and eighth-graders and to university students, Veenman, Wilhelm, & Beishuizen (2004) showed that metacognitive skills are domain-independent characteristics which develop partly independent of intelligence. According to the authors, training of metacognitive skills across domains may be successful, as long as the same approach is chosen across disciplines.

The position and behavior of students in a problem based learned group may be determined by the academic motivation of individual students. Rienties, Tempelaar, Van den Bossche, Gijselaers, and Segers (2009) studied six groups of students entering university education. The students met in a summer school and practiced the problem based learning method in their domain of international business administration. In groups of 11 to 17 participants, they solved six problems. After analyzing the content the students produced, the social networks in which they operated and the academic motivation of the students the authors concluded that highly intrinsically motivated students provided central and prominent contributions to the academic discourse. Extrinsically motivated students, however, contributed on average and were positioned in various places throughout their social network. The authors do not interpret their findings in terms of causes and effects. One can imagine that extrinsically motivated students feel less secure than intrinsically motivated students and, consequently, hesitate to post contributions to the discussion forum.

The studies reported all showed that student characteristics are an important source of differences in learning processes and learning outcomes in technology enhanced learning environments. Novices differ from experts, children differ from adults, and high intrinsically motivated students differ from low intrinsically motivated students or from extrinsically motivated students. Students with extrinsic academic motivation may have to cope with problems how to survive in the group, whereas students with intrinsic academic motivation may act in a more content oriented way. Therefore, students with extrinsic academic motivation may be less secure and less flexible in choosing their strategy than students with high academic motivation. The better equipped the student is, the more he or she can choose between strategies, particularly when the constraints are tight. This calls for fostering diversity in cognitive strategies, whenever instruction can be invoked to promote students' ability to cope with complex learning environments.

The Teacher

Dutch research into the role of the teacher in technology enhanced learning environments relates to the various roles of novice and experienced teachers (De Laat, Lally, Lipponen, & Simons, 2007) , the relevant expertise of Dutch teachers (Smeets, 2005) and the development of authoring tools for teachers (De Jong et al., 1998; Fisser & De Boer, 1999).

De Laat, Lally, Lipponen, and Simons (2007) studied the behavior of an experienced and a novice teacher in a networked learning community with mid-career professionals working on their Masters in Education. The students participated in five on-line workshops during a period of two years aimed at establishing a research learning community. The teachers tried to coach and support the groups, carefully seeking a balance between too much control and too much freedom. The experienced teacher allowed the group to gradually create a mode of collaboration which was in tune with the group's character. The teacher made use of advance organizers to create a zone of proximal development for the group. This teacher was successful in providing appropriate scaffolding and fading tuned to the development of the group. The novice teacher was insecure about her role and did not consider herself able to cope with the complex technology enhanced learning environment. She did not anticipate the specific needs of the learning group. The project showed that the role of the teacher in establishing a virtual learning community is very important and demanding, requiring specific teaching and pedagogic skills.

Smeets (2005) asked more than 300 upper primary school teachers about their pedagogical views in relation to the use of ICT in education. Although more than 70% of the teachers regularly or often paid special attention to information handling skills, discussed recent events during the lessons, or referred to the application of acquired knowledge and skills outside the school, and 93% of the teachers reported that they did apply ICT in their classrooms, the use was in general restricted to skill-based applications, which matched traditional views on teaching and learning. In this way, existing pedagogical practices were confirmed, not changed. Smeets (2005) advocated fostering the awareness and skills of teachers with respect of the use of ICT to enhance learning environments.

De Jong et al. (1998) developed an authoring tool for designing and creating simulation-based learning environments, SimQuest. Finding a proper balance between guiding students in the process of discovery learning and providing them with enough tools to regulate their own learning process was an important aim of the design. Teachers can prepare various types of assignments to guide the students. Students are asked to explore or investigate a simulation, to formulate rules or predict phenomena, or to optimize a certain process. The actual characteristics of the learning environment are determined by a set of rules, based on students' behavior and their preferences. One of the problems the authors have experienced during the process of implementing SimQuest is students' general tendency to follow the assignments without developing an independent and self-regulated way of discovery learning. Because feedback is connected to assignments students need complete assignments in order to receive feedback on their work. Since then, the authors have been developing feedback procedures which can be used to coach students during free exploration of the environment.

Fisser and De Boer (1999) developed a decision support tool for university teachers to re-design courses and curricula on the basis of the seven principles of good education, as proposed by Chickering and Gamsom (1987). Good education encourages contacts between students and faculty, develops reciprocity and co-operation among students, uses active learning techniques, gives prompt feedback,

emphasizes time on task, and communicates high expectations and diverse talents and ways of learning. Fisser and De Boer's (1999) decision support tool comprises three major decisions about the feedback the teacher provides to the student: (1) is the feedback structured or open? (2) Is the focus of the feedback the process or product of learning? (3) What is the extent of the feedback (short, long)? Teachers are able to use the instrument on-line and can compare their choices with those of other teachers.

Both De Laat, Lally, Lipponen, and Simons (2007) and De Jong et al. (1998) emphasized the importance for teachers to find a proper balance between guidance and support. The fact that De Jong et al. (1998) found that students tend to rely on assignments makes the task of finding the balance even more crucial. Too much guidance makes students dependend, too much freedom prevents the students from making progress. This balance problem is not new, but the introduction of technology in the learning environment makes the dilemma more articulate (see also Karassavvidis, Pieters, & Plomp, 2003). The balance problem pertains to both the level of cognitive operations and self-regulative control. Both De Jong et al., (1998) and Fisser and De Boer (1999) offered guidelines for teachers to structure the technology enhanced learning environment in accordance with their teaching strategy. Smeets' (2005) rather alarming findings that there exists a large gap between Dutch primary school teachers' views on learning and their ability to give concrete form to these views in computer supported learning environments underlines the need to both train teachers and provide them with on-line authoring tools to establish an efficient and effective technology enhanced learning environment.

The Learning Environment

Although the learning environment as a domain of study encompasses a rather wide scope of potentially interesting research questions, two issues stand out in our sample of Dutch studies into fostering self-regulated learning in technology enhanced learning environments. The first issue is complexity. Martens, Bastiaens, and Gulikers (2002) questioned the need for authenticity in technology enhanced learning environments. Karassavvidis, Pieters, and Plomp (2003) compared a traditional environment with a technology enhanced learning environment. Van der Meij (2000) studied the effects of various arrangements of text and images in a computer supported learning environment. De Vries, Van der Meij, & Lazonder (2007) provided a portal as a restricted set of websites to help children to localize information. De Jong and Van der Hulst (2002) manipulated the representation of the content of a hypertext in order to reduce complexity. Van Drie, Van Boxtel, Jaspers, and Kanselaar (2005) provided various tools to represent historical arguments. Task complexity caused a high cognitive load. Manlove, Lazonder, & De Jong (2009) observed that lack of domain knowledge prevented high school students to benefit from regulative support in a simulation-based learning environment. Akkerman, Admiraal and Huizenga (2009) used computers and cell phones to enable secondary school students to play an authentic history game in the historical center of Amsterdam. The complex real life environment of downtown

Amsterdam both enhanced the narrative force of the game and increased the cognitive load of the game. Van Gog, Paas, and Van Merrienboer (2004) argued that the transfer value of worked examples could be enhanced by adding explanations.

The second issue is interactivity, the extent to which the technology enhanced learning environment can be adapted to students' learning processes. Swaak, De Jong, and Van Joolingen (2004) compared the effects of providing assignments versus providing learning tools. Veermans, De Jong, and Van Joolingen (2000) designed computer generated feedback procedures to support discovery learning in a technology enhanced learning environment. Kester and Kirschner (2009) studied the effects of fading conceptual and strategic support to studying a hypertext document in a distance learning course.

Martens, Bastiaens, and Gulikers (2002) studied competency based computer supported learning environments (CCLEs). The authors varied the degree of authenticity of the learning environments. Psychology students had to discover why in a transport company so many bus drivers often fall ill. Three versions of the environment were compared: an authentic version with full learner control, a text-only version, and an authentic version with restricted learner control. Students' reports were evaluated. They also completed a knowledge test and a questionnaire about the experienced authenticity and clarity of the learning environment. The text-only version turned out to produce the best learning outcomes. Moreover, students did not perceive the authentic learning environments as more authentic or more motivating than the text-only version. The authors concluded that high expectations of the authentic learning environments were not corroborated by the learning outcomes. However, the authors did not advocate a restoration of traditional principles of instruction. Rather, they suggested to further explore the nature of student motivation in learning environments.

In perhaps one of the most explicit studies into self-regulated learning in technology enhanced learning environments of this review, Manlove, Lazonder and De Jong (2009) devised a so-called Process Coordinator (PC+) to provide regulative support to upper secondary students inquiring a fluid dynamics problem in a simulation environment called Co-Lab. PC+ provided a goal tree or a representation of goals in an inquiry cycle. This feature was heavily and successfully used by the students. Monitoring tools like a note pad, question prompts, timed cues and hints did not improve students' inquiry behavior. A lab report template clearly helped students to report and evaluate the outcomes of their inquiry. The authors emphasized the influence of domain related knowledge and experience on the efficacy of the regulative tools in PC+. Students were reported to have ample experience with lab experiments which made the goal tree instrument for planning useful. However, due to lack of knowledge about fluid dynamics they could not take advantage of the monitoring tool which was embedded in the problem space. In line with Moreno and Mayer (1999) the authors suggested to pretrain student on subject matter knowledge and skills before admitting them to complex simulation based learning environment.

Studying the effects of authenticity on the motivation of secondary school students was one of the aims of the FM1550 Project, in which students explored

the medieval center of Amsterdam and enacted various historical events. Field teams were guided by colleagues in the headquarters of the game. Akkerman, Admiraal and Huizenga (2009) collected data about the extent to which authentic context contributed to the acquisition of history knowledge and understanding and to the motivation of the students. The authors observed that the field teams were less able to grasp the story line and, consequently, focused on the practical issues related to locating assignment spots in the city, communicating through cell phones and recording video sequences. Students working the headquarters of the game were better able to create a narrative organization of all game elements representing the historical context of medieval Amsterdam.

A fine-grained analysis of teaching and learning protocols in a computer supported and a paper and pencil learning environment was conducted by Karassavvidis, Pieters, and Plomp (2003). Participants were two groups of 10 15 years-old secondary school students. They learned to solve correlational problems in the domain of geography, either with paper and pencil or by using a spreadsheet program. All lessons were videotaped, transcribed and analyzed. The most important finding was that both the teacher and the students set more explicit goals in the computer supported environment than in the paper and pencil environment. The authors attributed this difference to the increased opportunities for making task relevant decisions which a computer supported environment offers.

Van der Meij (2000) carefully compared three design formats for software documentation. The manuals differed on the use of full screen versus partial screen images, and on the layout of the text: a two-column layout, in which instructions were located either in the left column and images in the right column, or a layout with images in the left column and instructions in the right column. Participants were 48 inexperienced adult users. Participants read the manual, carried out the assignments, and were tested afterwards. The use of full screen images (instead of partial screen images) which were located in the right column of the page (instead of in the left column) produced shortest training times and best retention outcomes. The author interpreted the results in terms of cognitive load theory (Sweller, 1994; Van Merrienboer, Kirschner, & Kester, 2003).

De Vries, Van der Meij, & Lazonder (2007) developed a portal with a small set of websites to help children aged ten to twelve to find answers to particular questions as part of a writing assignment. In order to be an effective tool, the arrangement and presentation of the links was crucial. A simple listing of sites in two categories did not suffice. A hierarchical presentation together with short descriptions of the information in a particular website did help the children to localize information which contained an answer to their question.

