Self-regulated and Technology-enhanced learning: a European perspective

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ABSTRACT Self-regulation of learning, learning to learn, and their potential stimulation by specific Information and Communication Technologies (ICTs), are main topics in European policy. This issue of the 'European Educational Research Journal' (EERJ) focuses on research to develop, integrate, and evaluate self-regulation of learning and the potential and actual uses of ICTs in educational practice. In this paper, we introduce five articles on self-regulated and technology-enhanced learning representing development and research conducted in preschools, primary and secondary schools, and universities of various countries. This research was presented at two symposia of the 'European Conference on Educational Research' (ECER) in Cádiz (2012). The symposia were part of the ECER network 16 'ICT in education and training'. The research exemplifies three different models of ICT-based learning, ranging from 'traditional' via 'more flexible' to 'optimal' learning. We discuss the main characteristics and outcomes of the five articles. We conclude with theoretical and methodological aspects that may promote further development and research of self-regulated and technology-enhanced learning in a European perspective.

In European societies, individual responsibility for one's learning activities and progress, or self-regulation, is often said to be an important competence of the 21st century. In relation to self-regulation, learning to learn is one of the eight key competences enumerated in the 'Recommendation on Key Competences for Lifelong Learning', which was adopted by the European Parliament and the Council in December 2006 (European Parliament, 2006). These competences should function and be demonstrated at home, school, work, and during leisure time. Self-regulated learning (SRL) is, therefore, of critical importance for all learners, including those from disadvantaged backgrounds (see, for example, Bennett, Gordon, & Edelmann, 2012) as well as gifted learners (International Panel of Experts for Gifted Education [iPEGE], 2009). In addition, information and communication technologies (ICTs)

are expected to support self-regulated learning processes by assisting learners in monitoring, integrating, and evaluating their learning as they engage in learning tasks.

Some 15 years ago, global expectations for ICTs and their role in promoting SRL were hopeful and ambitious (Sinko & Lehtinen, 1999). In particular, ICTs were assumed to improve both personal and institutional performance, leading to better outcomes and a better life for all. When ICTs were first introduced in schools and universities, however, it was frequently observed that the technologies implemented were designed and used as a replacement for textbooks. For example, teachers uploaded text onto a learning management system and asked their students to download, read, and answer questions about them (Gustafson, 2002; Mooij & Smeets, 2001). Fortunately, this rather awkward approach is changing. Nowadays, digital online tools reflect social, cultural, educational, work, and societal realities (Kemp, 2000; Reynolds, 2005; The Scottish Government, 2009). Teachers and students use digital media in ways that are more in line with the potential of ICTs. Moreover, European researchers and developers increasingly collaborate to analyse and create educational conditions that fully support the potential and achievement of various types of learners across national borders (Bennett et al., 2012; iPEGE, 2009).

In line with this European effort, this issue of the 'European Educational Research Journal' (EERJ) focuses on common research activities to fully develop, integrate, and evaluate SRL and potential or actual uses of ICTs in relevant educational practices of various countries. We are convinced that both teaching and learning need to change to reflect more optimal pedagogical, didactic, organisational, managerial, and systemic aspects than are presently in use. Existing practices of teachers and students need, of course, to be taken into account in the design and implementation of more optimal practices in European schools and universities.

Self-regulation of learning and ICTs in schools and universities

Probably the best known theoretical model of SRL is that of Zimmerman (Zimmerman, 2000, 2002). Maureen Snow Andrade (third paper in this issue) summarises the relevant characteristics as follows. SRL theory concentrates on a learner's meta-cognition, motivation, cognition, and behaviour. Strategy instruction and learner understanding are served by six dimensions of SRL: motive, methods of learning, time, physical environment, social environment, and performance. These dimensions correspond to the following questions

related to learning: why, how, when, where, with whom, and what? Use of these six dimensions and application of related strategies and self-reflection activities help learners increase their levels of self-regulation and related performance and success.

