

Thematic Working Group 4 - Fostering Self-Regulatory Skills in Learners in Digital Learning Environments

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Background

A notable trend in learning and teaching that has been accentuated by the COVID pandemic is a move towards online, blended or hybrid learning scenarios. This particularly affects higher education but also extends to K-12 education, though the manifestations vary. Learning in diverse technology-supported learning environments poses certain challenges to students. For example, there are higher demands on students' abilities to plan, manage and reflect their learning in such environments - abilities that are part of students' competence to self-regulate their own learning (Azevedo, 2009).

The importance of students' self-regulated learning (SRL) has long been recognized in research and practice. Theories of SRL, i.e., the ways learners monitor, reflect on and regulate their motivation, cognition, metacognition & emotions in order to learn, have been developed and refined over a number of years since they emerged from educational psychology approximately 20 years ago (Panadero, 2017). Research has shown positive correlations between the use of SRL-strategies, learning processes and academic outcomes in face-to-face learning settings (Broadbent & Poon, 2015). Evidence for the importance of SRL-skills specifically in online and blended learning scenarios has also been accumulating (ibid.). Compared to face-to-face settings, SRL might be even more important because students are more often having to work without teacher support and thus need to be able to learn autonomously (Xu et al., 2023).

However, the relationship between SRL-skills, technology-supported learning environments and learning outcomes is complex and multi-directional. In recent years, research into SRL and how it may be supported by technologies has proliferated. At the same time, there is a need for orientation in the field. The aim of Thematic Working Group 4 (TWG4) was therefore to review what research has to say about the challenges of SRL in technology-supported learning environments and how these findings can be applied to the design of learning environments that effectively support SRL. This eBook report presents results of an international discussion of the members of TWG4 over several months in 2022 and 2023. The review of evidence from research publications enabled us to identify a number of challenges related to fostering SRL

in technology-supported learning environments and to propose recommendations for researchers, practitioners and policy makers.

Moving forward to new educational realities in the digital era

New educational realities

The implementation of online, blended or hybrid learning scenarios in all phases of education poses higher demands on students' SRL and raises the question of how to support SRL as well as to develop students' SRL-skills in these environments. Research and technological developments often focus on higher education, where students tend to learn in rather 'closed digital systems'. However, in K-12, we rather see a mix of homework assignments, blended learning, and frequent shifts between digital and physical spaces, enabled by tools such as tablets and mobile devices.

While the need for students to develop their self-regulatory learning skills has long been recognized, these SRL-skills are even more important in online and blended learning scenarios because students are more often having to learn autonomously (Xu et al., 2023). This need becomes even more significant with a stronger emphasis on educational approaches like personalized or self-directed learning, where students have to create their own learning goals and monitor and evaluate their learning progress. In addition, ChatGPT and other generative Artificial intelligence (AI) technologies have intensified discussions about what and how students need to learn in the future. Creating a conducive environment for learning, equipping students with the responsibility for their own learning and providing them with the ability to self-create their learning path are pressing concerns.

Learners face many difficulties while attempting to self-regulate their learning in technology supported as well as in traditional learning environments and need support to develop their SRL-skills (Ázevedo, 2009). Unfortunately, students often lack opportunities to enhance their SRL-capabilities in school. Research showed that teachers often integrate only little SRL support into their classroom practices (Callan et al., 2022). The direct instruction of specific SRL-strategies to students is especially rare (Dignity & Büttner, 2018). In addition, the development of SRL-skills at different school levels appears to be uneven. Notably, there seems to be an emphasis on the cultivation of SRL-skills during primary school education, but this focus diminishes during secondary school. However, we need a deeper understanding of the factors influencing the development of SRL. Despite the presumption that students possess a wide range of SRL-capabilities, there is only limited research on students SRL in technology-supported learning environments. A meta-analysis by Panadero et al. (2017) showed that SRL can vary extensively among students, important factors being age and gender as well as self-efficacy and motivation. However, research evidence with respect to students' SRL in diverse and mixed technology-supported learning environments is rare, especially for K-12 students.

Developments in online learning, specific digital functionalities as well as new applications of artificial intelligence (AI) provide more opportunities to scaffold students' self-regulated learning as well as to assess and promote specific SRL skills (e.g., planning, reflection). A range of instruments have been developed for these purposes (Alvarez et al., 2021). Studies have shown that these tools can be effective in promoting SRL-skills and improve learning outcomes

(e.g., Guo et al., 2022). However, some highly structured digital and AI-enriched learning environments may potentially also restrict opportunities and affordances for SRL and subsequently decrease SRL capabilities in some students. This is a possibility that requires further investigation and strategies for designers and educators on how to avoid this.

A further issue is the potential for increased inequalities among students. SRL-skills have a major impact on learning motivation and effective learning processes especially in digital learning environments (Xu et al., 2023). Therefore, a lack of these skills can be a disadvantage in terms of learning outcomes and subsequently educational or professional career choices. Since a lack of SRL-skills is particularly pronounced among students from lower socio-economic and/or academic backgrounds (Guo et al., 2022), this might reinforce existing inequalities. Fostering SRL skills in a technology supported learning environment in school is therefore also a question of providing equal opportunities to all students.

