

Self-regulation of learning in the context of modern technology: a review of empirical studies

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Abstract

Purpose – Self-regulation is the level of learning where the learner becomes an active agent in their learning process in terms of activity and aspects of motivation and metacognition. The current paper mostly deals with the metacognitive aspect. The purpose of this study is to gain insight into self-regulation of learning in the context of modern technology in higher education. This study also aims to highlight the direction, tendencies and trends toward which self-regulation of learning is moving in relation to modern technologies.

Design/methodology/approach – The review study was compiled via searches in three databases: Scopus, Web of Science and ERIC. A filter was used to search for empirical studies solely in English, published over the past decade on the topics of self-regulation of learning and technology in higher education.

Findings – The findings clearly show a correlation between self-regulation of learning and modern technology, especially after a significant event such as the Covid-19 pandemic. However, in the wake of this change, the field of education has seen the emergence of methods and new platforms that can provide support for the development of self-regulated learning strategies.

Originality/value – The originality of the study lies in the fact that it focuses on the link between self-regulation of learning and modern technologies in higher education, including some predictions of the future direction of self-regulation of learning in this context.

Keywords Future direction of self-regulated learning, Higher education, Literature review, Self-regulated learning, Self-regulated learning strategies, Technology

Paper type Literature review

Introduction

Our text presents a review study of empirical articles that relate to the self-regulation of learning in the context of modern technology in higher education. The ever-increasing development of society goes hand in hand with the development of modern technology, which increasingly affects the field of learning. It touches on topics such as new ways of learning or new educational practices. This reality could be observed with the transition from face-to-face to distance learning when the Covid-19 pandemic hit the



world. Face-to-face education at universities differs from distance learning in many ways, among them in student self-regulated learning (SRL). Modern technology has played a significant role in education in this situation. As a result of the circumstances, the notion of self-regulation of learning has again become prominent. However, it is not a new term.

Distance learning highlighted the fact that the self-regulation of learning has become a much more conscious process than it has been to date. Students had changed their routines entirely at both primary, secondary and university levels, with different ways of teaching and classroom organization, including testing. Zimmerman and Schunk (1989) define self-regulation as that level of learning where the learner becomes an active agent in their learning process in terms of activity and aspects of motivation and metacognition. He adds that self-regulation is not a mental ability but a learning skill. It is a process of self-management with the help of which students transform their mental abilities into the skills needed for learning (Zimmerman and Schunk, 1998). The autonomy and responsibility of students for their learning is a significant aspect of self-regulation of learning, as explained by Carneiro *et al.* (2015). The degree of student autonomy is increased by the physical absence of the teacher, not only at universities. Not all students are sufficiently motivated. They fail to use cognitive strategies and thinking skills; they may exhibit a lower level of self-monitoring. In the absence of self-regulation skills, students may not fully interpret autonomy correctly in a distance learning environment and may not complete learning tasks as required (Cho and Heron, 2015). Modern technology can influence the degree of students' self-regulation of learning. It depends on the ways in which technology is used to enhance the learning environment so that self-regulation is promoted.

Methods

The primary aim of this review study is to describe, through the analysis of empirical studies, the relationship between self-regulation of learning and modern technologies in higher education. The secondary aim is to provide an overview of what directions, trends and tendencies these two interlinked concepts have taken in the last 10 years. Our discussion of the connection between self-regulation of learning and modern technology is reflected in the recent topics, the research objectives, the research tools and the main research findings.

Literature review focuses on analyzing four areas appearing to be crucial within the studies reviewed. These are as follows:

- (1) Which topics within self-regulation of learning have been discussed?
- (2) Which research objectives and questions have emerged in the studies?
- (3) Which research tools have been used?
- (4) Which primary findings have been presented?

Study selection for analysis

The selection process for the empirical studies was as follows. The Scopus, Web of Science and ERIC databases were chosen for the search; they contain relevant resources in the field of educational research. The keywords at the beginning of the search were "Self-regulated learning" and "Technology*". The databases displayed 2,381 items that matched the search terms. More detailed search criteria were then established:

- articles from 2012 to the present;
- empirical studies dealing with the concept of self-regulation of learning;
- journal studies published in English; and
- research conducted at universities, specifically with the university students.

The justification for the last criterion is online learning and the introduction of modern technologies in university teaching, becoming very popular, especially in the past decade. Compared to the traditional concept of face-to-face teaching, there are two advantages: flexibility and accessibility (Golosova and Romanovs, 2018). These two advantages have been the reason why the barriers of time and space could be addressed (Li, 2019).

The criteria reduced the number of studies to 36 focusing on self-regulation of learning in the university context in connection with the utilization of modern technologies in teaching, teaching support or the development of self-regulation of learning. A more detailed diagram of study selection is depicted in Figure 1.