Actual SRL processes are thus influenced by environmental and personal conditions. While planning a learning activity, a student will not only have to assess the requirements of the task that lies ahead, but also estimate the ability of the available resources to cope with the task. These estimations are usually based on former experiences in comparable situations, evaluations of these experiences, beliefs concerning the student's abilities, and self-efficacy beliefs which direct the motivation to act (Bandura, 1997; Bowerman, 1978; Heckhausen, 1980). Former experiences in similar learning situations also consist of the feedback the learner received from the teacher and the learner's peers. Comments from the teacher and peers make a learner aware of possible alternative strategies to cope with a task and thus also influence SRL.

The main research question to be answered concerning SRL and ICTs, then, focuses on the various conditions and procedures by which ICTs can enhance the improvement of personal self-regulated learning and stimulate educational processes and outcomes. To answer this question, we need to look carefully at the different types of theoretical and practice-based conditions that will, or have been shown to, positively affect the learning functions of individuals and educational institutions. While some research on the potential of technology-enhanced environments to foster self-regulated learning has already been carried out in Europe (Bartolomé, Bergamin, Persico, Steffens, & Underwood, 2010; Beishuizen, Carneiro, & Steffens, 2007; Carneiro, Steffens, & Underwood, 2005; Mooij, 2006, 2007a; Steffens, 2006), we are still in a need of more conclusive evidence that ICTs will in fact support SRL. In this respect, *the goal of this issue* is to shed light on the conditions mentioned and their outcomes. This will be achieved by including five papers that are based on presentations at two symposia of the 'European Conference on Educational Research' (ECER) in Cádiz (2012). The symposia were part of the ECER network 16 'ICT in education and training'. The symposia were entitled 'Self-regulated learning in technology-enhanced learning environments' and 'ICT in education: Examples of good practice'.

The five papers report on research conducted in countries distributed throughout Europe; one paper is based on research in the USA. The papers give an impression of some of the theoretical, methodological, and practical aspects related to answering the research question above about SRL and ICTs. We also address the various levels of psychological development or educational attainment of the learners, which are relevant in answering the research

question. Moreover, we focus on different types of methodology and practice situations which contribute to the answers presented in the papers in this EERJ issue.

Generally, the five papers show that the use of ICT-based learning environments to support SRL is developing, and the same is true for research on the evaluation of SRL. At present, three more or less contrasting developmental models can be distinguished. These models can be summarised as:

1. ICTs to assist or replace traditional education and research;
2. ICTs to promote differentiated teaching and / or self-regulated learning;
3. ICTs to explore, specify, and check optimal educational conditions including criterion- and norm-based indicators to realise optimal, self-regulated learning.

In the first model (ICT-based learning, model 1), technologies are used as a replacement for traditional educational experiences such as when ICTs contain parts of textbooks and student monitoring systems replicate classroom tasks and organisation patterns. This design may even replicate or stimulate well-known dysfunctions of learning for specific groups of learners in that learners who already perform well in traditional schools without ICTs show the most improvement in SRL behaviours. A second developmental model (ICT-based learning, model 2) is to advance SRL by implementing relevant ICTs with the goal of giving both teachers and learners more freedom in school or at university. Technology-enhanced learning environments need to be flexible to accommodate single users, small groups, whole classes, or specific categories of students. Changes in the spatial set-up of the learning environment aim at being responsive, to enable ICTs to support the development of various aspects of SRL. According to model 2, learning is a process based on questioning, exploring, evaluating, and investigating, instead of memorising content that may not be related to students' lives. The assumption is that human learning occurs by continuous interactions between personal and environmental characteristics (Magnusson & Allen, 1983). The environment influences a person's development or learning; therefore, the teaching environment is designed to promote self-regulated exploration and successful learning progress at a level that is slightly above the actual level of competence (Bowerman, 1978; Kalyuga, Rikers, & Paas, 2012; Sternberg & Grigorenko, 2002; Vigotsky, 1978). Finally, a third approach (ICT-based learning, model 3) uses the assumptions of model 2 to explore, specify, and check optimal environmental or educational and diagnostic conditions to support SRL in order to foster optimal learning processes and controllable outcomes for each learner. In the context of model 3, ICTs are designed as environmental conditions that are integrated in education and may continuously support learning in or across various learning environments. According to model 3, theory and