The often documented "lost in hyperspace" phenomenon was tackled by De Jong and Van der Hulst (2002). They created a "visual" layout of a hypertext on fuel supply systems, in which the basic structure of the domain was presented in such a way that learners were "unobtrusively encouraged" to follow a predesigned path through the text. Left-to-right ordering of nodes indicated either a temporal or a causal relationship between the nodes. Vertical ordering indicated specification relationships, in which lower nodes specified upper nodes. This layout was compared with two random arrangements of nodes. In the hints condition

highlighting was used to indicate a proper reading path through the text. In the control condition, no help was offered at all, student simply received the random layout of the nodes in the text. Assignments were completed by 46 first year undergraduate psychology students. After having been trained students worked in the experimental hypertext environment and received three posttests: a propositional test which assessed the relations between the concepts, a definitional test which tapped knowledge of the individual nodes, and a configural test which measured the extent to which students had grasped the structure of the text. The data showed that students in the enriched conditions used the information provided and followed the paths which were suggested by the layout of the overview. There were no differences in exploration routes between students in both enriched conditions, but only in the visual condition did students produce a significantly better representation of the structure of the text and better knowledge of the propositional relations between the nodes than students in the control condition. As expected, there were no differences in knowledge of the individual nodes between the three conditions. De Jong and Van der Hulst (2002) concluded that presenting an overview of a hypertext which displays the relationships between nodes adds important informant to the content of the text, from which readers take advantage.

Van Drie, Van Boxtel, Jaspers, and Kanselaar (2005) compared three representational formats in a CSCL environment, in which 65 pairs of secondary school students had to complete a historical writing assignment. The participants had to collect information from textbooks, photos, views of historians, tables, and interviews and had to prepare a 1000 words essay on the issue whether the changes in the behavior of Dutch youth in the nineteen sixties were revolutionary or not. The pairs worked in separate rooms and had to communicate through the CSCL environment. Three tools were compared: an argumentative diagram, in which students could place and arrange arguments to be included in the essay, a simple linear list of arguments to be used in the essay, or a matrix in which arguments can ordered on various characteristics like the source from which the argument was taken or the domain (e.g., sports, economy, culture) to which the argument belonged. Chat interactions were analyzed, as well as the quality of the constructed representations, the final essay, and the outcomes on an individually taken knowledge test. The various tools facilitated various reasoning structures. Using the matrix produced more interactions about historical changes, whereas the diagram focused students more on the balance of arguments. However, these differences did not result in different essay or leaning outcomes. Students in the matrix condition and students in the control condition (no tools available) spend more interactions on discussing the approach to be taken to carry out the task. The authors attributed this lack of effect on the outcome variables to the cognitive load which the task imposed on the students.

In the domain of cognitive load theory (Sweller, 1994) the worked example effect has often been reported: novice student learn more from studying worked examples than from solving problems, because of the heavy cognitive load of solving these problems. Van Gog, Paas, and Van Merrienboer (2004) argued that worked examples might function better when they are accompanied by an

explanation which clarifies why and how the steps to solve the problem were taken.

The question whether inquiry learning in a simulation learning environment leads to quantitatively and qualitative better learning outcomes than expository instruction in a hypertext environment was studied by Swaak, De Jong and Van Joolingen (2004). They tested the performance on various posttests by 112 16-17 years old secondary school participants preparing for university education. Participants were randomly assigned to either a simulation environment or a hypertext environment. Both environments contained a considerable number of assignments. The hypertext environment led to better learning outcomes than the simulation environment in terms of knowledge of definitions and relations between concepts. It turned out that participants in both conditions closely followed the assignments without using the facilities for self-regulated learning. The authors concluded that simulation based learning environments should only be developed and implemented when they provide clear advantages to the students, when the domains are really complex, and when students receive considerable amount of freedom to explore and self-regulate their learning process.

Veermans, De Jong, and Van Joolingen (2000) compared two methods of providing computer-generated feedback in a simulation-based discovery environment. The first method was based on the current hypothesis of the learner and the current experiment in which the hypothesis was put to the test. According to the second method, students received predefined feedback on the basis of the student's hypothesis, without taking the student's experiment into account. Secondary school students, 15 to 16 years of age, experimented in a simulation environment on collisions. Students' experimenting behavior was recorded, as well as their performance on various knowledge tests. Both groups performed equally on the posttest. However, participants who received feedback according to the first method developed a more inquiry-based learning strategy than students who received predefined feedback. The authors conclude that relating hypotheses to experiments is a powerful form of feedback which fosters the development of inquiry skills, rather than encouraging students to complete given assignments.

In a distance course on instructional design Kester and Kirschner (2009) presented a hypertext document to 41 adult students, together with conceptual support in the form of concept map, and strategic support with the help of a flow chart displaying the main steps to be taken and heuristic advice on each of the steps. In the fading condition, the concept map was tuned to the particular problem students had to solve, whereas the heuristic advice was gradually removed from the strategic flow chart. Students benefited from fading, navigation accuracy increased under fading conditions. However, task performance did not improve. The authors contended that students did not invest enough time and effort to complete the assignment.

Dutch research into complexity in technology enhanced learning environments showed that complexity as such does not exist. Rather, complexity is related to the student’s level of expertise or available self-regulation and/or cognitive strategies. As Martens, Bastiaens, and Gulikers (2002) and Akkerman, Admiraal, and Huizenga (2009) showed, authenticity is not always functional. Again, the level of

expertise of the student determines the educational value of authenticity. Novice learners should be supported by worked examples, as Van Gog, Paas, and Van Merrienboer (2004) underlined. In general, complexity should be tuned to the level of expertise of the learner. Studies into the characteristics of interactivity in simulation based learning environments showed that feedback should be based upon both the student's hypotheses and his or her experiments (Veermans, De Jong, & Van Joolingen, 2000). A similar conclusion was drawn by Kester and Kirschner (2009): conceptual and strategic support during a hypertext studying task should be faded along with increasing experience with the task.

The Community of Learners

We have collected five studies under the heading of community of learners, because in these studies the relationships between students in a technology enhanced learning environment played an important role. To a certain extent, the factors highlighted above, the learner, the teacher, and the learning environment, all return in research into the community of learners. Apart from De Laat and Lally (2004), who developed an analysis tool for studying group dynamic processes, all studies reported technological enhancements of a learning environment to foster the work of a community of learners. Van Eijl, Pilot, De Voogd, and Thoolen (2002) paid attention to the learner's preferences, Janssen, Erkens, Kanselaar, and Jaspers (2007) studied a particular learning tool in an environment for collaborative learning, and Saab, Van Joolingen, Van Hout-Wolters (2007) focused on the effect of providing guidelines to foster collaboration, and Kirschner, Beers, Boshuizen, and Gijselaers (2008) instructed teams of three students to elaborate on individual contributions to the solution of a common problem.

De Laat and Lally (2004) asked mid-career professionals, working on their masters in education, to join asynchronous Networked Learning discussions, and applied content analysis to the recorded interactions to explore emergent role development and group awareness processes. Three individual student participants were interviewed to analyze critical events, a "task-focused completer/finisher", a "group-focused facilitator", and a "task-focused ideas contributor". The authors concluded that their methods of observing and analyzing role development and group awareness processes has helped them to understand the processes of teaching and learning of professionals in a community.

Van Eijl, Pilot, De Voogd, and Thoolen (2002) asked university students, enrolled in a course on 19th century English literature how they preferred to work in the course's electronic learning environment: alone or in groups of two to four students. High achieving students preferred to work in groups. Collaborating students benefited from group work.

Janssen, Erkens, Kanselaar, and Jaspers (2007) developed a software tool to visualize participation in a computer supported collaborative learning environment. Each participant was represented by a sphere, connected to a central circle, the size of which reflected the length of the messages sent by the group. The distance between a sphere and the central circle was an indicator of the number of messages sent by the participant. The tool was actively used by small groups (3 or 4

students) of 16 years old secondary school students in a collaborative learning task. Groups in which the tool was available more actively engaged in collaborative work and issued many planning messages through which the social activities of the group were coordinated and regulated. Although the group awareness and the quality of the group product were not higher in the experimental group as compared with the control group, the authors concluded that visualization of participation can contribute to successful CSCL.

Saab, Van Joolingen, and Van Hout-Wolters (2007) developed an instruction for students working in a technology enhanced collaborative learning environment. Four rules were included in the instruction: respect ("everyone will have a chance to talk", "everyone's ideas will be thoroughly considered"), intelligent collaboration ("sharing all relevant information and suggestions", "clarify the information given", "explain the answers given", "give criticisms"), deciding together ("explicit and joint agreement will precede decisions and actions", "accepting that the group, rather than the individual, is responsible for decisions and actions"), and encouraging ("ask for explanations", ask until you understand", "give positive feedback"). Pairs of 76 tenth grade secondary school students (age 15 - 17) were randomly assigned to either an instruction or a control condition. The students had to discover the rules behind a simulation about collisions, implemented in SimQuest (De Jong et al., 1998). The instruction improved the quality of communication (describing and recognizing relations), discovery activities (drawing conclusions) and regulative interaction between the pairs, but the learning outcomes of instruction group and control group did not differ.

In a series of four experiments, Kirschner, Beers, Boshuizen and Gijselaers (2008) tested a script which forced three participants in a group problem solving assignment to contribute to the common discussion platform and to discuss all contributions before deciding on the acceptance of the contribution as a step in the process of solving the problem. Not surprisingly, the stricter the protocol, the more contributions each participant posted to the discussion platform. This more intense collaboration improved the common ground at which the problem solving group arrived. The authors concluded that coercion helps a community of learners to increase goal-directed interactions.

The studies on collaboration in a technology enhanced learning environment showed that not all students equally prefer to work in a collaborative learning environment (De Laat & Lally, 2004). Therefore, freedom of choice is appreciated by students and may in fact add to the beneficial effect of computer supported collaborative learning environments. Collaboration can be actively fostered by providing tools and or guidelines. The good news is that the quality of the collaborative processes increases. The disappointing news is that these process-oriented measures do not always enhance learning outcomes.

DISCUSSION

Recent Dutch research into self-regulated learning in technology enhanced learning environments has disclosed important relationships between the arrangement of the learning environment, the learning process and the learning outcomes. The

conclusions can be arranged under four key characteristics of technology enhanced learning environments: complexity, interactivity, articulation, and balance. Although self-regulated learning is in many studies not explicitly mentioned, the issue is often inexplicitly addressed or implied.

Complexity

The complexity of technology enhanced learning environments is both an advantage and a potential threat to successful learning. The advantage has to do with the possibility to create authentic contexts which resemble the real life situations for which we educate our students. Authentic conditions may foster students' intrinsic motivation to learn. Various studies explored authentic and complex technology enhanced learning environments, not only simulation based learning environments (Swaak, De Jong, & Van Joolingen, 2004; Manlove, Lazonder, & De Jong, 2009; Saab, Van Joolingen, & Simons, 2007) but also authentic learning tasks (Martens, Bastiaens, & Gulikers, 2002; Akkerman, Admiraal, & Huizenga, 2009). These studies highlighted the threats of complex environments. They may create a cognitive overload preventing the student from using the tools provided or from any learning whatsoever.

As explained above, complexity as such does not exist. The concept of cognitive load relates the objective complexity of the learning environment to the learner's perceived complexity. Reducing the cognitive load of the learning environment enables the student to focus on the learning process by deploying and further developing self-regulation skills (Martens, Bastiaens, & Gulikers, 2002; Van der Meij, 2000; Van Gog, Paas, & Van Merrienboer, 2004).

Interactivity

Increasing the interactivity of the learning environment by means of technological support is a successful way to foster learning processes (Karassavvidis, Pieters, & Plomp, 2003; Swaak, De Jong & Van Joolingen, 2004). However, time and again it has been shown that fostering learning processes does not necessarily lead to improved learning outcomes (Martens, Gulikers, & Bastiaens, 2004; De Jong et al., 1998; Van Drie, Van Boxtel, Jaspers, & Kanselaar, 2005; Swaak, De Jong, & Van Joolingen, 2004; Veermans, De Jong, & Van Joolingen, 2006).

Articulation

An important beneficial effect of technology enhanced learning environment is that often the structure of the learning task and the learning process is made transparent by visual tools. This was illustrated in two recent studies on collaboration between students in a Community of Learners (Janssen, Erkens, Kanselaar, and Jaspers, 2007; Saab, Van Joolingen, & Van Hout-Wolters, 2007). As Van Drie, Van Boxtel, Jaspers, and Kanselaar (2005) and De Jong and Van der Hulst (2002) made clear, various visual tools have various effects on the learning process, but the

articulation characteristic is itself an important asset of technology enhanced learning environments, fostering both learning processes and regulative behavior.