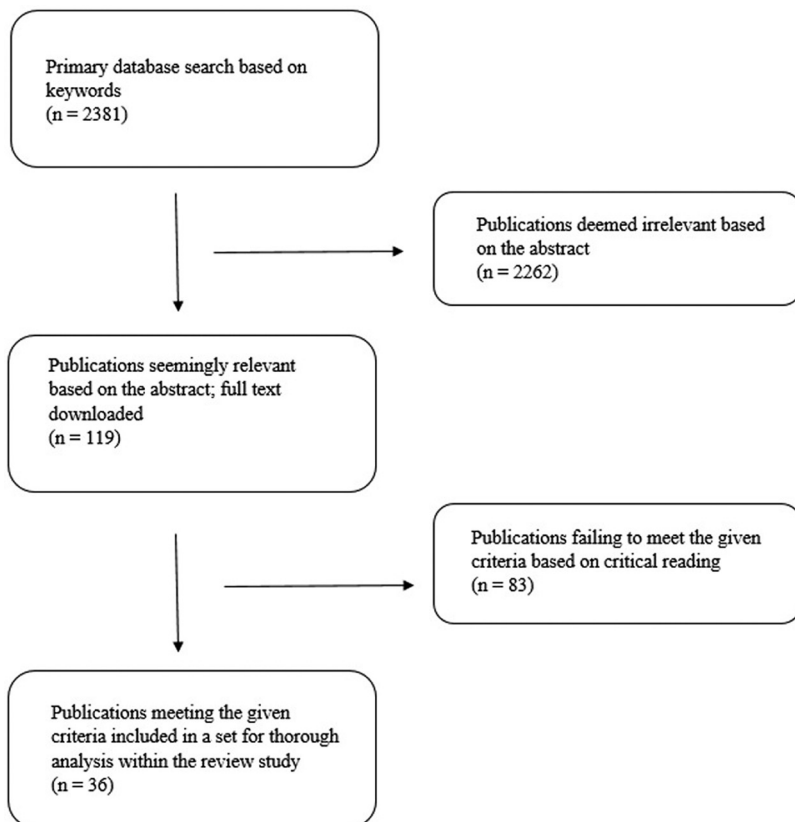


Figure 1.
Diagram of the study selection procedure

Source: Developed by the author (2023)

Results of the selected studies analysis

In this chapter, the results of the analysis of the selected studies will be discussed in the order of the defined questions, focusing on the key topics, objectives or questions, research tools and primary findings.

Which topics within self-regulation of learning have been discussed? In the studies that were analyzed, the conceptual framework of the entire study was mainly composed of multiple topics the authors discussed. However, the study always included the concept of self-regulation of learning. In more than half of the cases, the concept of SRL was present, referring to Zimmerman and Schunk (1989, 1998) or Pintrich (1991, 1999). Six categories were created based on the analysis.

SRL and Covid-19. The first category consists of four studies that explicitly address self-regulation of learning in the context of the Covid-19 pandemic and online education. All but one study addressed students' readiness for online learning and their SRL strategies and competencies (Naujoks *et al.*, 2021; Li *et al.*, 2019; Klimova *et al.*, 2022). However, Hadwin *et al.* (2022) went further in their investigations and pointed to the influence of self-regulatory practices that promote adaptation to new contexts, tasks and situations, which is associated with mitigating the impact of Covid stressors. The sudden transition to a different mode of education has caused several topics to emerge. They included digital literacy, IT equipment, previous experiences with online learning or sharing information in the online space and topics directed toward the self-regulation of learning, such as structuring the environment, time management, help-seeking and the question of motivation. Lee and Tsai (2011) found in their research that students' self-regulation of learning varies depending on the learning environment. These findings are followed up by Carter *et al.* (2020), who argue that students in online education face a greater need to self-regulate their learning.

SRL and style of learning. The SRL and style of learning category contains five studies that explicitly and implicitly focus on learning styles comprising serious game, game-based learning (GBL) and differentiated instruction (DI), including flipped classroom (FC). These learning options have much in common. In all cases, they directly support the development of self-regulation of learning, emphasizing the value of modern technology and digital tools in the actual process of self-regulation of learning in and out of the classroom environment. The identification and strengthening of SRL strategies is achieved with the help of serious game (Ocampo, 2017). For example, focusing more on the concept of game-based design. Wan *et al.* (2021) discuss GBL as an essential tool to motivate students to learn actively and constructively. The study focuses on aspects of SRL such as concentration or feedback using GBL. The study mentioning DI looked at the level of SRL using DI (Meşe and Mede, 2022). Last but not least, there is FC, which focuses on SRL strategy development, among others (Blau and Shamir-Inbal, 2017; Yoon *et al.*, 2021).

SRL and platforms. SRL and platforms emerged as another category comprising eleven studies. The SRL-connected theme was prevalent – the massive open online course (self-regulated learning). Even though the MOOC is not a novelty, it offers an environment where individual students can self-regulate their learning and determine what content and activities they will engage in at what time (Hood *et al.*, 2015; Littlejohn *et al.*, 2016; Lan *et al.*, 2019). Pérez-Sanagustín *et al.* (2020) even linked the concept of self-regulation of learning, FC and MOOC. MOOCs have been present in the education market for some time now, so they are starting to face challenges related to efficiency, relevance and innovation. In response to this, Reparaz *et al.* (2020) focus on assessing differences in SRL and other variables (perceived effectiveness, MOOC interaction, motivation and sociodemographic characteristics) related to MOOC sustainability. The ePortfolio, on the other hand, has been developed to help students document, monitor and review their learning. A critical aspect of ePortfolio is that it contributes to students' academic development in the context of SRL. The effect of the ePortfolio

intervention on SRL and specifically on aspects of cognitive, affective, behavioral and contextual processes has been investigated by [Alexiou and Paraskeva \(2019, 2020\)](#).