research are multidisciplinary and longitudinal, while educational conditions include criterion- and norm-based indicators to diagnose and realise optimal, self-regulated learning throughout the school year or school career. In this way, it is expected to ensure optimal development and learning, while preventing potentially weak or dysfunctional aspects of education and their effects on students (see further Mooij, 2007a and Mooij et al in this issue).

The Articles

In the first paper, Ton Mooij, Elma Dijkstra, Amber Walraven and Paul Kirschner start with a contribution about children's self-regulation of playing and learning in preschool and primary school. Depending on innate potential and interactions in the home environment, young children vary in their cognitive and meta-cognitive competencies including their abilities to develop relatively autonomously and in a self-regulative way. In the Netherlands, preschool entrance is at about four years of age and institutional playing and educational processes are usually organised according to age level. This means that for about 10% of the less-developed and about 10% of the highly-developed children, the playing and learning activities that occur in school do not fit their level of psychological development. This condition implies that these young pupils are hardly or unable to self-regulate their activities in a psychologically responsible way. This misfit is responsible for many psychological, behavioural, and motivational problems of children who initially function at either a lower or a higher level than their age mates.

In line with SRL, learning processes in school are adapted to the level of psychological development of each child or learner in a group context. Yet the main ICT-based pupil-monitoring systems for preschool and primary school in the Netherlands are characterised by age- and group-based organisation (ICT-based learning, model 1: see also Meijer, Ledoux, & Elshof, 2011; Slinger, Van Trijp, Verheijden, & Van Empelen, 2011). To work in a developmentally and psychologically adequate way, teachers have to carry out general bureaucratic operations, but in addition, much more detailed work for each pupil who does not fit the mean level. Moreover, as ICT-based pupil-monitoring systems do not integrate playing, the learning of content, and the evaluation of learning into one system, teachers are additionally required to guess for each child which content will be evaluated by which aspects of the monitoring system (Mooij, 2007b, 2009).

This ICT burden can be overcome by designing and using curricula in the form of flexible blocks or modules. Specific contents refer to specific school subjects or other types of activities, which results in a clear pedagogical structure of organisationally-flexible playing and learning blocks characterising a school career. In addition, each curricular block may be characterised by two types of diagnostic indicators. The first one indicates the content or difficulty level of the learning tasks or activities in the block ('criterion-based diagnostics'), while the second type refers to norm-based diagnostics concerning the mean age or standard score of a representative group of peers. Curricular blocks then may include 'double diagnostics', which can be used to flexibly structure, differentiate, and evaluate the learning processes. For example, learning and grouping of learners may be based on criterion-based indicators, or on norm-based diagnostics, or on both of these. In this way it is also possible to organise learners according to their learner characteristics, strategies, or progress, or according to tasks or activities carried out with peers, or combinations thereof. The available pedagogical-didactic block structure thus enables flexible grouping of learners, based on the diagnostic and organisational choices made by the teacher or school. Moreover, the main diagnostic indicators provide an efficient overview of the core structure of the learning processes and the whole curriculum for teachers, schools, pupils or students, and parents.