Balance

Too much structure in the technology enhanced learning environment creates dependent learning behavior (De Laat, Lally, Lipponen, & Simons, 2007; De Jong, et al., 1998; Fisser & De Boer, 1999; Swaak, De Jong, & Van Joolingen, 2004; Kirschner, Beers, Boshuizen, & Gijselaers, 2008). Therefore, teachers play an indispensable role in technology enhanced learning environment. They should develop and apply a powerful repertoire of design and support strategies to enrich the learning environment with both technological tools and personal support and feedback (De Laat, Lally, Lipponen, Simons, 2007; Smeets, 2005; De Jong, et al., 1998; Fisser & De Boer, 1999). The principal role of teachers in a technology enriched learning environment is establishing a balance between structure and freedom to learn in self-regulated way.

In many ways students display different learner characteristics. In the studies reported here, we have encountered differences in search skills (Lazonder, 2000), in domain-specific knowledge (Prins, Veenman, & Elshout, 2006), in motivation (Martens, Gulikers, & Bastiaens, 2004; Rienties, Tempelaar, Van den Bossche, Gijselaers, & Segers, 2009), in metacognitive skillfulness and in intelligence (Veenman, Wilhelm, & Beishuizen, 2004). The existence of technological support creates opportunities for adapting the learning environment to learner differences, both in complexity (De Vries, Van der Meij, & Lazonder, 2007) and in interactivity. Moreover, by adapting instruction in a technology enhanced learning environment to varying learner characteristics, a proper balance may be found between structure and freedom to learn in a self-regulated way (Martens, Gulikers, & Bastiaens, 2004; Van Eijl, Pilot, De Voogd, & Thoolen, 2002; Veermans, De Jong, & Van Joolingen, 2006; Kester & Kirschner, 2009).

The study by Manlove, Lazonder, and De Jong (2009) may serve as a basis for a general conclusion regarding the gearing of regulative support to students' expertise and experience in a technology enhanced learning environment. First, regulation tools are used to the extent that students recognize the value of the tool. Recognition is based on a match the strategic basis of the tool and the strategic approach of the student. Secondly, because cognitive load is a serious problem in many technology enhanced learning environments, students should be pretrained and prepared as much as possible in order to enable them to take full advantage of the enhanced learning environment.

Together, the studies reported in this paper provide a realistic evidence based account of the effects of technology enhanced learning environments. Teachers, learning tools and appropriate assignments all help to improve the quality of learning and self-regulation. Further research is necessary to explore the relationship between quality of learning and self-regulation on the one hand and learning outcomes on the other.

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TECHNOLOGICAL TOOLS TO SUPPORT SELF-REGULATED LEARNING

INTRODUCTION

This chapter presents a short review of technological tools that can support Self-Regulated Learning (SRL). This review is mainly related to research projects that were conducted in France, in the domain of "Technology Enhanced Learning Environments".

The concept of Self-Regulated Learning is not very used as such in France. However, it should be noted that research has been conducted on related concepts including self-directed learning (e.g. Portine, 1998; Albero, 2000, 2003; Linard, 2003) or metacognition (Noury et al, 2007). Several disciplines are involved: Psychology, Sociology, Computer Science, Artificial Intelligence and Education (AIED), etc. These disciplines are not always connected, but the necessity of adopting a multi-disciplinary approach is often stressed. Many practical studies can also be found in the field of ICT for education. Consequently, a quite large corpus of work related to SRL could be considered even when limited to Technology Enhanced Learning Environments (TELEs).

Our concern is not here to be exhaustive but to give an insight of research work about SRL in TELEs from our point of view, which is grounded in Computer Science and Learning environments for education. We will focus on technological facilities that can foster SRL. Influenced by Boullier (2001), we consider technical and pedagogical choices to be closely related. In the following, we first present some technological tools and environments that have the potential to support SRL, either when used in isolation, or in collaboration, particularly within the context of open and distance learning. We will then focus on recent work on activity tracing and interaction analysis that provides metacognitive support, and finally we describe a study that evaluated the potential of a TELE within the framework of the Telepeers project (Steffens 2006).

TOOLS AND ENVIRONMENTS FOR SUPPORTING SRL

In France, formal learning still often involves the presence of a teacher or a tutor in the environment. SRL is seen as reserved to a small proportion of students in higher education. Even within Information and Communication Technologies

R. Carneiro et al. (eds.), Self-Regulated Learning in Technology Enhanced Learning Environments, 123–132.

(ICT) the role of the tutor is often stressed. However, priorities are changing with the need for life-long learning and with the development of open and distance learning courses. A higher degree of autonomy is required from the learners, and this often leads to difficulties or failures.

Many propositions were made to address this problem. From a technological perspective, a range of tools were proposed to help the tutor track the progress and activity of the learner. These tools provide indicators that can be helpful to enhance the learners' autonomy and their self-regulation. In collaborative environments, 'dashboards' can be used to facilitate awareness among learners. Structured forums can also contribute to supporting SRL. Another option is to provide learners with a 'learning memory' (i.e. a computer-based memory of their activity). This kind of memory can contain personal information added by the learner as well as objectives to learn; it relies on a model of the learning domain, and more generally it can be an image of the learning organisation.

In the following, we describe some research projects related to these four directions: progress indicators, awareness tools, structuring of forums and learning memories.

Progress indicators

Learning Management Systems (LMS) usually include learner follow-up functionalities regarding consultation and access to pages. They can provide indicators such as: connection time, types of consulted or downloaded documents, number of exchanged messages, etc. All of these indicators do not constitute collectively a pertinent view of the learner progress. In order to address this problem, Després and Coffinet (2004) proposed a tool, called 'Reflet', which intends to visualise learner progress in open and distant learning courses. This tool is based on the Module, Activity, Task model (MAT), which has a tree structure: a module comprises sub-modules and activities, and an activity comprises tasks. The learner must indicate when a task is completed and the tool calculates a percentage for achievement in the activities and modules. An informal experiment showed that this kind of tool can be useful for students. It has been integrated into the WebCT learning management system and would be easily integrated into other LMS. However, this tool is quite simple and the authors mention in the paper that, influenced by Dourish and Belloti (1992), they plan to design a dashboard in order to foster awareness in collaborative situations.

Awareness Tools

Temperman, Depover and Delievre (2007) from the University of Mons-Hainaut, Belgium, propose such a dashboard and analyse its usage in a collaborative distance learning environment. The dashboard is based on the history of learners' activity. Learners can visualise their progress by means of a double-entry table. Each cell of the table is associated with one learner and one activity of the pedagogical scenario. A row provides information about the progress of a learner (or group of learners), and a column reports the progress of an activity for all learners. In this environment, Temperman et al study two variables: the first

variable is related to the application of a procedure inciting learners to access the awareness tool (the table); the second variable represents the type of planning and involves three possible values: imposed planning, negotiated planning or no planning.

The study reveals that the awareness tool is used more frequently in the first part of the training in order to coordinate individual tasks and prepare collaborative tasks. It is useful to provide the learners with a global view of the learning progress in the training environment. There exists compensation between the two variables: the dashboard is more useful in non-planned activities, however forcing or negotiating an initial agenda helps the students to build their own point-of-reference and, in this way, to establish a greater awareness of the work to achieve.

Structuring forums

George (2006) studied context-aware computer-mediated communication for distance learning systems. He relates his work to the paradigm of 'Cognitively Informed Systems', which defines systems that utilise, as a basis for their design, some form of cognitive findings to enhance the effectiveness of the systems in achieving their goals. He argues that linking deeply communication to learning activities offers an interesting approach to develop the efficiency of systems in facilitating the emergence of learners' communities. Indeed, in a socio-constructivist approach (Doise & Mugny, 1984), interactions between learners play a dynamic role regarding individual learning. George advances the idea of contextual display of forum messages. He proposes a forum model, named CONFOR (CONtextual FORum), including two ways for contextualisation. The first one is based on structuring forums according to the on-line course structure. The second one takes into account the cognitive structure of the course. The result is a discussion tool which displays to the learner an 'activity topic' and several 'knowledge topics' linked to the current learning resource. By helping to monitor and regulate the learning process, these tools support metacognition and SRL.

Learning memories

Learning memories can be used to support SRL by helping students to remember work they have completed, and plan what they will do next (Azouaou et al, 2003). They can also be used to store documents and resources that are potentially useful for a given course. In order for these resources to be usable, they must be structured as it is unlikely that access to unstructured resources would lead to efficient learning, even if the student possessed SRL abilities. In the MEMORAe project (Abel et al 2006), the structuring of resources is based on two ontologies: the first one contains general concepts relative to learning; the second one contains the learning objectives of a specific course. Facilitated by this approach, students can index resources by the concepts of the two ontologies and access these resources by notion. Notions are organised in a graph that is presented to students. They can access the resources via this graph (Figure 1).

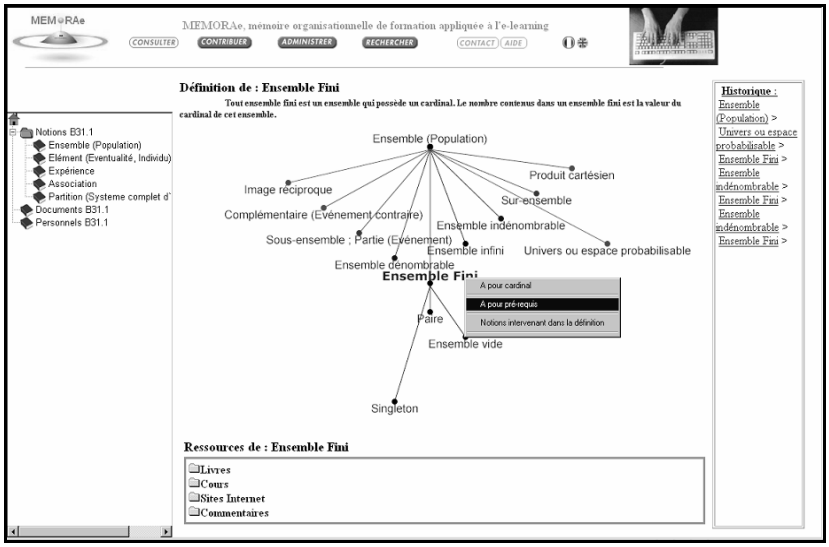

Figure 1: *Navigation in the memory*

In MEMORAe, a course or a training unit is considered as being an organisation. Indeed, a course involves actors (learners, trainers, course designers, administrators, etc.), uses resources of different types (definitions, exercises, case studies, etc.) and different forms (reports, books, web sites, etc.), and is intended to provide knowledge and skills. Following a knowledge engineering approach, the resources and knowledge of this particular organisation are managed by means of a 'learning organisational memory' based on ontologies. Learners as well as teachers have access to this memory, which is different from a classical organisational memory (used in the domain of knowledge management) because its goal is to provide users with content, specifically, pedagogical content. This content is the result of the capitalisation of knowledge, information and resources relating to the training or course unit.

A prototype of TELE relying on this approach has been developed for a course on applied mathematics at the University of Picardy. The general principle is to provide the learner with either accurate information regarding the information (s)he is searching for, or with graphically displayed links that permit to the learner to continue to navigate within the memory. (S)he has no need to use the keyboard in order to formulate a request, although the environment supports this if preferred.

The user interface (Figure 1) offers:

– Entry points: located on the left of the screen, these allow the user to start the navigation with a given concept. An entry point provides a direct access to a concept of the memory and consequently to the part of the memory dedicated to notions. The course leader must define the notions that are considered as essential.

– Resources: located at the bottom of the screen, the contents of the resources are related to the current concept and are ordered by type (books, course notes, sites, examples, comments, etc.). Starting from a notion, an entry point or a notion accessed by the means of the ontology, the user can directly access the associated resources. Descriptions of these resources help the user choose appropriate resources to use.
– A short definition of the current notion: this provides the learner with a preview of the notion thus aids their decision making process.
– A history of the navigation: This reminds, and promotes awareness in the learner of the path they followed before. Of course, they can return to a previously studied notion if required.
– Last but not least, the part of the ontology describing the current resource is displayed at the centre of the screen.

Navigating among notions is not only hierarchical; it can also be 'horizontal' for instance when following links such as 'is-a-prerequisite-of' or 'suggests' (Figure 2).