The category also contained studies discussing other platforms, such as Live Chat. [Broadbent and Lodge \(2021\)](#) explored how students perceive using Live Chat as a tool for finding academic help online. There is also a novel block-chain-based metacognitive learning management systems (LMS). The article primarily discussed an online SRL intervention program based on Blockchain, which allowed students to develop SRL skills within realistic learning goal setting, self-monitoring, self-reflection or self-awareness. The program securely stores extensive SRL data on student scores and results ([Saadati et al., 2021](#)). Finally, there are studies that work with clickstream data (CSD). [Cao et al. \(2022\)](#) used CSD to reveal the temporal management of SRL. In contrast, [Rizki et al. \(2022\)](#) work with SPADA uses CSD, which helps teachers to observe students' learning behavior patterns in real time. SPADA is one of the LMS. [Baker et al. \(2020\)](#) discuss the use of modern technology in education, specifically online learning systems. They conclude that the systems help to understand student behavior in the context of SRL.

SRL and language learning. This category consists of three studies focusing exclusively on SRL and foreign language acquisition, specifically on the relationship between SRL and foreign language learning through modern technology. A stimulating environment facilitating learners' self-regulation is crucial in language learning. Almost a decade ago, [Andrade \(2014\)](#) explored a model of self-regulation of learning in distance education in relation to student success. [Zheng et al. \(2016\)](#) focused their attention on researching the concept of students' beliefs and their level of learning self-regulation in online learning. In contrast, [Supriyono et al. \(2020\)](#) believe that their research would contribute to the development of the theory of technology integration in language learning in relation to self-regulation skills. [Schwienhorst \(2002\)](#) adds that virtual environments can promote motivation and improve self-regulation regarding second language learning.

SRL and strategies. The fifth category, comprising six studies, does not address the process of learning self-regulation *per se* but targets SRL strategies. Some studies focus on the relationship between SRL strategies and the use of technology in the context of planning, organizing and facilitating student learning ([Broadbent, 2017](#); [Yot-Dominguez and Marcelo, 2017](#); [Loeffler et al., 2019](#)), including the achievement of academic goals using students' personality traits ([Bruso et al., 2020](#)), preferences and talents or feedback ([Inan-Karagul and Seker, 2021](#)). Others also raise the issue of promoting digital literacy and digital learning to enhance the effectiveness of human capital for sustainable development in lifelong learning ([Anthonysamy et al., 2020](#)). Digital technologies give room for new alternative learning opportunities that favor the acquisition of self-regulatory skills ([Bernacki et al., 2011](#); [Schneckenberg et al., 2011](#)). As [Scott \(2015\)](#) argues, the most relevant skills for learning and work come from the areas of self-regulation and digital literacy.

SRL in general. The last category includes eight studies failing categorization into any of the previous collections. They deal with self-regulation of learning in a general way, both explicitly and implicitly. However, these studies also build conceptual frameworks that do not rely solely on SRL but also include, for example, monitoring student behavior, the impact of different SRL approaches, including support and a better understanding of learning processes, the development of learning-related skills and problem-solving ([Barak et al., 2016](#); [van Harsel et al., 2021](#)), what factors may influence learning self-regulation ([Nuankaew et al., 2019](#)), the relationship between SRL and school assessment in the context of academic success, including students' attitudes and approaches to SRL. Some studies explicitly engage an analytical approach. Universities collect a variety of data on students through which they attempt to gain insight into students' learning processes. The analytical

approach helps not only students but also provides benefits for all stakeholders in the educational arena, at the mega level (government), macro level (institutions), meso level (curriculum, teachers) and micro level involving students. Learning analytics offers a promising approach to support and a better understanding of students' learning processes (Schumacher and Ifenthaler, 2018, 2021). Broeren *et al.* (2021) addressed how instructional intervention can increase SRL. Broadbent *et al.* (2021) tested SRL characteristics as a driver of performance during a formative task in two learning contexts. However, all studies implicitly pursue the same goal of promoting the development of self-regulation of student learning.

Which research objectives and questions have emerged in the studies? Several trends emerge from the research objectives in the empirical research studies. The purposes of the studies were classified into seven basic groups. However, some studies pursue more than one purpose, so they may simultaneously occur in more than one group.

The first group contains goals focusing on academic performance (Lan *et al.*, 2019; Yoon *et al.*, 2021; Broeren *et al.*, 2021; Schumacher and Ifenthaler, 2021; Cao *et al.*, 2022), achievement (Lan *et al.*, 2019; Hadwin *et al.*, 2022), feedback and evaluation (Pérez-Sanagustín *et al.*, 2020; Loeffler *et al.*, 2019; Broadbent *et al.*, 2021; Andrade, 2014) and academic performance (Alexiou and Paraskeva, 2020; Broadbent, 2017) in correlation with students' self-regulation of learning and modern technologies.