Mooij et al (this issue) sketch a theoretical framework in which such pedagogical-didactical and organisational conditions support diagnostically-based playing and learning processes for each pupil in a preschool group or primary class. Double diagnostics, which include both criterion-based and norm-based diagnostics, are used to structure and evaluate the learning processes. ICT characteristics to further support and integrate differentiated playing and learning processes (ICT-based learning, model 3) are specified as well as opportunities to develop self-regulated playing and learning in optimal ways for pupils and schools. Specific ICT-based learning environments can then be designed to support individual, criterion-based learning progress, and norm-based comparisons with national standards, if desired. Within schools, or for specific pupils, teachers can further adapt the preparation of didactic content for teaching different groups of learners. In this way, improvement of SRL is expected to be realised at much higher levels than nowadays in Dutch preschools and primary schools. Mooij et al also describe a pilot to screen a pupil's beginning or baseline characteristics by an infant day-care teacher, the parents and the preschool teacher. Moreover, he presents information about an ongoing randomised experiment to develop core-structured learning processes in regular integrated preschools and primary schools, years 1 –

3. The results reveal actual characteristics of school innovation processes that may promote further improvement with respect to SRL and ICTs in educational practice.

The second paper in this issue is written by Karl Steffens. Its focus is on the use of ICTs at home and at school, and on their relationship with students' achievement in secondary school. In the year 2000, the Organisation for Economic Co-operation and Development (OECD) initiated the 'Programme for International Student Assessment' (PISA). PISA assesses competences in three main fields: reading, mathematics and sciences. Within this programme, data on the school-related knowledge and skills of 15-year-old students are collected on a large scale. PISA studies are performed every three years and the number of countries participating has steadily increased. With each assessment, the focus is on one of the three main fields. Steffens uses PISA data to find out whether using ICTs in school and at home is related to students' achievement: increased use of ICTs is expected to result in higher achievement on the PISA. In this context, the use of ICTs at secondary school can be interpreted as an application of ICT-based learning, model 1; the use of ICTs at home is an application of ICT-based learning, model 2. Steffens' paper informs us that, according to the PISA 2009 survey (OECD, 2011, p. 165), computer use in class is relatively low: at most, 25% of the students report that they use a computer during regular classroom lessons at least some time during the week. At home, computers are used for a wide variety of activities, with relatively high frequencies (OECD, 2011, p. 158). Computer use at home for school-related activities is not popular (OECD, 2011, p. 160). Interestingly, low use of ICTs as well as high use of ICTs tends to be related to low PISA achievements (OECD, 2011, pp. 181, 184).

Steffens then concentrates on three European countries with different results on the use of ICTs in school: Germany with 31%, Finland with 51% and the Netherlands with 85% (according to the 2006 PISA study). In Germany and the Netherlands, the frequency of computer use at home is very high (92% and 97%, respectively), while the secondary students who indicated not having a computer at home obtained lower scores in all three PISA 2009 competences (reading, mathematics, science). Steffens suggests that families without a computer at home may be low-income families, which is another obstacle to reaching high PISA scores. In contrast, frequency of computer use at home is lower in Finland (77%); Finnish students who did not have a computer at home, or did not use it, did better on the PISA 2009 than Finnish students who had, or used, a computer at home. Further exploration reveals that using a video games console at home varied across the three countries from 58 to 66%. In addition, students who used a video games console at home showed relatively poorer

PISA achievements than the other students. Students who had no video games console at home scored the highest in all three countries.

Furthermore, Steffens seeks to clarify whether the use of computers and video games consoles is related to family characteristics of the student. Here he uses an index of economic, social, and culture status (ESCS) related to (1) home possessions (including, for instance, the number of books), (2) parental occupation, and (3) parental education (number of years of schooling) which was used in the PISA studies. This index can function as an operationalisation of Bourdieu's concept of 'cultural capital'. The three countries differ with respect to the relationship between ESCS and the use of a computer and video games console at home. In Germany, the absence of a computer at home is related to low scores on ESCS; in Finland and the Netherlands no significant difference exists, although the Dutch trend resembles the German finding. In the three countries, the relatively highest ESCS index is found for students who have a desktop computer at home, but do not use it. In Finland and in the Netherlands, the absence of a video games console at home is related to the relatively lowest ESCS index; this is not true for Germany. Finally, Steffens relates the use of the Internet for school and leisure time or fun activities to the ESCS index. In Germany, the ESCS index increases as Internet use at school and for leisure activities increases. A similar pattern emerges in the Finnish and Dutch samples. He concludes that it does make a difference whether secondary students have, or use, a computer at home or a video games console. In other words: SRL by computer use at home is positively related to PISA achievements; in contrast, using a video games console is negatively related to PISA achievements. Moreover, it is necessary to look closely at specific situational conditions of SRL – like family, educational, and national conditions – and the kind of ICT equipment being used, how it is used, and in which European country.