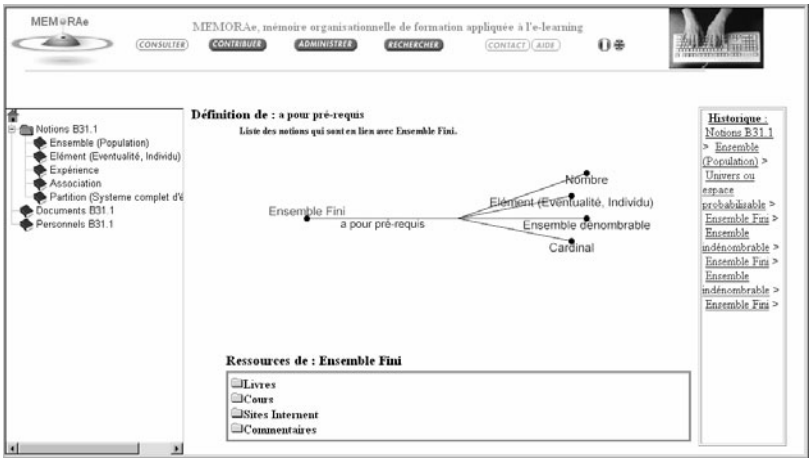

Figure 2: *Horizontal navigation*

This work is now continued through the extension of this environment within web 2.0 capabilities. A new TELE, named E-MEMORAe2.0, has been developed on the basis of the first one. This one enhances social aspects by enabling learners to work independently, as part of a group, or at the course level, and allows communication resources, such as forums to be structured using the concepts of each ontology.

The environment seems to have interesting features to support SRL. Students can choose their entry points into the domain and are can augment a notion thanks to the various documents contained in the memory. Students can reflect on their progress using the navigation history and can realise new ideas using the graphical

representation of the domain ontology. A first experience with students in the context of the applied mathematics course at the University of Picardie has confirmed these potentialities for SRL. However, more focussed experiments still need to be done.

ACTIVITY TRACING AND INTERACTION ANALYSIS

In this section we pay special attention to new directions that have recently emerged in order to personalise learning environments: interaction analysis and learners' activity tracing. These two approaches can both be pertinent for supporting SRL.

Interaction Analysis for Metacognitive Support and Diagnosis

Dimitracopoulou (2004) developed this theme in collaboration with other European researchers in two work packages of the Kaleidoscope network of excellence. The study focuses on interactions that occur via TELEs designed for both stand alone and collaborative use. Special emphasis is given to interactions analysis outputs that could support the learning activities of participants engaged in cognitive and metacognitive reflection and thus in self-regulatory operations. Additionally, the analysis pays particular attention to enriched learning environments and contexts designed or used under constructivist and socio-constructivist theoretical considerations, implying multidimensional and complex interactions.

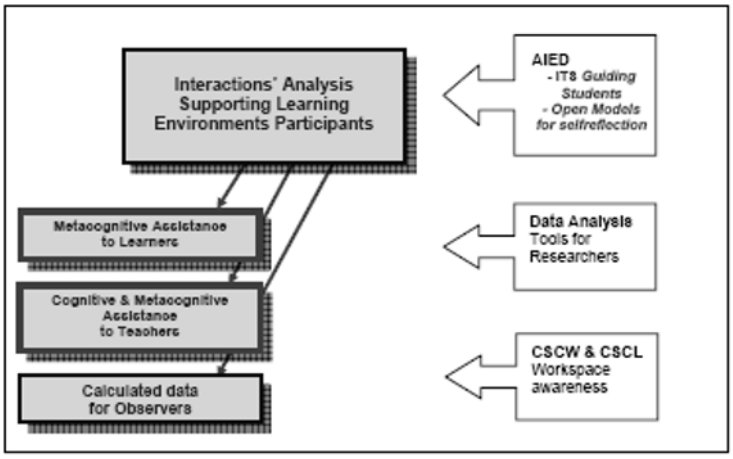

Figure 3: *Interaction Analysis source fields and SRL field (Dimitracopoulou, 2004)*

The interaction analysis results were shown to the participants of the learning activities and displayed in an appropriate format (usually graphical, but also numerical or literal).

It is argued that the corresponding information provides an insight into their current or previous activity, allowing reflection at a metacognitive level, which encourages and supports the acquisition of self-regulating strategies which can be applied to their activities. A link between interaction analysis source fields and SRL is proposed (Figure3).

In the same way, Dimitracopoulou and Bruillard (2006) present several indicators related to cognitive, social and affective dimensions that are used to inform discussion forums users.

Learners' Activity Tracing

Learners' activity tracing is presently a major concern for research on TELEs in France. A summer school has been organised on this theme in 2007. Activity tracing is primarily aimed at helping experimental research or personalisation of TELEs (Settouti et a1 2006). It can also help to facilitate the activity of learners. Lund and Mille (2009) think that self-appropriating TELEs is mandatory for learners, both to understand the computer environment and to learn what they are supposed to learn. They consider interaction traces as potential sources for facilitating self-understanding of both environment and lessons. Appropriation is believed to be linked to the Vygotskian process of self-development.

They define 'traces' as information sequences inscribed by, or in, the environment, linked to the way a learner has used this environment. Lund and Mille argue that raw information collected by the environment is not sufficient. The TELE has to offer tools associated to interaction traces in order to facilitate users' activity. In particular it would be useful to offer the learners:

– Feedback on their interaction history in real time, relying on 'viewpoints;' which could lead to reflection on their activity and associated human development processes.
– The means to get a clearer view of what they are doing by exploiting their traces,
– The means to compare their traces with past traces or with other learners traces, in order to augment and negotiate a common understanding.

ASSESSMENT OF TELES THAT PROVIDE SRL SUPPORT

In the context of the TELEPEERS project (http://www.lmi.ub.es/telepeers) which was aimed at identifying the potential support to SRL provided by TELEs, Trigano (2006) reports an experience at the University of Technology of Compiegne, a partner of the project. The experience is related to an environment on Algorithms and Programming. The TELE's potential to foster SRL was analysed by means of two evaluation tools (questionnaires) developed during the TELEPEERS project: TELE-SRL for teachers and TELESTUDENTS-SRL for students. The TELE-SRL is devoted to teachers and/or SRL experts for an *a priori* evaluation of the TELE's potential, while the TELESTUDENTS-SRL is addressed to the TELE's users and allows an *a posteriori* assessment of the tool and its use.

The goal of the study was to establish whether a course comprising SRL aspects confers better results than traditional teaching. The course, entitled, 'Introduction

to Algorithms and Programming', was taught during the 2004 fall semester and the 2005 spring semester at the University of Technology of Compiègne using different pedagogical methods. In the first condition, SRL was firmly encouraged by various means; in the second condition the pedagogy was more traditional. In both conditions, students had access to a website that included many resources: simulation, exercises, quizzes, electronic notes, links to other notes, etc.

In accordance with other participants of the TELEPEERS project, four dimensions were evaluated: cognitive, motivational, social and emotional aspects. Below are some features of the TELE relating to these four dimensions that have been positively received by learners:

Cognitive aspects

– freedom to switch to a new learning strategy if necessary
– feedback about the extent to which the student is achieving their learning goals
– the possibility to choose which skills to self-assess

Motivational aspects

– personalise the user interface
– feedback reminding the student of knowledge and skills relevant to solve tasks is given
– suggestions are made to the student about how problems might be solved
– the student's confidence in his or her own abilities is increased

Emotional aspects

– a positive working attitude can be restored at points where the student is active

Social aspects

– the possibility to contact and receive help from the student's tutor/instructor

The results also showed that the same TELE was more appreciated in the first condition (SRL encouraged) than in the second condition (traditional teaching). The study concludes that if technological tools (web sites, hypermedia, LMS etc.) are useful to support SRL, they cannot be used alone. They have to be integrated into pedagogy and need human intervention (tutors, teachers, discussions), and social aspects.

In accordance our statement at the beginning of this review, the role of teachers is again stressed in this study.

CONCLUSION

In this short review which does not pretend to be exhaustive, we have tried to present some technological tools that could enhance SRL. Students' activity traces can be easily captured by the environment, but these traces by themselves are likely to be of no use. They need to be modelled and worked with in order to provide students with images of their activity. Furthermore static images may not be sufficient. Interaction means need also to be defined to allow students to have different perspectives on their activity and on the activity of other students.

We predict that this trend to design tools to support both learners' cognitive and metacognitive activities and also to reflect their motivational and emotional states, either in collaborative or individual situations, will be confirmed in the future. However, it is important to realise that there are few experiments that regard the potential of TELEs to facilitate SRL.

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Part C: SRL in TELEs: Perspectives on future developments

PAUL LEFRERE

TECHNOLOGY ENHANCED LEARNING: SOME IMPRESSIONS

INTRODUCTION

The UK is the main source of the examples used in this chapter. Independence in learning, which has some similarities to SRL, has long been talked about in UK higher education but has had difficulty in getting significant public funding to aid its institutionalization. Despite that lack of funding, the UK has been a pioneer in this area. An example is the 1974-2004 R&D programme of Higher Education for Capability, HEC (Cairns & Stephenson, 2009). Unusually, HEC developed holistic self-capability (meaning for life as well as for work). UK ministries rejected that holistic vision, in favour of a narrow focus and directed their funding to that narrower goal. Trans-European funding (eg via the Framework programme of the European Commission) is now the main source of support for R&D into SRL in TELEs. At the time of writing, only a small number of UK institutions were participating in that R&D. Details of that work are given later.

An obvious question to ask of UK higher education is whether its institutions are engaged in any substantive way in supporting SRL or independence in learning. A subsidiary question is how the UK compares with the US on this matter. Desk research was chosen as a low-cost way to determine this. In 2007-2008, and then on a smaller scale in 2009, the author undertook an informal comparison of the terms used by the web sites of leading UK and US universities to describe their undergraduate courses in science, engineering, education, arts and the humanities. The web sites looked at covered course goals and content; the teaching methods and underpinning theories used in courses; the amount of discretion accorded to students in what and how they would learn; and the nature of "graduateness" (qualities desired in people who have an undergraduate degree). Impressionistically, the US higher education institutions placed more emphasis on longitudinal integration of the learning experiences in an undergraduate programme, culminating in so-called "capstone courses" that went beyond UK project courses in the extent to which students were expected to draw upon all of their previously-studied courses and to use their own discretion in how they did this. The web pages for US capstone courses were noticeably more likely than UK pages to use terms that emphasized self-reliance, for example Self-Regulated Learning, SRL, and Self-Directed Learning, SDL. The UK pages were similar to

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the US pages regarding the proportion of pages that mentioned teaching methods that mixed directive teaching with elements of SRL, e.g. Problem-Based Learning, PBL; Enquiry-Based Learning, EBL; Collaborative Learning; and Inquiry or (Scientific) Discovery Learning.

That brief comparison of UK and US practices provided no evidence that UK university teachers are ignorant of SRL. Quite the reverse, UK university web pages offered a number of courses on learning to learn or on the psychology of learning which mentioned terms associated with SRL (e.g., independent learning; autonomous learning; learning to learn; reflective learning). However, the SRL literature cited in those web pages tended to be classic European and North American work (e.g. Bandura, 1991, 1997; Boekaerts, 1999; Zimmerman, 2000; Boekaerts & Cascallar, 2006), of the type cited in a Kaleidoscope study of SRL (Hulshof, 2005). UK research on SRL in general, as well as SRL in Technology Enhanced Learning Environments, TELEs, has a smaller literature that is cited far less often. Possible causes: that UK research may be less known or less accessible than US or European literature, and/or may be seen as less significant for UK practice, and/or is not the focus of current UK educational research. This would fit with the lack of recent publications specifically on SRL or SRL in TELEs by leading educational researchers in the UK.

No claims are made for the generalisability or validity of the impressions gained from the above web-based comparisons. However, as outlined in the methodology section below, those searches informed the approach of a study that the rest of this chapter is based upon.

For example, to check the extent to which the web searches mapped to practices of academics known to the author, this study began by asking a few personal contacts amongst UK academics, active in research into teaching and learning, about their attitudes to and use of SRL, and the relation of that to their colleagues' and institution's strategy and practice in teaching and in research related to learning. They were also asked if they knew of any external influences on their institution's strategy and practice regarding SRL.