Another group consists of activities related to the process of self-regulation of learning. Some studies have addressed activities in the context of SRL at a more general level (Mese and Mede, 2022), whereas others have focused on more specific ones, such as time management in the context of SRL (Pérez-Sanagustín *et al.*, 2020; Cao *et al.*, 2022), choice and selection of tasks (van Harsel *et al.*, 2021; Broeren *et al.*, 2021) or SRL strategies (Reparaz *et al.*, 2020; Ocampo, 2017; Yoon *et al.*, 2021; Naujoks *et al.*, 2021; Yot-Domínguez and Marcelo, 2017; Bruso *et al.*, 2020; Broadbent, 2017; Anthonysamy *et al.*, 2020; Loeffler *et al.*, 2019; Inan-Karagul and Seker, 2021). Two studies have focused on skills in the context of SRL (Broadbent *et al.*, 2021; Barak *et al.*, 2016). Strategies and skills can sometimes seem to overlap, but they are fundamentally different. According to Mares (1998), skills can be seen as partial learning goals or outcomes of the learning process, whereas learning strategies are larger-scale procedures through which the student carries out a given plan when solving a task.

The third group consists of factors that are part of the learning self-regulation process (Klimova *et al.*, 2022; Reparaz, 2020) and, conversely, those that influence the learning process (Hood *et al.*, 2015; Nuankaew *et al.*, 2019). Some studies focus on one of the self-regulatory aspects within SRL, namely, motivation (Littlejohn, 2016; Li *et al.*, 2019).

The next group of goals revolves around the subject of psychology, including behavior (Schumacher and Ifenthaler, 2021), perception (Nuankaew *et al.*, 2019; Schumacher and Ifenthaler, 2018; Lan *et al.*, 2019), expectations (Schumacher and Ifenthaler, 2018), perceptions (Zheng *et al.*, 2016), attitudes (Nuankaew *et al.*, 2019; Broadbent, 2021; Wan *et al.*, 2021), individual's personality traits (Bruso *et al.*, 2020) and stress (Hadwin *et al.*, 2022).

The fifth group examines the relationship between modern technology and SRL, including students' readiness for learning via other than face-to-face method (Naujoks *et al.*, 2021) and the use of technology itself (Supriyono *et al.*, 2020; Yot-Domínguez and Marcelo, 2017).

The penultimate group consists of studies that explicitly discuss the impact of modern technology on the self-regulation of learning, whether it is Serious Game (Ocampo, 2017), SPADA (Rizki *et al.*, 2022), ePortfolio (Alexiou and Paraskeva, 2019, 2020) or FC (Blau and Shamir-Inbal, 2017).

The last group includes studies that explicitly or implicitly address supportive SRL in connection with modern technologies. Anthonysamy *et al.* (2020) deal with it in general

terms, whereas Saadati *et al.* (2021) focus on the creation of new tools and Klimova *et al.* (2022) study support from teachers.

Which research tools have been used? The principal methodology was quantitative, which occurred in 25 studies, followed by mixed methodology, represented in 10 studies. A purely qualitative methodology was used in one study.

In the study based on the qualitative methodology, the authors worked with a paradigm of the description of experience and its interpretation. Grounded theory was chosen as a framework, and data were collected and analyzed using reflective writing by participants.

As for the quantitative methodology, eight cases were experiments that included both a pretest and a posttest phase. The conduct of the experiments and the different phases varied according to the research needs. In four cases, the experiment included a questionnaire as one of the data collection methods: a modified Web version of the motivated strategies for learning questionnaire (MSLQ) appeared twice, a weekly planning report designed as a questionnaire once and the online self-regulated learning questionnaire once. The questionnaire was the most represented data collection method, appearing separately in 11 studies. In three cases, it was combined with measures of academic performance, learning outcomes and tasks in the context of formative assessment. Two studies that worked with secondary data (specifically, CSD) also appeared in the analyzed studies.

In most cases, the mixed methodology included a combination of the questionnaire as a quantitative tool in addition to a qualitative tool, e.g. a semistructured interview, an interview, data analysis using inductive thematic analysis (live chat data) and analysis of students' reflective journals or essays. One study combined the quantitative method of focus groups with quantitative work with secondary data (CSD).

The standardized quantitative instruments were adapted to the needs of the research in most of the surveys. However, five studies worked with an instrument of their own construction. Regarding the items in the questionnaires, 14 were Likert-type and three were bipolar. In some studies, the type of item was not recorded. The following research instruments were mentioned in the studies: MSLQ, achievement goal questionnaire, conceptions of learning English, online self-regulation for English learning questionnaire, online SRL questionnaire, SRL work questionnaire, SRL motivated questionnaire, DAUS1, SRL with technology at the University, EGame flow, unified theory of acceptance and use of technology, SRL interview schedule, SRL profile and self-diagnostic instrument, the SRL-practices scale, SRL challenges scale, self-regulation scale in writing, big five inventory, learning analytics features, learning analytics benefits and learning analytics privacy.