Contributions of the TWG to the new educational realities

Reviewing evidence from recent research has led us to the identification of five interrelated challenges:

1) Theoretical clarification of SRL concepts to inform development of digital supports

Several theoretical SRL models have been developed in the last 20 years (Panadero, 2017). Related concepts such as metacognition are also used in the literature. Recent theories of SRL also apply not only to individual self-regulated but also to co-regulated learning and socially shared regulation of learning (Hadwin & Oshige, 2011). In higher education the term “self-directed learning” (SDL) has been used to describe the behaviors of students who take responsibility for directing their own learning. Thus, SDL focuses on examining students’ behaviors and has a much more limited theoretical base than SRL. The relationship between SRL and SDL, however, has often been confusing (Saks & Leijen, 2014). “Personalized learning environment” (PLE) is another concept that is strongly related to and influenced by SRL concepts (Dabbagh & Kitsantas, 2012). PLEs are individually tailored (digital) learning environments that provide opportunities for students to learn at their own pace and interest. Research suggests that learners with higher SRL abilities might be better prepared to take advantage of a PLE (Xu et al., 2020). Theories about how students can regulate their learning and become autonomous learners have also been influenced by research on formative assessment and there is in turn strong evidence that formative assessment practices can promote SRL (Greene, 2020). In summary, SRL is a widely used concept in research on technology supported learning environments but has also a) strong overlaps with related theories which are not always clarified and b) no sufficient theoretical integration of the role of technologies in different SRL-processes.

2) Effectiveness of specific types of technological support to foster learners’ SRL

Many different digital tools have been developed to support SRL and to promote its development. This includes the identification of relevant SRL-related behaviors and SRL learning profiles in online-learning and their visualization (e.g. in dashboards), scaffolds for specific SRL sub-processes (e.g. a planning assistant) or for co-regulated learning sequences (e.g. awareness tools for group work).

Technology enhanced instructional designs can emphasize a more direct or indirect approach to the promotion of SRL (see Figure 1). Direct promotion of SRL can be explicit, e.g., using video instructions or context-specific instructional comments. Others are implicit, such as prompting self-regulatory cognitive and metacognitive processes. Another approach is to design the overall learning environment and embed indirect promotion of SRL through, for example by introducing complex problems or formative assessment methods.

<p><u>Direct promotion of SRL (“teaching” SRL):</u></p> <p><u>explicit:</u> e.g. video instructions, instructional comments</p> <p><u>implicit:</u> e.g. prompting of the self-regulatory cognitive, metacognitive and motivational processes</p> <p><u>Indirect promotion of SRL (activating SRL through the design of the learning environment):</u></p> <ul style="list-style-type: none">- e.g. scaffolding of the self-regulatory cognitive and metacognitive processes- e.g. opportunities for elaborated feedback- e.g. opportunities for formative assessment

Figure 1 Different types of SRL promotion (adapted from Fahrni et al., submitted)

Research revealed that both direct and indirect types of SRL support in computer-based learning environments produced positive effects on academic performance (Guo et al., 2022, Xu et al., 2023). Furthermore, SRL is a complex process with a number of phases and sub-processes. Therefore, it also needs to be considered which type of tool better supports specific processes. Based on a systematic review, Álvarez et al. (2022) showed that goal setting, monitoring and self-evaluation are the SRL processes supported the most by current existing tools, whereas help seeking and self-reflection were not sufficiently addressed in research. Zheng’s (2016) meta-analysis suggested that it is necessary to use scaffolds to support SRL during the whole process by integrating SRL tools with multiple functions.

However, there is little research on the effectiveness of particular combinations of technologies, SRL processes and instructional approaches in promoting students SRL. Furthermore, it is also important to monitor the impact of these technology supported learning environments not only on learners academic outcome but also on the social wellbeing of students.

3) Role of learning analytics and AI in supporting SRL in technology supported learning environments

Learning analytics (LA) and AI functionalities currently being embedded in educational software include, for example tracking and clustering of online learning activities, automatic assessment of students’ skills; visualization and personalized feedback and intelligent (pedagogical) human–computer interaction systems. Multimodal multichannel data, e.g. to identify students' emotional regulation, is increasingly being utilized in recent research (Molenaar et al., 2022). Many of these functionalities can be harnessed to assess and support SRL and there is a growing body of evidence on the value of AI-enabled learning environments to support SRL (ibid.). Recent developments in AI functionalities have also suggested ways in which the development of SRL can be supported by a combination of digital tools, AI support and human support (Molenaar, 2022). Challenges lie in the identification of meaningful SRL

profiles from log data, the visualization of information on SRL behaviors and the interpretation and utilization by teachers and students. In addition, there are also a variety of risks to consider, e.g. impact of algorithmic bias in AI applications that might result in unfair outcomes.