One finding was that respondents typically subscribed personally to the notion that graduates should be able to think for themselves; yet they reported that their own teaching was very directed, as was the teaching of their colleagues. Anecdotally, the institutional pressure to teach in that way has increased in 2009, as a result of tighter funding. Logically, they knew that independence of thought (needed to be an autonomous learner: e.g. Ehiyazaryan & Moore, 2008; or to develop into a researcher: e.g. Jenkins & Healey, 2008) is not easy to achieve if students experience only directed forms of learning. Yet there was a clear disconnect between their espoused view (independence of thought should be encouraged) and their revealed view (students need strong guidance if they are to learn efficiently).

That disconnect seemed to occur partly for managerial reasons: SRL is perceived as likely to require more resources at some stage, for example by requiring university staff to spend more time remedying poor study habits in their students, hence is potentially costly and inefficient, compared to more directed approaches. The latter are seen as more likely than SRL to reduce the cost of teaching each student, and to deliver consistent results across student cohorts,

regardless of who does the teaching (reproducibility is important in quality assurance). The popularity of more-directive approaches with managers reflects economic factors associated with massification of UK higher education (which are beginning to impinge on even top UK universities) and reduces the institutional support for SRL.

As to the apparent lack of interest in researching into SRL, the general UK constraint is that the bulk of external funding for academic research and teaching-oriented research comes from UK funding councils and linked bodies such as the Joint Information Systems Committee, JISC, and the perception is that those bodies favour more-directive approaches over SRL. A similar pattern is apparent in the UK's design, take-up and deployment of TELEs.

Until the recession hit in 2009, the situation in Ireland appeared to be different; there, until 2009 it seemed that universities were still committed to the "graduates should be able to think for themselves" notion (part of what used to be called "graduateness", in the days before massification), and saw this as a way to make Irish graduates more valuable to employers (hence more employable) and to make Ireland more competitive. As a result, SRL was given increasing attention by researchers in Ireland (see e.g. Rainsford & Murphy, 2005; Hall et al., 2007).

BACKGROUND

Earlier studies of aspects of self-regulation (e.g. Hulshof, 2005) set out some of the key literature on SRL, and provided an analytic framework. Thus, regarding the framework, Ton de Jong (2005) says of inquiry or (scientific) discovery learning that "learners more or less take the role of scientists who want to design theory based on empirical observations", with "a fair consensus about which processes basically comprise inquiry learning… orientation", "hypothesis generation", "experimentation", "drawing a conclusion" and "making an evaluation"; "this does not mean that this is necessarily the order in which the processes are carried out by the learner. …De Jong and Njoo (1992) added the concept of regulation of learning, which comprises processes aimed at planning and monitoring the learning process" (de Jong, 2005, p.30).

That study was long enough ago to influence UK policy, yet even now most TELEs used in the UK still do not make explicit provision for that regulation of learning.

METHODOLOGY

Data was gathered in three ways, predominantly during 2007 but with some revisiting in summer 2008 and 2009, to look for any major changes since 2007:

- An impressionistic desk study of education press pieces in the year (newspapers: The Times Higher Education Supplement; The Guardian);
- Informal and impressionistic interviews of a small number of university teachers and researchers in campus-based institutions;

– A desk study of current UK academic interest and practice in SRL, TEL and related areas, as represented by (a) publications by UK researchers; (b) papers accepted by UK editors of journals relevant to TEL and TELEs (primarily the British Journal of Educational Technology); (c) the type and number of SRL-relevant presentations from UK researchers at major conferences on teaching, learning and TEL, such as ALT-C).

KEY FINDINGS

Study 1: impressionistic desk study of newspaper editorials

Negative comments were more common than positive comments, in editorials (including leaders and think pieces) about UK higher education and about the quality of its outputs (their ability to think for themselves, and other attributes of "graduateness" that might be expected to follow from experience of SRL). The editorials were taken at face value (i.e., no attempt was made to verify the claims), and no checks were made to see whether the picture was different prior to 2007/9. The tone of the extract below is typical, in this case claiming that there are systemic weaknesses in UK education, associated with being too didactic:

> This education system fails children by teaching them to parrot, not think… What the top universities are looking for, besides academic performance, is intellectual creativity, a capacity for lateral thought and argument, and a deep knowledge of and enthusiasm for the subject [but, in many schools preparing children to gain the qualifications needed to apply to university, the priority is]… the delivery of the test results and statistics which prove that education is a success. [In today's UK]… what most children learn is that as long as they memorise what they are told for tests, and repeat the key words on the mark schemes in exams, then a questioning approach and wider reading are neither necessary nor welcome [thus...] the experience of a history teacher, in an apparently excellent state school, who finished teaching his 14-year-olds about the first world war on a Tuesday. The following Thursday the class began studying the rise of Nazi Germany, 1933-39. After 20 minutes, one child put her hand up to ask what had happened between 1918 and 1933. "We really don't have the time to go into that now" the teacher said. So they never did.
>
> The limitations of this kind of approach are increasingly being acknowledged by the government's own agencies. This summer [the government agency] Ofsted issued a report on the teaching of history. It said that a "successful curriculum" had been "faithfully delivered". And what was the result of this success? Why, in Ofsted's own words, that young people "could not answer the big questions of history", that they had "little sense of how events connected", that their knowledge was "patchy", their "sense of chronology weak", and that "they are generally unable to reflect on themes and issues, or relate a longer story of the history of Britain, Europe or elsewhere over an extended period of time" (Russell, 2007, p.35).

Study 2: informal interviews of university teachers

Background: UK universities often use a mix of commercial and academically-developed TELEs. No published surveys could be found on the main ways in which individual teachers use those two types of TELE, particularly in the context of directed and undirected learning. Neither could the author find any unpublished surveys, despite talking to knowledgeable representatives of the for-profit and open-source communities: members of the European Learning Industry Group, ELIG, and the developer of the open source TELE, Moodle (Martin Dougiamas).

Information gathering: To begin to understand the present pattern of usage of TELEs (in the context of SRL), colleagues in several UK universities, active in research into teaching and learning, were asked in unstructured interviews to talk about their attitudes to and use of SRL, and the relation of that to their colleagues' and institution's strategy and practice in teaching and in research related to learning. Additionally they were asked about research and practices in their institutions regarding TELEs (both desk-based and accessed via mobile devices), and specifically about use of SRL and PBL (problem-based learning). Finally they were asked if they knew of any external influences on their institution's strategy and practice regarding SRL. The style of interview was naturalistic, meaning conversational, without taking notes. The author made notes of key points after the face-to-face or telephone conversation.

The impression gained was that SRL, and hence research into SRL, was of little interest to them or their colleagues. Regarding teaching:

– In their experience the most common application of TELEs used for mainstream (institutionally-supported) teaching was to highly-directed forms of teaching, which allow the learner little or no discretion in what they learn and how they learn it.
– Self-directed (student-directed) PBL is rare, like student-directed SRL, and was only mentioned in connection with academic-sourced TELEs.
– Directed forms of PBL were common, and experience of those forms of PBL is captured and shared across the UK via a dedicated CETL (Centre of Excellence in Teaching and Learning); there are many CETLs in the UK, each covering a specific topic and involving a small group of universities. Unfortunately the UK government's funding for those centres stopped at the end of 2009.
– Interviewees tended to be negative about the whole idea of SRL as part of university teaching, making comments such as "risky" compared to didactic approaches (would the syllabus be "covered" if students had more choice in what they learned, when, and how?); "inappropriate for my students"; and "inefficient and costly". SRL was felt not to maximise the number of students who pass through the checkpoints (e.g., exams) that determine whether their institution receives funding for students enrolled on a course.

On the face of it, those views are inconsistent with the view of the UK Prime Minister that students should receive a personalised education, including opportunities to learn to think for themselves.

Study 3: analysis of conference articles

To get a fuller picture of current UK practice regarding SRL in TELEs, indirect measures were sought of UK (and near-UK, meaning Irish) interest in SRL and in the use of TELEs for SRL. The measures chosen included the type and number of SRL-relevant presentations from UK researchers at major conferences on teaching, learning and technology-enhanced learning, TEL, inside and outside the UK, such as ALT-C and ECTEL, as well as papers in one of the leading educational technology journals in the UK. The assumption was that data on the coverage of each conference, and the coverage of UK-published research papers, versus that of comparable work in North American centres, symposia and journals would serve as a proxy for SRL-related priorities, influences and practices in UK higher education.

Papers were assigned to four categories: (1) papers about SRL, EBL (enquiry-based learning) or PBL (problem-based learning), (2) papers about the effects of use of TELEs, (3) papers about reflection tools and (4) papers about features of TELEs. The proposed classification is neither complete nor exhaustive; it is a first attempt which could be elaborated. For each category, a few examples will be given, from 2006-8. Interestingly, in 2009 there were far fewer such papers at ALT-C (the main UK event to report relevant R&D).

Papers about SRL, EBL or PBL: Breakey at al. (2007) from the University of Manchester developed an innovative approach, suitable for both SRL and directed learning. Enquiry-Based Learning environments to promote group-based and faculty-led engagement, interaction and enquiry, in the form of physical and virtual learning spaces, were created from videoconferencing tools, such as Macromedia Breeze (Marratech and Horizon Live Classroom), within computer clusters to extend real-time lectures and seminars to students remote from the Faculty, including those on industrial placement.

Anon (2007) describes a facilitator-led approach to Enquiry-Based Learning, EBL, developed at the UK's Centre for Excellence in Enquiry-Based Learning and implemented at the University of Manchester, but not specifically using TELEs. In this learning environment, the student can choose a scenario and then takes the lead in choosing the process of enquiry. With the guidance of their facilitator, and working within the scenario, students identify their own issues and questions. It is assumed that EBL allows students to develop a more flexible approach to their studies, giving them the freedom and the responsibility to organize their own pattern of work within the time constraints of the task.

Papers about effects of use of TELEs: The study by Allan & Lewis (2006) from the University of Hull reports on a 4-year longitudinal study which investigated how membership in a secure and supportive TELE, a virtual learning community (VLC), gave rise to changes in students' "horizons of action" and learning and career trajectories. There was evidence that VLC membership tended to encourage SRL.

Kalyuga (2007) from the University of New South Wales argues that the design of TELEs can be informed by Cognitive Load theory (itself the subject of much

research, because its foundations may be less secure than once thought, see eg, de Jong, 2009; Moreno, 2009). TELE design in the UK tends not to draw upon such research, so lacks the possibility set out in this paper of being able to manage cognitive load and enhance the teaching and learning efficiency of TELEs.

Papers about reflection tools: In the UK, one popular category of extensions to TELEs is for reflection: support and scaffolds to help users to review their experiences in a manner that helps them to learn more from them, and if necessary demonstrate to others where they have got to as a result.

An example is the ePortfolio approach: providing users with a personal database that can help them to develop a meaningful integration of practice (e.g., samples of what they did using the TELE or can do as a result of using it), and iterative review of that practice (considering why they have chosen those samples of work for their portfolio).

Another example is the development of self-directed learning strategies as part of actively monitoring, evaluating, and modifying their thinking and comparing it to the models of experts and peers. The US leads the UK on theoretical and practical aspects of such work, and here it is US rather than UK research that is influential in the UK.

To illustrate, there is a body of US work on assessing the cognitive effects of case-based formats such as problem-based learning (PBL), specifically assessing problem-solving processes as well as products, to check achievement of the theoretical goals of PBL within a domain. As Hmelo at al. (1997) pointed out, in medicine, these goals would include “clinical reasoning, integration of scientific and clinical knowledge, and lifelong learning skills” (Hmelo at al., 1997, p.387). In their study, Hmelo at al. used cognitive measures associated with expert performance to assess the extent to which PBL affected the development of expertise. Their results indicate “that cognitive measures can be used to distinguish students who have participated in PBL from their counterparts in terms of knowledge, reasoning, and learning strategies” (Hmelo et al., 1997, p. 387). If comparable or stronger work is being undertaken by the UK's specialist centre in PBL, the PBL CETL, it is not apparent at first glance.

Papers about features of TELEs: Childs et al. (2007) provide a snap-shop of UK operational use of TELE “Learning Design” tools, in this case resulting from the UK's EDIT4ALL project. The EDIT4ALL tools are typically used for directed learning rather than SRL. In this paper, users report that both tools are "too linear" and have an “impoverished educational model”. Despite those criticisms, the tools have sector-wide institutional support.