Which primary findings have been presented? Concerning the relationship of SRL and academic performance, results or feedback, a positive effect of modern technology on students' self-regulation of learning is evident. The findings showed that if self-regulation of learning is promoted through modern technology, thus actively engaging students in learning, their academic performance will improve. Students without the support of self-regulation of learning experience a decline in academic performance over time (Yoon *et al.*, 2021). Related to this are the characteristics of SRL as a driver of performance during a formative task. The students who were confident, able to manage their study time and regulate their effort enjoyed significant advantages over those who did not achieve such a high level in SRL, which was also reflected in their performance (Broadbent *et al.*, 2021). However, one of the analyzed studies reported that the academic performance of university students could not effectively predict their SRL in the context of online learning (Li *et al.*, 2019). Students with varying academic results varied in their time management SRL (Cao *et al.*, 2022). Effective use of learning time and internal resource management contribute positively to subjective learning success (Loeffler *et al.*, 2019). The question also arises of the

visual feedback that helps maintain pace during a course (Pérez-Sanagustin *et al.*, 2020). A cellphone application using self-regulated activity improves students' time management and promotes improvement in their performance. Without high-quality feedback, students do not penetrate deep into problem-solving and only skim the surface (Andrade, 2014). The positive effects of SRL practices (promoting students' adaptation to new learning environments, tasks or situations in the online environment, especially in times of pandemic) on academic performance are obvious, including the positive effects of SRL and its intervention during online Covid instruction, where SRL resulted in softening Covid anxiety about academic challenges, which resulted in lower levels of social-emotional, cognitive and metacognitive challenges for first-year students Hadwin *et al.* (2022).

SRL strategies are a major topic by themselves because some strategies support the learning success of individuals and lead to the learning goal. Prior to the Covid-19 pandemic, the most frequently engaged strategies were cognitive and metacognitive ones, along with effective use of time, reflected in students' subjective learning success (Loeffler *et al.*, 2019). Metacognitive strategies were the ones most weakened during the pandemic. Students exhibit significant challenges in metacognitive strategies, especially in terms of reflective and critical thinking, analysis and evaluation (Klimova *et al.*, 2022). Among the listed strategies that students use to a lesser extent is time management itself, which is associated with personality traits. Individuals who are classified as open, extroverted, agreeable and conscientious are far more likely to use SRL strategies such as effective time management, including checking the syllabus, marking deadlines on the calendar, highlighting different types of assignments, creating a to-do list, continuously planning and spreading work over the semester, setting sufficient time allowances for completing assignments and defining a structure of mini- and partial goals (Bruso *et al.*, 2020). Our aforementioned metacognitive strategies, including metacognitive knowledge, resource management and motivational beliefs, positively affect digital literacy (Anthonysamy *et al.*, 2020).

Before the Covid-19 pandemic, students used digital technologies quite frequently, but they mostly used them to search for information on the Internet or follow social media (Yot-Domínguez and Marcelo, 2017). Since the pandemic, more platforms have emerged that also focus on the process of self-regulating student learning in higher education, including the transformation to online learning. The platforms that worked with self-regulation of learning before the pandemic, such as MOOCs, still remain on the educational scene. They, however, face challenges of attrition and modification. Self-regulation of learning is essential for completing MOOC courses. Learners who complete the course show higher levels of self-regulation of learning and levels of perceived effectiveness associated with the MOOC content. The findings indicate that the main predictors of MOOC completion by the university students are goal setting, interest in tasks and academic rigor (Reparaz *et al.*, 2020). However, all tools or platforms have a common goal, which is to monitor and control students' learning processes. Modification of behavior and study strategies is necessary to meet learning goals and promote academic performance or self-reflection. This applies to platforms as well as learning styles; thus, it can be described as a certain type of intervention using modern technology where students develop SRL skills and use SRL strategies effectively. Such technologies are, among others, ePortfolio, Serious Game, SPADA or other LMSs, including the use of DI or learning analytics. Using these, students have expectations that these systems will help them to support the planning and organization of their learning or form personalized analyses of their learning activities (Schumacher and Ifenthaler, 2018, 2021). The systems can also act as an intermediary between students and teachers. Indeed, help-seeking is a fundamental self-regulatory and metacognitive skill. Students greatly appreciated getting help in real-time and especially during the pandemic using Live Chat. The platforms such as Live Chat have been very well received among the students, and this

has increased their level of satisfaction. They felt that lecturers were interested in them and provided real-time help, support and answers to their questions (Broadbent and Lodge, 2021).

Certainly, modern technologies do not stand alone and are embedded in a learning context and educational environment, such as Flipped Learning. This concept is not new either; a degree of modification is evident in the role of the instructor and students and their peer assessment associated with the use of modern technology (Blau and Shamir-Inbal, 2017). Using this modified model, students' active engagement in and out of the learning environment occurred before, during and after the lesson. The instructor's contribution was the support for independent learning, self-regulation of learning, constant dialogue and peer collaboration.