In the third paper in this issue, Maureen Snow Andrade explores the relationship between dialogue and structure in ICTs in higher education that aim to enable learner self-regulation in technology-enhanced learning environments. She states that distance learning, including technology-enhanced learning environments, provides a solution to the ever-increasing global demand for higher education. To be successful, learners must be self-regulated, or have the ability to control the factors affecting their learning. She bases her study on theories of transactional distance, SRL, language acquisition, and the model of self-regulated distance learning. The relevant model has already been shown to increase learner self-regulation and success. This type of research can be seen as an example of ICT-based learning, model 2.

The exploratory study in Andrade's paper examines the impact of dialogue, or teacher feedback, and structure on the effectiveness of SRL activities in an English language course based on the model of self-regulated distance learning. The study involves 75 students from over 20 different nations, and two teachers. The course design model focuses on increasing self-regulation (i.e., the ability of learners to control the factors and conditions that affect their learning) alongside English language proficiency. In the course, structure consists of pre-prepared course materials accessed via links on the home page to course components, calendars, and deadlines for assignments, readings, instructions, media presentations, and overall course content. Dialogue involves interactions between the student and teacher, and among students. Dialogue occurs through assignment feedback, e-mail, discussion boards, and technology-mediated real-time one-on-one tutoring. This aspect of the course also provides the interactivity and communicative practice necessary for language acquisition. As students engage in the course, and specifically the learning tasks and SRL activities, the goal is that they become more responsible for their learning and need less structure. Thus, their capacity for autonomy should increase.

The review of teacher dialogue indicates that the first teacher provides extremely limited feedback and fails to notice the structural problems in the learning management system. In contrast, the second teacher comments on every assignment, notes strengths and weaknesses, and makes suggestions for improvements. This teacher gives extensive feedback on the SRL assignments, reminds students to complete them if needed, and notes their purpose and value. According to Andrade, the findings indicate that a lack of dialogue on the part of the teacher and missing structural elements in the learning management system (that the second teacher fails to notice) are related to students completing the activities superficially, with inappropriate sequencing, or not doing them at all. Across the two semesters studied, the teachers varied in the extent and quality of their feedback, and structural problems undermined the value of the activities. Consequently, changes were made to the course set-up and teacher training provided.

In the fourth paper of this issue, Daniel Cebrián Robles, José Serrano Angulo, and Manuel Cebrián de la Serna focus on the design of the so-called 'Federated eRubric tool' to support university students' learning. The authors state that students in higher education should achieve certain skills through a self-study process, which is supported by their teachers and ICTs. For example, students should be able to appreciate and identify the indicators and evidence of their learning related to the professional skills they are expected to develop in a course. Furthermore, students should have the ability to discuss the quality of the learning

process with their teacher and to evaluate or assess their learning using the indicators and criteria specified in the rubric. On the other hand, teachers must be able to define expected skills and associated criteria and indicators, and apply these to the evidence of learning that students submit.

The eRubric, then, can serve as a formative but also a summative tool for assessing instructional aims. To realise these aims, students must get involved with the learning process, self-evaluate, evaluate their classmates, co-evaluate with the teacher, and participate in designing the rubric. In other words, the use of an eRubric is expected to support SRL and improve learning quality. Across different universities, and using their own institution's login, groups of students and their teachers can choose a variety of digital services and tools with which to develop an eRubric. The eRubric supports student self-assessment and peer assessment, while assisting teachers in assessing competency and improving communication with students about their learning. This approach can therefore be seen as an example of ICT-based learning, model 2. The eRubric tool is a service that can be accessed by every Spanish university and research institution; it is hoped that other European institutions will join soon.