Until recently, TELEs were deficient in that they did not adequately support self-regulated learners in the task of reflective monitoring of the knowledge resources they have encountered during SRL. That gap is now being filled. An example is tools to generate maps showing what learners have encountered during SRL, which allow them to reflect on those maps from other perspectives, then publish their maps and compare their maps with those of other learners. Early

research in Japan (Kashihara et al. 2002; Ota & Kashihara, 2005; Kashihara & Kamoshita, 2006) is leading to the creation of useful tools in the UK, such as in the EC-funded FP7 project ROLE (European Commission, 2009).

ROLE has R&D partners across Europe. The three UK partners comprise two universities and one membership organisation (representing several hundred training and e-learning companies). They are collaborating with the other European partners to extend current visions of TELEs to include learner-controlled personalized environments, based upon learning environments that learners already have access to (eg Moodle) as well as general-purpose collaboration environments now becoming available (eg Google Wave). The implementation work includes developing and testing combinations of web-based tools (widgets) that can be used to personalize such environments and tailor them to learning needs. In principle, each learner could select their own set of tools, moment by moment, to suit the tasks being undertaken. One challenge is to reduce the cognitive load of making those choices, so that learners are not overwhelmed. Another challenge is to give users an 'inner sense of personalisation'; an innovative solution, first developed with Moodle, is to present users of a TELE with tracked information that makes visible to them how they are interacting with it (Verpoorten et al, 2009).

Research on many such issues is underway and should reduce the barriers to offering users a wide repertoire of tools for SRL, and keeping them informed about superior or improved tools (and sources of support for mastering those tools). Key technical building blocks here include *recommender services* (analogous to how Amazon alerts you to other books you might like), and *aggregation services* (to bring to one place relevant information from many places).

CONCLUSIONS

When the first version of this chapter was drafted, a year ago, it seemed that the mass of UK higher education was somewhat negative about SRL or initiatives with similar elements such as education for capability. Lack of resources seems to be a factor here. Projects such as ROLE suggest that the cost of SRL is set to decline and its scope and value are set to increase. As a consequence, UK institutions may soon find staying with the status quo (low use of SRL) is riskier and dearer than offering SRL in TELEs. Being very optimistic, a virtuous cycle is in prospect: learners use TELEs to learn to learn; experience effects come into play (they learn to improve); people learn how to help others to improve; then a critical point is reached, in which enough people are involved in each of the above stages, often as volunteers, to make SRL self-sustaining and to drive down its cost to institutions.

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BIG ISSUES: THE EXAMPLE OF LEARNING PLATFORMS

GRAND CHALLENGES, BIG ISSUES

The term "Grand Challenge" is widely used to signify an overarching and often visionary goal that requires a large-scale, concerted effort for its achievement, harnessing a wide range of expertise, knowledge and capabilities. Associated with that concerted effort are many subsidiary yet complex challenges. Such challenges are often capable of being met to a limited extent by cross-disciplinary effort using existing knowledge, but requiring a new focus or further research and development, if the initial solution to a Subsidiary Challenge turns out to be unsatisfactory. We use the term "Big Issue" to refer to these Subsidiary Challenges.

An example of a global Grand Challenge would be "develop a cure for Malaria". A Big Issue there might be "find sustainable ways to pay for the cure".

An example of a Grand Challenge for SRL would be "To use software to improve an increasingly wide range of cognitive skills in learners". A related Big Issue might be "To identify component skills that can be taught individually." Exemplar skills would include metacognitive strategy skills for actively reading and then self-explaining a complex text, such as predicting, elaborating and paraphrasing. Other Big Issues that spring to mind are "Motivate students to invest time in mastering component skills" and "Reduce interference between component skills".

Yesterday's Grand Challenge, once achieved, may become routine until new factors emerge. An example is powered flight: challenging for the Wright brothers, and today challenging for a quite different reason: globalisation with all its incipient costs and benefits and impact on the climate.

As stated in the Foreword to this book, a successful self-regulated learner should be able to *recognise a need to learn*; *make wise choices in relation to that need;* and *satisfy that need efficiently and affordably*. Each of those italicised phrases could become a Grand Challenge, with some rephrasing and recontextualisation.

Looking ahead, the pace and scope of change is adding to the number and complexity of things that need to be learned, making the transition from novice to expert self-regulated learner increasingly hard for the unassisted learner to reach.

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So a longer-term Grand Challenge for formal or informal SRL might focus on providing system-changing assistance to the learner, that is "To develop tools for TELEs that augment the capabilities of students so that by the end of their first year of study they can reach an expert level of performance in solving problems in their field, currently only achievable at the end of ten years of professional practice." A Big Issue might focus on bringing positive feedback to bear, to reduce the difficulty of the Grand Challenge: for example, "Develop tools for TELEs that make it faster and easier to develop the TELEs themselves". Using positive feedback to reach a Grand Challenge goal could bring closer the realization of smart machines, termed the Singularity by visionary Ray Kurzweil. This would have a large impact on society, both at the mundane level of commoditizing all human expertise (knowledge-based jobs would no longer command a salary premium) and more seriously, by giving rise to emergent phenomena that right now are hard to predict.

If you find the Grand Challenges and Big Issues approaches interesting, you might consider getting in touch with the STELLAR network, a European network of excellence in technology enhanced learning[1].

THE ROLE OF SRL IN ACHIEVING TOMORROW'S ENGINEERS' GOALS

According to the National Engineering Education Research Colloquies (2006, cited in Harris & Cullen, 2009), five areas of research into "how content should be taught and how learning environments should be designed" are needed to facilitate "…the growth of students from [directed] novice to [self-directed] expert with an emphasis on deep learning as opposed to added content" and to "…ensure a coherent, rigorous and innovative foundation for systemic and sustained transformation of our engineering education system" (p.257). The five areas that tomorrow's engineers will have to master, whilst becoming self-directed learners, are "…engineering epistemologies, engineering learning mechanisms, engineering learning systems, engineering diversity and inclusiveness, and engineering assessment".

As Harris & Cullen (2009) observe, this shift from a content to a process orientated curriculum is being accompanied by a shift away from the *pedagogy* of formal education, defined as the art and science of teaching, and often biased to transmissive teaching, rather than transactive or transformational teaching, towards the SRL-like *andragogy* of peer-to-peer and mentored learning. This latter conceptualization of pedagogy defines it as the art and science of helping others to reflect critically and thereby learn how to teach themselves and transform themselves through autonomous thinking.

The ready availability of TELEs to engineering students makes engineering a good candidate test-bed for R&D into tools to improve SRL.

[1] http://www.stellarnet.eu/

EXAMPLES OF TOOLS NEEDED TO FACILITATE SRL IN TELES

As Nückles et al. (2010) observe, a tool to support SRL should be designed in a manner that enables learners to derive sustained benefits from using the tool. In their study, they found that there was an "expertise reversal" effect when learners received persistent help, such as prompts to deploy specific cognitive and metacognitive strategies. As their students internalized the desired strategies, the external prompts turned from being helpful to being "a redundant stimulus that interfered with the students' internal tendency to apply the strategies and, thus, induced extraneous cognitive load". The solution was to fade out "the prompts in line with the learners' growing competencies". Further research is needed to determine whether expertise reversal is a general effect.

Scholl et al (2009) describe a quite different challenge: how to support SRL before, during and after a task that was particularly demanding for learners. The task involved self-directed, resource-based learning with web resources, so their TELE supported goal management. Learners "…have to plan, monitor and reflect on their learning process in order to reduce disorientation and enhance quality of their learning achievements". Their TELE took the form of a scaffold for learning to plan the task and learning to monitor their performance on the task. They supported the learner in regulating three different systems: "… to think about search query words that are likely to lead to success, … overcome procrastination or better cope with obstacles … eventually leading to forming of strategies to enhance his learning processes".

Evaluation data from such examples shows the importance, at the Big Issue level of R&D, of understanding just what is entailed in acquiring specific competencies in self-organization and self-motivation.

HOW WILL CHANGES IN LEARNING PLATFORMS AFFECT SRL IN TELES?

In recent years, the term Technology Enhanced Learning Environments has shifted in meaning, from encompassing small scale highly specific educational packages, through to large scale multifunctional Virtual Learning Environments (VLE), then Learning Platforms (LP), then Personalized Learning Platforms (PLE). The latter being a user-configurable, dynamically-changeable amalgam of peer-to-peer learning (P2P), community of practice insights (CoP), and a Learning Platform (LP), which itself comprises the teaching and learning functions of a VLE and the management of learning functions commonly encapsulated in a Managed Learning Environment (MLE). While there will always be tutors, and indeed commercial software houses, to develop the small scale bespoke learning package; such as the fire training course many of us have been obliged to complete as part of the university's health and safety programme; in this closing part of the final chapter we want to reflect on the impact of SRL in TELEs of the rise and possible demise of the LP and its possible replacement by the PLE.

That we should question the future of LPs may appear outrageous to some as the development of these multifunctional environments are a key element in the educational strategy of education departments of many governments and in higher

education and commercial training companies across the world. For example LPs are at the centre of Next Generation Learning, a UK government initiative to ensure the effective and innovative use of technology throughout learning and education[2]. There are also strong commercial interests in LP development with companies such as Blackboard and Desire2learn having established a global market for their products, while Moodle, a free and open source e-learning software platform, had almost 50,000 registered sites world wide in 2009.[3] However there are grounds to question the growing dominance of LP, at least in their current conception, and those grounds relate largely to learner acceptance and engagement with these systems. This is a speculative argument that we are putting forward here but in doing so we raise important questions about tutors' and developers' understanding of learners and their interaction with the digital world.

We start by looking at the nature of the LP and the educational goals that are being met through the use of such technologies, for example in the context of SRL. In principle a LP is a safe and secure customisable environment that is reliable, available online and accessible to many users. It consists of a collection of tools and services designed to support teaching, learning, management and administration. Learning resource management includes the creation, storage, access to and use of digital learning resources which may be unidirectional such as a piece of text or a podcast; bi-directional as in a quiz or test; or multidirectional as in a collaborative multi-user game or simulation. Administration functions range from lesson planning, assessment and personalisation of the learning experience through managed access to learner information and resources and tracking of progress and achievement. The degree to which learners have access to their personal records, that is have online feedback of their performance, is a significant differentiating factor in how LPs are used in any one institution. In some institutions a pupil or student will be able to monitor his or her own performance on a regular basis, as might their parent in the case of school children (Underwood et al., 2007). In others such information lies firmly in the hands of tutors and they are the source of feedback to the learner. Communication within a LP should enable learners and tutors and parents to engage in discussion and share information rapidly, overcoming some of the barriers of time and place through emails, notices, chat, wikis and blogs. This furthers collaborative working both within the classroom and beyond.

In a recent UK survey, 100% of secondary and 91% of primary senior leaders held the view that their learning platform implementation will have a positive impact on improving teaching and learning at their school (BESA 2009). The study is, however, not impartial research; it was conducted by the British Educational Suppliers Association. Over 70% of primary and 60% of secondary teachers surveyed report that the learning platform is useful or very useful for storing and accessing learning resources and teaching software (Smith et al., 2008). Amongst teachers who have access to a learning platform, over 29% of primary teachers and

[2]http://publications.dcsf.gov.uk/default.aspx?PageFunction=productdetails&PageMode=publications&ProductId=DFES-1296-2005

[3]http://moodle.org/stats/

24% of secondary teachers surveyed felt that its use saved them time; around 60% felt it was time neutral. By contrast, 10% of primary teachers and 14% of secondary teachers reported that it lost them time (Smith et al., 2008).

LPs that facilitate SRL are a move away from a closed educational architecture in which hardware, software, learner role and content are 'centrally' prescribed. Such a closed system was at the heart of Soviet education until very recently (Uvarov, 2004) but mini-Soviet systems abound. A current live debate currently on one international educational forum hosted by Mirandanet concerns the educational use of YouTube. While it is not that surprising that many schools do not allow direct use of YouTube we were surprised to hear that in one UK educational authority video is banned as standard practice. Risk-aversive centralised management has significant impact on the availability of content and tools for learners and acts as a brake on the level of openness of the LP.