However, in order for learning to be self-regulated, another aspect that needs to be discussed is motivation, which is one of the subjects of some of the studies examined in this paper. Motivation has a privileged position related to the initiation of the self-regulatory process. Thus, it stands at the very beginning of the self-regulation of learning. Modern technologies, such as GBL, can contribute to this stage of self-regulation of learning. GBL requires students to apply their knowledge of the subject matter when they encounter optimal challenges. The whole process keeps students at a high level of attention, which can lead to the promotion of motivation and metacognitive activities. GBL can be seen as a motivational tool associated with sustaining attention, creating space for knowledge acquisition and improving academic performance (Wan *et al.*, 2021). Tables 1–9 offer an overview of the research study concepts, objectives or questions, tools and technologies involved in learning.

Discussion

The presented study is the first review study focusing on the relationship between SRL and modern technologies in higher education over the past decade, including the period before and after the Covid-19 pandemic. The study aims, among other things, to point out the direction, tendencies and trends in the self-regulation of learning in connection with modern technologies. Countless pieces of evidence in the studies that were analyzed pointed to the use of modern technologies as positively related to the promotion of self-regulation of learning and thus to the self-regulatory strategies themselves, which lead to increased academic success and achievement.

The impact of technology on SRL is particularly noticeable with metacognition, which is one of the SRL aspects. Technology can regulate students' metacognitive abilities when students use technology to plan, gather information, improve knowledge, enhance learning and self-regulate to achieve learning goals. Technology supports students' SRL by being able to provide them with rich resources for learning (Candy, 2004). Research linking SRL and modern technology is mostly conducted in the short term. There is certainly room for longitudinal studies to monitor students' progress as SRL increases, including motivation and other aspects.

Motivation, as one of the metacognitive determinants, plays a crucial role in starting the whole self-regulatory process. However, for students to remain motivated throughout the learning process, they need to be challenged and able to focus. For this reason, the design of educational online games can be an excellent starting point, as the essential element of these games is the elimination of distracting elements along with an acceptable workload. This learning environment offers students a space where they can focus on the task at hand while minimizing the distress of overload, allowing students to learn motivation and learning strategies. There is certainly a constant need to revise the quality of gamified courses and platforms to improve the learning process (Wan *et al.*, 2021; Li *et al.*, 2019). Thus, there is

Study	Concept and technologies involved in learning	Aim/question	Tool	Samples size
Andrade (2014)	Self-regulated learning, transactional distance and language acquisition Online learning environment	– To examine the role of dialogue and structure on the effectiveness of SRL activities in an English language course based on this model	Predominantly qualitative data; the quantitative aspects: reviews of student assignments and student marks	75 students and 2 teachers
Hood <i>et al.</i> (2015)	Self-regulated learning and MOOC MOOC	– To examine how a learner's current role and context influence their ability to self-regulate their learning in a MOOC: Introduction to Data Science offered by Coursera	Questionnaire	141 students
Barak (2016)	Self-regulated learning, self-regulation in distance learning and cognitive transfer skills Online learning environment	– To identify self-regulation skills required for online learning – To characterize the transfer skills of on-campus and online undergraduate students	Online survey and semistructured interviews	84 students
Littlejohn <i>et al.</i> (2016)	Self-regulated learning and MOOC MOOC	– To investigate the self-regulated learning (SRL) learners apply in a MOOC, focusing on how learners' motivations for taking a MOOC influence their behavior and employment of SRL strategies	Quantitative data collected through a survey posted on the course message board and semistructured interviews	264 students
Zheng <i>et al.</i> (2016)	Self-regulated learning and online self-regulation, language learning and beliefs, conceptions of learning and online self-regulation Online learning environment	– To explore the relationship between Chinese university students' conceptions of English language learning and their online self-regulation	Two questionnaires	401 students

Source: Developed by the author (2023)

Table 1.
Analyzed studies

room for platform developers to provide enough flexibility and software customization to enable teachers to create a more individualized learning design. Platforms can also include features that may not be primarily related to metacognitive strategies, but support increases in both cognitive and social presence (Li *et al.*, 2019). This may include key features for social learning and collaboration (e.g. thumbs up or comfort with synchronous and asynchronous communication).

Study	Concept and technologies involved in learning	Aim/question	Tool	Samples size
Blau and Shamir-Inbal (2017)	Flipped classroom, digital environments, self-regulated learning and co-regulation Flipped classroom	– To investigate the core elements of pedagogical design in FC, as well as SRL elements	Interviews and document analysis	36 students
Broadbent (2017)	Online learning, blended learning and self-regulated learning Online learning, blended learning	– To assess differences in the perceived frequency of use of self-regulated learning strategies in two different learning modes (blended learning vs online learning) – To examine the relationships between SRL strategies and subject grades for both groups – To explore whether contributions of the SRL strategies for subject grade differed across the two groups	Questionnaire and subject grade	606 students
Ocampo (2017)	Self-regulated learning and a serious game Serious game	– To examine educational praxis linked to serious game, in order to identify the self-regulation strategies that are enhanced	The data collection instrument (EABJS) designed from the self-regulated learning interview schedule (SRLIS) developed by socio-cognitive researchers Zimmerman and Martinez-Pons (1986)	40 students
Schumacher and Ifenthaler (2018)	Self-regulated learning, learning analytics and learning analytics feature Learning analytics	– To investigate students' expectations toward features of learning analytics systems – To investigate students' willingness to use these features for learning	Interviews and questionnaires	216 students
Yot-Dominguez and Marcelo (2017)	Self-regulated learning and technology Use of digital technology	– Which technologies do university students use to self-regulate their learning? – What self-regulated learning strategies do they develop using technologies? – What profiles could be identified among students based on their use of self-regulation strategies with technology?	Questionnaire	711 students