4) Understanding the interaction of students' SRL competencies with other student characteristics and digital SRL supports

To date, it remains unclear, particularly in K-12, how students with different SRL abilities cope with the demands of learning in more open technology supported learning environments. Some students might benefit from more SRL scaffolding to compensate for their lack of SRL skills (Koivuniemi et al., 2021). However, highly structured digital learning environments can also potentially decrease SRL capabilities by providing too little freedom for students to develop their own goals and decisions. This inherent contradiction can only be addressed by adaptive learning approaches considering the different SRL skill-levels of students. For example, SRL support could be differently designed for novice and advanced learners: novice learners might profit from cognitive strategy scaffolds (e.g. a knowledge map), for advanced learners prompts for planning and monitoring activities might be more effective.

Another area of focus pertains to learner characteristics that influence the effective use of specific SRL supports (e.g. SRL attitudes, self-efficacy). Furthermore, students might have certain preferences concerning specific digital tools and it might be helpful if they participate in the design of their personal SRL support. The relationship between learner attributes and the application of individual SRL supports is an important avenue for future research.

5) Understanding teachers' roles in supporting SRL in technology supported learning environments

Teachers face a number of challenges both for utilizing digital technologies and for associated SRL support and development. They need to acquire new competences to design and implement digital learning environments that effectively provide adaptive SRL support. These competencies are typically context-specific and require a solid foundation in technological and pedagogical knowledge, which in turn may also be related to teachers' own SRL capabilities (Huang et al., 2021). Furthermore, teachers are also experiencing a growing tension in balancing and integrating data-driven instructional suggestions (e.g., from dashboards) with their own experience and expertise (van Leeuwen et al., 2023). How teachers handle these tensions is not clear. A recent systematic review revealed that research on how teachers perceive and use opportunities in technology supported learning environments is rare (Fahrni et al., submitted). There is a growing need for both teacher support and technological support to develop students' SRL. This also includes new ways of conceptualizing and implementing opportunities for hybrid teacher-student-AI support (Molenaar, 2022).

Key insights from other TWGs

With reference to TWG1 (Artificial Intelligence and big data), AI applications, their opportunities and risks, are intensively discussed in recent research and we therefore included this as a challenge in our report. Our discussion with TWG5 (Learning beyond formal schooling) brought up the very important fact that informal learning spaces are important opportunities for learning SRL and the question of how we can make sure to transfer these experiences to

formal schooling. With reference to TWG 9 (Social emotional aspects) we discussed the (underrated) role of socio-emotional regulation in SRL research and the fact that students' wellbeing is not given enough attention as a goal of SRL. The ideas of TWG7 (Post pandemic online learning) sharpened our thinking about shifts between digital and physical spaces and what challenges that poses to the promotion of SRL for example by teachers.

Strategies and actions

Strategies and actions for researchers

- Based on the existing research on SRL and technology-supported SRL, theoretically clarify the SRL-concept, specify similarities and differences with related concepts such as PLE and specify the role of digital technologies including hybrid forms of human-AI co-regulation.
- Conduct empirical studies on ...
 - students' capacity for SRL in technology supported learning environments, and the enabling and hindering factors for the development of SRL skills. Analyze also possible negative effects for instance on learners' autonomy.
 - how specific digital technologies promote SRL skills of students considering various learner characteristics. Explore the role of teachers and learners and ways in which they can act synergistically with digital technologies (including AI)
 - how to use LA and AI for supporting students and teachers. Carefully document and evaluate the use of indicators and models for SRL assessment and support, including teachers' understanding and reasoning as well as unintended side effects for students' learning, wellbeing and new inequalities.

Strategies and actions for practitioners

- As a teacher, recognize the importance of SRL in digital learning environments and know the opportunities and limitations to support SRL by technology, to be able to design a learning environment with learning activities for students that support their SRL.
- As an educator, teach SRL to teachers not only as an ability to teach SRL to students, but also as a personal skill to empower teachers' own teaching and learning.
- As a developer, include researchers and teachers in the development of new digital tools or functionalities for the assessment and the promotion of SRL.
- Raise awareness about issues of equity for students from different backgrounds and document and analyze possible factors related to aspects of equity.

Strategies and actions for policy makers

- Based on the existing competencies frameworks for teachers: make sure that these frameworks include SRL and ways to support this by technology. Also include SRL competencies in current curricula, but do not add (again) things "in the yard of teachers" but highlight connections with existing concepts.
- Strengthen SRL as part of teacher education and provide resources to enable professional development in relation to (technology-supported) SRL.
- Ensure educationally relevant data literacy levels and teachers' capacity to use data for decision-making and instructional design, including a better understanding of the pedagogical contributions and risks of AI applications.

- Develop policies, guidelines and best practices examples for stakeholders surrounding the use (and risks) of LA and AI applications for SRL support.

Actions from the TWG

We plan to take the following actions:

- Proceed with an umbrella review and write an academic journal article.
- Present themes and challenges identified by TWG4 at key conferences and meetings.
- Translation and publication of brief companion pieces in national educational channels & networks.

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