Uvarov (2004) argues that a closed educational architecture supports a minimum standard of education for all, a worthwhile but not sufficient goal that ironically has points of similarity with the 'No Child Left Behind' scheme of the US. Given the accelerated pace of technological and social change in this post-industrial society, he argues that the key goal is to educate the next generation to live and work in this rapidly changing environment. Uvarov has termed the gap between the current concept of education as knowledge and skills transfer, even when delivered digitally, and the need to produce flexible thinkers and debatable citizens the Toffler Crisis, in homage to Alven Toffler's thought provoking work "Future Shock".

Open educational architectures according to Uvarov can be viewed as open for teachers or for students. The pedagogical drive behind LPs may be seen as an open system from the tutor's point, that is they are not learner centred. A study of over fifty UK schools with working LPs, showed that where staff viewed LPs unfavourably, it was often because the system was geared to the needs of the institution and the teaching staff rather than to those of the learner (Underwood et al., 2008). In this survey the teachers recognised that the LP was a tool for them but wanted a tool that they and the learners benefited from. So a common complaint of rejected LPs was that they were teacher-oriented and although they were useful for planning and delivering lessons, the teachers felt that such tools were in conflict with the personalising learning agenda, which they felt was crucial in a modern educational system. The teachers argued that there should be the opportunity for learners to set their own targets and workloads (as in SRL) and use the LP to organise their learning effectively and that the LP should permit the student voice to be heard, allowing opinions to be expressed and boundaries between years permeated.

In an open educational architecture, which is focused on the learner, the emphasis is on self-education and self-regulation of the learning process and this will eventually lead to post-modern education. New educational institutions are and will be born out of this move to open educational architectures and they will be ones where "education will not only be declared, but will be individual" (Uvarov, 2004, p. 149).

While educators, researchers and policy makers debate the direction of education, learners of all ages have recognised the affordances, or action possibilities (Gibson, 1997; Norman, 1988), of the digital world and have begun to create their own digital learning environments. Fifteen year old Matthew Robinson's report for the international banking conglomerate Morgan Stanley (2009), which was based on a survey of some 300 friends and acquaintances, illustrates the profound way that digital technologies are transforming lives, creating new opportunities and disrupting old patterns of work, learning and leisure behaviour. He asserts that adolescents are consuming more media, but that the media of choice allows a level of personal control, so the PC is preferred to the TV or the cinema even to watch films, because it allows the user to view anytime and anywhere. They are multi-platform users "happy to chase content and music across platforms and devices (iPods, mobiles, streaming sites)" (Hill-Wood et al., p.1). They are also active users of social networking sites such as Facebook but find applications such as Twitter boring because it is in essence hierarchical, a guru with followers, while the internet is used primarily as a source of information with Google being the tool of preference, simply because it is well known and easy to use.

The level of sophistication of digital technology use is growing. Learners often start with simple activities such as creating a personal web page, and then through the use of a growing set of free and simple tools and applications, they are creating customized, personal web-based environments. Such personal webs explicitly support the individual's social, professional, learning activities via highly personalized windows to the networked world. Learners no longer need to be aware of the underlying technology that supports the web; all that is necessary is to know which tools to use and the associated tasks required in organizing, creating and distributing content. This is analogous to our relationship with the motorcar, backyard mechanics are increasingly rare now cars are computerized but we can all drive and also use the SatNaV. These highly flexible personal web environments foster personal and social forms of learning and expression. In the world beyond the class or lecture room there are free or very low cost tools to support collaborative working such as those of joint writing and problem solving.

A further blow to learner use of 'formal' educational tools is that learners are drawn to 'known' tools. We always use the easiest or best-known tools shunning new tools as we already have a skills-set honed to the job in hand. Higher education in the United Kingdom has heavily funded digital library services in order to develop a coherent Information Environment (IE) (Ingram & Grout, 2002). The IE was designed to support interoperability across the extensive resources held by the sector. However, Griffiths and Brophy (2005) found that despite the availability of such tailor made tools, use of commercial Internet search engines dominated students' information-seeking strategy. Forty-five percent of students used Google as their search tool of choice, while only 10% used the university's own electronic library catalogue. Results of students' perceptions of ease of use, success, time taken to search, and reasons for stopping a search are also presented. Similarly the librarians at the University of South Carolina were chastened to find their newly developed information system was being by-passed by students who remained wedded to Google.

The mobile phone is another ubiquitous tool of the young. In the US Pew International reported that in 2004 half of U.S. 12 to 17 year olds owned a mobile phone compared to 65% of adults, but that this had risen to 71% of teenagers in 2008 while there was a small increase to 77% for adults (Lenhart, 2009). A recent study in Spain, which drew on a sample of one thousand 11 to 20 years old, found 11.6% of the sample came from homes that did nor have a landline phone at home. In contrast, 99.9% had their own mobile phone (Fundación Pfizer, 2009). It is seen as "a vital tool for young people's social lives" (Haste, 2005, p.2) as illustrated by the fact that over half of her national sample texted friends more than five times a day. Here the mobile fulfils an essential social need stimulating 'therapeutic gossip" and providing societal 'glue'. "Paulo Freire's (1994) long-espoused assertion that the development of any literacy takes off when it speaks to the needs of the individuals is clearly exemplified by the rapid assimilation of mobile communications technologies into the fabric of the lives of those of us less than twenty-five years of age" (Underwood, 2005, p.217).

Education, on the whole, does not love the mobile phone. Schools often have a ban on students' use of them and they are unwelcome in the lecture hall also. For many staff they are equated with cyberbullying (Slonje, & Smith, 2007; Sharriff, 2008) and academic cheating (Underwood, 2007; Common Sense Media, 2009). However, the latest generations of mobile phones have a wide range of functionality and can be excellent learning aids. From their mundane use as a stopwatch in the science laboratory through practice pronunciation in language classes, to the production of full motion video and podcasts, this tool has much to offer to education not least because such a large proportion of students already own one.

There is a growing perception, particularly in Higher Education, that linking the personal (the mobile phone) to the institutional (the LP) will have enormous potential for learning. However, the educational values embedded in many commonly used LPs retain an element of transmission rather than the problem oriented model required in the 21st century, Such a model often leads to disappointing learning and teaching experiences (Sullivan & Czigler, 2002; De Freitas & Oliver, 2005). We may be building tools that are already past their sell by date as learners move to create their own learning environments.

CONCLUSIONS

There is a high level of current demand for more research in education. This is predicated on the perceived need by policy makers for research of higher quality and greater utility than previously presented (Feuer et al., 2002; Heck 2004). "One of the things most astonishing to posterity about our times will not be how much we understood but how much we took for granted." (Heck, 2004, p.9). It is imperative to develop concepts, theories and rigorous and appropriate methodologies to provide a robust evidence base and understanding of the impact of digital technologies on the educational process. There is also a need to identify,

promote and support good practice and models of change to produce sustainable change.

We started with the dual concept of the Grand Challenge and the Big Issue. If the Grand Challenge is "to prepare citizens (learners) to function effectively in a post modern world"; then the Big Issue here concerns "The importance of digital technologies in achieving that goal by supporting both formal and informal learning." Technology has led to a globalization of education through the ease of flow of information and ideas. This has resulted in not only international comparisons of the health of national education systems, a significant influence on national policies, but also the movement of students across international borders. Although, we would contend that pockets of good practice remain isolated. For example, crossing the discipline boundary may prove to be a particularly difficult transition. To break down these barriers we need detailed meta-analysis such as the one conducted by the U.S. Department of Education (2009) of on-line learning. Such analyses allow us to pick out the essential recurring features of the stimulants and barriers of effective practice.

The barriers of time and distance are also falling. The move to greater mobility "is more than merely an expectation to provide content: it is an opportunity for higher education … (and increasingly schools)… to reach its constituents in new and compelling ways. " (Johnson et al, 2009, p.6). However, the benefits of such technological advances will only come to full fruition in the hands of a self-regulated learner. Changing our students' perception of what it is to be a learner and what it is to learn is probably the biggest educational challenge of all.

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JEAN UNDERWOOD AND PHILIP BANYARD

SELF-REGULATED LEARNING IN TECHNOLOGY ENHANCED LEARNING ENVIRONMENTS IN EUROPE: FACILITATORS AND BARRIERS TO FUTURE DEVELOPMENT

Today's students are no longer the people our educational system was designed to teach.
Prensky 2001

INTRODUCTION

The substance of these collective reports concerns our understanding and conceptualization of self regulated learning and the role of digital technologies, specifically Technology Enhanced Learning Environments or TELEs, in supporting learner self-regulation. The contributions here present a rich picture of the activity in the European countries participating in this review but they are necessarily a snapshot of a rapidly evolving field.

The founding premise, espoused in the introductory chapters by Beishuizen and Steffens, is that learner self-regulation is beneficial in that it leads to more effective, embedded learning. Of equal import is the view that TELEs can provide supportive environments which encourage self-regulation. The focus on self-regulation and TELEs is not an arbitrary one. These seemingly disparate concepts epitomise two current trends in education, the move to learner-centred learning and the growing reliance on technology based learning.

IS EDUCATION WORKING ?

Placing the learner at the heart of education is an accepted goal across the European and North American educational perspectives. Why are we seeing this shift from teacher to pupil and indeed from pupil to learner? Educational initiatives are set in a context of societal change and while there are many factors which have encouraged the move to learner-centred education, the rise of digital technologies has provided a mechanism through which a more learner-centred education can be delivered. Computing and the World Wide Web are permeating people's lives and provide both formal and informal learning opportunities across the age span.

R. Carneiro et al. (eds.), Self-Regulated Learning in Technology Enhanced Learning Environments, 155–163.

There is a paradox within this goal because at the same time as placing the learner at the heart of learning, greater controls have been placed on what people learn, how they learn it and how their learning will be validated. For example, in the UK the A Level examination programme (pre-university assessments) have become exercises in reproducing information in a standard format. The publication of detailed mark-schemes has led to teachers coaching students to produce work solely aimed at achieving the best score rather than gaining the best understanding. Commentary, debate and dissent are not encouraged because they are not pragmatic strategies for gaining high marks and teachers therefore adopt a cook-book approach to teaching (Green, 2007).

A further paradox encountered by students is that their education is predictable but the future usefulness of that education is uncertain. On the one hand the courses are clearly prescribed and the assessment neither exciting, nor novel, but the long term benefits of this education are very unpredictable. In a world of dramatic technological change it is not clear which current skills will be valuable in even ten years time. Take keyboard skills, for example, children use keyboards as soon as they start school so it would appear an obvious benefit to train them in touch typing at an early age, but in the UK schools are not doing this. There are a number of reasons for this but one major one is that by the time these children leave school keyboards might well be obsolete. The structure of employment is changing and the skills needed to deal with this are also changing. This means that for young people in contemporary society a career path is less predictable than it has been for the parents' and grandparents' generations. This uncertainty has brought new challenges as an individual's path through life is no longer predictable (Kemshall, 2008).

The widespread acceptance that education needs to change and that learner-centred learning is the way forward is largely a result of the developed world's concerns about an education system that is failing both the society and many individual learners. This failure at a societal level is both economic and social. At an economic level we are producing too few workers with the skills that will allow them to take part fully in the post industrial eras of the Information Age or indeed the Conceptual Age, which some would say we have now entered (Pink, 2005). In the UK, for example, there are significant numbers of adolescents who leave school with insufficient skills to take their place in the workforce. These are generally 16-18-year-olds who are Not in Education, Employment or Training and are commonly referred to as NEET adolescents. The drive to minimize NEET adolescents is one of the ambitions of the UK government's policy outlined in the white paper "Every Child Matters: Change for Children" (DfES, 2003).

At the EU level, about one-third of the European workforce has the equivalent of lower secondary schooling, and approximately 25 per cent of 15-year-olds have low reading skills. Such figures are the raison d'etre for the policies emanating from the Lisbon Strategy. The goal of a high-skilled citizenry of course has implication across the educational sector particularly for higher education and work-place learning. Most governments across Europe have policies in place to increase the number of students entering higher education. This is based on the assumption that higher education can supply the skills and qualifications in terms of "human capital" required for a more complex and technological working life.

This is clearly seen in the UK Government's target of 50% young people entering higher education by 2010 although countries such as Finland have even more ambitious targets. This target does not have universal approval and a university education is not always so well regarded by the world of business and commerce. For example Richard Lambert, director general of the Confederation of British Industry asserts that graduates leave university with inadequate communication and language abilities skills in team working and managing their own time including the ability to "get up in the morning" (Curtis, 2008).