Table 2.
Analyzed studies

Source: Developed by the author (2023)

Study	Concept and technologies involved in learning	Aim/question	Tool	Samples size
Alexiou and Paraskeva (2019)	Self-regulated learning and SRL models ePortfolio	– To develop and test the prototype of the self-regulated oriented ePortfolio system for HE in order to support students (future graduates) to enhance their SRL skills and manage their academic path	Experiment	86 students
Lan et al. (2019)	Self-regulated learning and MOOC MOOC	– To investigate learners' behaviors and correlate patterns of self-regulated learning (SRL) with performance and achievement during a MOOC in Implant Dentistry	The clickstream data	7 608 students
Loeffler et al. (2019)	Self-regulated learning, cognitive strategies, metacognitive strategies, resource-management strategies, process model of SRL, assessing SRL, fostering SRL Interactive ambulatory assessment	– To identify characteristics of successful daily life learning situations – To develop an intervention approach to support adequate learning strategy use in university students	Experiment	78 students
Nuankaew et al. (2019)	Self-regulated learning, Thai education model and child behavior and data mining in education Using applied statistics and machine learning technology	– What are the significant factors (attributes) in the theory of Self-Regulated Learning (SRL) that affect learners' perceptions and acceptability? – How much can the learner accept the factors (attributes) of Self-Regulated Learning (SRL) theory to adapt their learning behavior?	Questionnaires	409 students

Source: Developed by the author (2023)

Table 3.
Analyzed studies

A very important educational player in terms of SRL and modern technologies is software that maps students' activities during the learning process, such as CSD or learning analytics. These platforms are very closely related to personalized learning, which allows the creation of a personalized environment that adapts as much as possible to the individual needs of students. It relies on three pillars: it is grounded in SRL theories, it works with trace data and it provides clear and practical recommendations to improve the self-regulation of student learning ([Molenaar et al., 2020](#)). This area is also experiencing rapid developments, culminating in the

Study	Concept and technologies involved in learning	Aim/question	Tool	Samples size
Alexiou and Paraskeva (2020)	Relationship between self-regulated learning and ePortfolio development, and a multidimensional self-regulated learning model for ePortfolios ePortfolio	– To investigate the effect of an ePortfolio intervention on self-regulated learning (SRL cognitive, affective, behavioral and contextual processes) and academic achievement	Experiment	123 students
Anthonysamy et al. (2020)	Education in the age of disruption, blended learning, digital literacy and self-regulated learning strategies Online learning environment	– To examine how self-regulated learning strategies (SRLs) can foster the enhancement of digital literacy in digital learning to increase efficiencies in human capital for sustainable development in lifelong learning	Questionnaire	563 students
Bruso et al. (2020)	Types of self-regulated learning strategies, self-regulated learning profiles, big five personality traits and self-regulated learning in online environments Online learning environment	– To investigate the relationship between the Big Five personality traits and the use of SRL strategies – To extend research on the specific personality traits of openness, conscientiousness, extraversion, agreeableness and neuroticism as possible predictors of SRL strategy use	Questionnaires and semi-structured interviews	452 students
Pérez-Sanagustin et al. (2020)	Self-regulated learning, MOOC, flipped classroom and blended learning MOOC	– Is there a relationship between the SRL technological scaffold and the students' course grades? – Is there a relationship between using the SRL technological scaffold and the way students perceive their time management on the course? – How does the relationship between the SRL technological scaffold and students' engagement with the course content manifest in terms of their behavior?	Experiment	242 students

Table 4.
Analyzed studies

Source: Developed by the author (2023)