Research using the eRubric tool to explore the skills of university students was conducted by Manuela Raposo Rivas, Manuel Cebrián de la Serna, and Esther Martínez-Figueira. In paper five of this issue, these researchers present a quasi-experimental pilot to explore the use of the eRubric with Spanish students and their teachers. Their research can be seen as an example of ICT-based learning, model 2. The experimental group (n students=33) used the eRubric and the control group (n=29) did not use the eRubric. The pilot reveals the students' and teachers' results and their views about the opportunity to use self- and peer evaluation. As far as their competences were concerned, the experimental group performed better than the control group, although these differences were not statistically significant for all the activities involved. Also, the experimental students perceived the use of the eRubric to be a positive resource because it encouraged an objective evaluation.

Conclusions

We draw several conclusions from this introduction. The first is that SRL in technologically enhanced learning environments has many faces, facets, and applications. This is not a bad situation, of course, but it seems that stricter theoretical modelling of SRL and its technological support, and using more rigorous model and methodological features in both

design and research, will improve the accumulation of relevant knowledge and result in increased expertise of learners and teachers. The different levels of educational attainment (preschool, primary school, secondary school, higher education) also play an interesting role; it seems that differences in psychological development levels, levels of SRL, and corresponding learning requirements for students influence theorising and research approaches. As such, these psychological differences among learners seem to be more relevant than differences among European educational conditions, cultures, or countries. Moreover, expertise in the fields of the psychology of learning, diagnostics, developmental and social psychology, as well as in collaborative group work, and corresponding theoretical knowledge, are also relevant in designing optimal ICT-based learning environments for different types of learners and teachers. Realisation of this rather complicated work will cost much effort and many years of careful design in conducting theoretically adequate, practice-based research.

It therefore seems worthwhile to include SRL in technologically-enhanced learning environments in an integrated, comprehensive European project to study the effects of identical and varying features across countries. A way to do this is to group researchers from various countries and support them in developing a comparable theoretical approach that may be situated in different educational systems, at various levels of attainment, but uses comparable operationalisations to intervene in schools or universities and to collect and analyse longitudinal data at multiple levels. Such a European collaborative effort would also align with the aim of EERJ to promote common research in educational practices of various countries in order to work towards realisation of more optimal pedagogical, didactic, organisational, managerial, and systemic aspects than exist nowadays. And, as we demonstrate in this issue, ICTs can strongly support the design of optimal learning environments for different types of learners and teachers.

A second conclusion is related to the differences in levels of educational attainment and in the information about preschools and primary schools. If the situation described for Dutch young learners (see the article in this issue by Mooij et al) is valid in other countries (which seems to be the case; for example, consider Germany, the UK and Belgium), realisation of an early preventative and diagnostically based approach to stimulate SRL is expected to have positive effects on students' school careers in other countries, too. This issue could also be included in longitudinal comparative research across European countries. Furthermore, early stimulation of SRL in school may lead to other learner preferences and competences in secondary school, which could modify the present outcomes in secondary school as found by

Steffens (this issue). The same could be true for SRL processes and effects in higher education as well (see the other papers). Testing such a hypothesis could be an important subject of future European research.

The third conclusion based on the papers in this EERJ issue is that, in line with our expectations, ICTs do indeed seem to enable flexibility in education and, in doing this, may improve both personal and institutional performance. Compared with some 15 years ago, teachers and students can now use digital media in ways that may realise the expected potential of ICTs. Furthermore, as expected, full development, exploitation and use of the potential of ICTs in educational practice require that both teaching and learning have to change profoundly to realise more optimal learning processes and outcomes for every learner in school or at university. This means that ICT-based learning, model 3, has to be worked on further, in combination with ICT-based learning, model 2. This modelling may direct SRL theory, technological development, and the design of European research in the future.

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Note. The two symposia at ECER 2012 were organised by Karl Steffens; Ton Mooij was the discussant.