The emergence of an out-group unable to partake of the richness of a developed society can lead to disaffection with all the social ills that accompany it. This has led to a problematisation of youth and a growing perception of 'youth-at-risk' (Kelly, 2001; Furlong & Cartmel, 2006). Teachers and policy-makers are concerned that pupils' negative attitudes to school make it harder for them to progress in education, and may lead to truancy or exclusion. Educational intervention is seen as central to reengaging the 'disaffected' adolescents by providing them with skills, values and attitudes required to make successful and acceptable transitions to adulthood. The focus on the disaffected has also led to a focus on basic skills but Shaffer and Gee (2007) argue that the focus on basic-skills-for-all means that young people are being prepared for the sort of jobs that can be done more cheaply and as efficiently in the developing world. The inevitable consequence of which is that they will be priced out of jobs. More worrying still, they point to the rise of the high-skilled industries in countries such as India and China which threaten not only the low-level commodity jobs but also high-value jobs which we in Europe and North America have seen as our own. So, while it is necessary for all to have a toolkit of basic skills they argue that the survival of first world countries is dependent on the creation of a generation of flexible problem solvers.

The focus on skills in education and training creates a further paradox. As noted above, the recent focus on skills based assessment in academic qualifications such as A levels has led to a more impoverished learning experience. Elsewhere the workforce is being de-skilled to carry out the routine tasks that are difficult for machines. This follows the successful business model of McDonalds that has been applied far outside the retail sector. Ritzer (1993) suggests that all parts of society, even the health services, are affected by the McDonalds' culture. Medicine is becoming an assembly line process, and patients are now called customers or consumers. We don't *receive treatment* any more; we *consume* the services of health workers. The management of the health service is concerned with efficiency, numbers of units, and through-put. They are starting to develop 'walk-in-doctors', where the patient will go to an emergency room and receive fairly speedy treatment. The emergency room will deal with a limited range of disorders but will be able to deal with a lot of them and very quickly. This is like a fast food restaurant, such as McDonalds, where the diners have a limited menu choice but know exactly what they will be getting, and know they will get it quickly. The de-skilling of workers that goes along with this business model denies them access to more sophisticated jobs. The paradox then is that the focus on a limited set of basic

skills in fact limits that person to that basic set of skills. As Shaffer and Gee (2007) argue, the focus on basic-skills-for-all means that young people are being prepared for such commodity jobs.

The conceptualisation of young people who are not engaging in education as NEETs or 'youth-at-risk' is problematic because it pathologises the individual. It is based on the belief that all people want to engage with the larger society and endorse its values and its direction. However, the impact of such education on learners in general is equally disturbing. Gallacher (2005) who, in reference to a NFER survey of 11-18 year-olds' views of their educational experience, noted that: "A disturbing picture emerged of a culture of compliance without engagement among even the brightest of our young people. The majority felt that schooling was relevant only for passing exams and jumping hurdles and had little relevance to their lives now or for the future."

Another view of this behaviour sees it as collective resistance against a culture that they do not want to embrace. When policy makers look at school avoidance they often want answers to the question *'why do children play truant from school?'* but as Corrigan (1979) points out there is a related question that also needs to be asked and that is *'why do we make children go to school?'* The answer to this is not as obvious as it might appear and can help us understand, and hence deal better with, the children who do not engage with school-based learning. If you not have a realistic chance of making significant progress or getting access to the better paid jobs then why would you buy into the system? These young people are the disenfranchised, with no voice and no access to the better paid jobs except through the routes that do not require formal education such as sporting success or television talent shows such as The X-Factor. The problem lies less with the individual child and more with the structures that limit their expression and opportunities for personal enhancement.

TOWARDS SELF-REGULATION

In the mainstream it assumed to be a different story although Gallacher (2005) questions this complacency. However, for children who have not rejected formal education, the debate about learner-centred methods still has something to tell us. To say learning has replaced teaching at the heart of the educational process is not a trivial statement, for it necessarily engenders a shift in how education is perceived and operationalised. Crook (2007) highlights the shifting theoretical vocabulary of learning which is now clearly embedded in socio-cultural theory in which the terms 'community', 'situated' and 'tools' are central to a mode of learning focused on the learner in context. The acknowledgement of the importance of the learner's self-regulation of his or her own learning is one consequence of this shifting perspective from teacher to learner.

The term SRL came to the fore in the 1980's emphasizing as it does emerging autonomy and responsibility of students to take charge of their own learning. It has its educational roots in Corno and Mandinach's (1983) theory of cognitive engagement styles in which SRL played a central part. From this cognitive perspective they argued that it "is an effort to deepen and manipulate the associative network in a particular area (which is not necessarily limited to academic content),

and to monitor and improve that deepening process" (Corno and Mandinach, 1983, p. 95.). The concept of SRL captured research on behavioural variables such as cognitive strategies, metacognition, and motivation in one coherent construct that emphasized the interplay between these forces. Latterly this research at the behavioural level has been drawn together with research at the operational level, where concepts such as personalization of learning are in evidence (Underwood et al, 2008; Underwood & Banyard, 2008). The interrelationships between personalised learning, meta-cognition and self-regulated learning are discussed at some length in the opening paper of this book (Beishuizen & Steffens).

The practical importance of the theory of SRL is that it provides a framework to describe the ways that people approach problems, apply strategies, monitor their performance, and interpret the outcomes of their efforts. It contains the following three components:

– Metacognition; strategic action (planning, monitoring, and evaluating personal progress against a standard),
– Motivation to learn including engagement with learning
– Self-efficacy; beliefs (whether or not accurate) that one is capable of performing in a certain manner to attain certain goals.

In particular, self-regulated learners are cognizant of their academic strengths and weaknesses, and they have a repertoire of strategies they appropriately apply to tackle the day-to-day challenges of academic tasks. Finally, students who are self-regulated learners believe that opportunities to take on challenging tasks, practice their learning, develop a deep understanding of subject matter, and exert effort will give rise to academic success (Perry et al., 2006).

Having established the benefits of SRL we now move to assess the extent to which this approach to teaching and learning is being taken up across Europe. There are two main findings concerning SRL per se and neither is encouraging. In the first instance SRL is a concept rarely used and not fully understood within our collective educational systems. Lenne and his colleagues point out that in France the term self-regulated learning is rarely used but there are related concepts termed self-education and autonomous learning. This also reflects the position in Norway, Spain and in the UK. In Spain and in the UK the concept of self-regulation *per se* and SRL in particular is firmly established in the psychological rather than the educational literature. In Spain, for example, Bartolome points out that the experts in ICT tend to put more emphasis on the study of metacognition rather than on the impact of the new technologies on SRL. In Germany and the Netherlands there is greater sharing of terminologies between the domains of education and psychology and Italian researchers and educationalists are now showing increased interest in SRL.

Should we be concerned about the differences in terminology or should we adhere to old Shakespearean adage the 'A rose by any other name would smell as sweet'? We would like to argue here that the terminology does matter. Replacing SRL by self-education and autonomous learning we maintain the child-centred focus and with it the concept of engagement but we lose that vital focus on the repertoire of strategies for successful learning. While the more able develop such

strategies as a matter of course this is not true for the less-proficient, but the evidence shows such skill can be taught (Perry et al.; 2006; Parsons, 2008) and indeed should be taught.

SRL and TELEs

Secondly and unsurprisingly, given the above finding, there is limited evidence from these surveys of the concept of self-regulated learning permeating Technological Enhanced Learning Environments (TELEs). This is clearly illustrated in the chapter by Hansen and reiterated by Caneiro and Simao. While one could argue that with the increasing number of students, the development of open distance learning and the need for life-long learning, SRL should be of rising importance, there is no evidence from these surveys that this is fact the case. TELEs such as web sites, portfolios, or collaborative tools have been developed in order to complement lectures and to support self-regulated learning at a resource provision level. Recent policy changes, effected at both European and national levels, that favour competence-based curricula namely at basic and secondary education, led to a surge of interest in portfolios as a reliable tool to define and measure competencies. The development of the portfolio approach has been particularly active in Portugal where policy makers have seen it as a key plank of their educational policy. However, providing students with adapted tools is not sufficient to make them self-regulated learners. The most common application of TELEs used for mainstream (institutionally-supported) teaching tend to be highly-directed forms of teaching, which allow the learner little or no discretion in what they learn and how they learn. Such TELEs engender little support from the teaching staff.

One factor inhibiting the use of TELEs to enrich learning and enhance SLR is the structure of the technology. Research on virtual learning environments in UK schools (Underwood et al, in press) highlights the difficulties of rolling out basic technologies in schools because of issues to do with reliability and ease of use. Technology that has the potential for interactive and challenging learning can become merely a notice board for class notes.

Hope for the future?

Beishuizen points out in the Netherlands more advanced TELEs are emerging. The Dutch research into SRL in TELEs has disclosed important relationships between the arrangement of the learning environment, the learning process and the learning outcomes. The conclusions can be arranged under four beneficial characteristics of TELEs: adaptability of complexity, interactivity, articulation, and balance.

– Complexity: The complexity of TELEs can be adapted by properly arranging learning materials and by providing various learning tools. The concept of cognitive load relates the objective complexity of the learning environment to the learner's processing capacity. Reducing the cognitive load of the learning environment enables the student to focus on the learning process by deploying and further developing self-regulation skills.

– Interactivity: Increasing the interactivity of the learning environment by means of technological support is a successful way to foster learning processes. However, time and again it has been shown that fostering learning processes does not necessarily lead to improved learning outcomes.
– Articulation: An important beneficial effect of TELEs is that often the structure of the learning task and the learning process is made transparent by visual tools. This was illustrated in two recent studies on collaboration between students in a Community of Learners. As other authors made clear, various visual tools have various effects on the learning process, but the articulation characteristic is itself an important asset of TELEs, fostering both learning processes and regulative behaviour. Portfolios seem to have some promising characteristics; this will probably also be true of ICT- based portfolios, i.e. digital portfolios. The literature on digital portfolios is, however, still very scarce and focused in the higher education sphere.
– Balance: Too much structure in a TELE creates dependent learning behaviour. Therefore, teachers play an indispensable role in TELEs. They should develop and apply a powerful repertoire of design and support strategies to enrich the learning environment with both technological tools and personal support and feedback. The principal role of teachers in a TELE is to establish a balance between structure and freedom to learn in a self-regulated way.

This description fits well with the current data from the Impact 2007 project in the UK (Underwood et al., 2008)

IN CONCLUSION

There is an uneven spread and in some instances a paucity of research on SRL and TELEs within the member states of the EU. The national studies presented here have identified the level of both activity, and indeed inactivity, in TELE usage for learning across age range, from youngest to the oldest citizens within Europe. They have also sought to show how the concept of SRL, which is key to learner-centred and its associated concepts of metacognition and personalized learning, can be married effectively with, what at first sight appears to be a very top-down didactic system, a TELE to produce a personalized learning environment

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. There are exceptions to this many of which are to be found outside of the EU.

Efficient and effective learning only occurs if learners actively engage in processing learning material (Underwood, 2008). While learners are becoming adept at using the digital toolkit to support both their internal mental space or thinking (Mayer et al., 2003) and also the public and external world of tools and artefacts (diSessa, 2001), we the pedagogues seem less able to fulfil our part in the brave new world. Essentially we need to provide learners of all ages with the skills (SRL) and the tools (TELEs) to be independent of us. This is an uncomfortable but potentially very exciting position for teachers to be in. This places the onus on

educational designers and teachers to develop strategies which encourage, prime and guide learners in actively processing the web-based material (e.g., Mayer, 2003; Mayer & Moreno, 2002). This is no easy matter as Narcis and her colleagues found (2007) when they developed their 'Study Desks' as part of the Study2000 project in Germany. While students rated the usability of this facility as high, they in effect made minimal use of the active learning, elaboration and monitoring tools. Tool provision did not engender SRL skills.

The exciting and uncomfortable observation is that changes in the way people deal with information and communication are being driven bottom-up and leaders in education (and elsewhere) are playing catch-up. The managers who take decisions on communication and learning technologies are rarely enthusiastic users themselves. To unleash the power of TELEs it may be necessary to let the users develop their structure and their uses, maybe there is a learning equivalent of Facebook waiting to emerge if only there was the opportunity.

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