Study	Concept and technologies involved in learning	Aim/question	Tool	Samples size
Reparaz et al. (2020)	Self-regulated learning, MOOC and human and contextual factors MOOC	<ul style="list-style-type: none"> – Which self-reported SRL strategies are most helpful to achieve MOOC completion in undergraduates? – Which variables related to human and context factors are most helpful in achieving MOOC completion? 	Questionnaire	176 students
Schumacher and Ifenthaler (2021)	Prompts supporting self-regulated learning and learning analytics Learning analytics	<ul style="list-style-type: none"> – To investigate how prompts impact learning performance, learning behavior, – Perceptions if online learning behavior enables an understanding of learning performance 	Quasi-experiment (knowledge test, transfer test, perceived difficulty, perceived confidence, prompt evaluation)	110 students
Supriyono et al. (2020)	Self-regulated learning, technology and language learning Online learning environment	<ul style="list-style-type: none"> – How do the EFL learners use technology to regulate their language learning? – To what extent does technology acceptance correlate to the EFL learners' self-regulated learning? 	Questionnaire and interviews	102 students
Broadbent and Lodge (2021)	Online academic help-seeking within SRL and Live Chat Live chat platform	– To explore the use of Live Chat technology for online academic help-seeking within higher education, with a focus on different perceptions of online or blended learning students	Questionnaire and Live Chat platform	246 students
Broadbent et al. (2021)	Self-regulated learning and formative assessment Online learning environment	– To investigate the effects of SRL capabilities on a formative task and the enactment of formative feedback to improve a summative grade in online vs. blended learning contexts	Questionnaire and formative assessment task	181 students

Source: Developed by the author (2023)

Table 5.
Analyzed studies

implementation of artificial intelligence (AI) in this concept. The role of AI is to measure and support SRL using real-time trace data, leading to increased metacognitive activity and supporting the monitoring of student activities ([Lim et al.](#),

Study	Concept and technologies involved in learning	Aim/question	Tool	Samples size
Broeren <i>et al.</i> (2021)	Self-regulated learning, an instructional intervention and retrieval practice Online learning environment	<ul style="list-style-type: none"> – To compare the self-regulated study choices the experimental and control groups made in the OLE across three study sessions – To compare their performance on the final course exam 	Experiment; self-study choices, (correct) retrieval attempts, performance and scoring of open-ended questions	116 students
Harsel <i>et al.</i> (2021)	Self-regulated learning of problem-solving tasks with examples and problems and strategy instruction to support self-regulated learning of problem-solving tasks Online learning environment	<ul style="list-style-type: none"> – Does the finding that students' choices during self-regulated learning align with the instructional design principles for optimizing the acquisition of new problem-solving skills for novices? – Is self-regulated learning as effective, efficient and motivating as a fixed task sequence based on the principles derived from instructional design research? 	Experiment; pretest, instructional video, task database, task sequences and task selection and posttest	150 students
Inan-Karagul and Seker (2021)	Self-regulated learning strategies in writing An online training scheme	<ul style="list-style-type: none"> – To find out the effects of the SRL online strategy training scheme, developed to equip learners with SRL strategies for academic writing courses on higher education learners' reported strategy use while exploring their opinions on such a training experience 	The self-regulation scale in writing and research-integrated argumentative writing tasks	135 students

Table 6.
Analyzed studies

Source: Developed by the author (2023)

2023). All of the introduced possibilities (online learning environment, style of learning or platforms) that are part of SRL contribute to enhancing students' academic performance and success. However, despite how modern technologies can help us with SRL, we must not forget about the teachers who act as facilitators and can support students' metacognitive strategies by monitoring their learning, reviewing their progress, providing opportunities for self-reflection or being able to provide constructive feedback in an online environment ([Klimova *et al.*, 2022](#)). [Dowden *et al.* \(2013\)](#) discuss feedback as being at the core of learning. It can be seen as

Study	Concept and technologies involved in learning	Aim/question	Tool	Samples size
Naujoks et al. (2021)	Self-regulated learning, digital readiness and online learning environment	<ul style="list-style-type: none"> – To investigate students' digital readiness for the sudden switch to online learning – Differences between students' intended and actual use of external resource management strategies – The influence of students' digital readiness on their actual use of resource management strategies 	Questionnaires	662 students
Saadati et al. (2021)	Self-regulated learning strategies in online higher education learning, learning management system in online higher education learning and blockchain technology A novel blockchain-based metacognitive LMS in online higher education	– To develop a blockchain-enabled LMS as a metacognitive tool in online higher education with SRL adaptive intervention (AI) to improve planning, monitoring, collaboration, zone of proximal development (ZPD), scaffolding and reflection toward self-regulation development and learning achievement	Questionnaire and essay analysis	33 students
Yoon et al. (2021)	Self-regulated learning in flipped classroom, and principles for supporting SRL Flipped classroom	<ul style="list-style-type: none"> – What is the effect of the SSRL on students' use of self-regulated learning strategies? – What is the effect of the SSRL on student engagement (i.e. behavioral, cognitive, emotional)? – What is the effect of the SSRL on student learning performance? 	Experiment	45 students

Source: Developed by the author (2023)

Table 7.
Analyzed studies

an assessment tool but can also contribute to the development of social relationships, including the exchange of ideas and shared responsibility.

Limitations

This review study has some limitations. The first of these applies to studies published only in English. This means that there may be relevant research studies in other languages that were excluded as a part of our requirements. The search for studies was conducted using three databases, and over 2,000 results were found. Some relevant studies may have been overlooked in such a large number. In addition, studies searched were exclusively related to self-regulation of learning in higher education in the context of technology over the past decade.

Study	Concept and technologies involved in learning	Aim/question	Tool	Samples size
Wan et al. (2021)	SRL, learning motivation and learning Strategies of GBL, technology acceptance of GBL, GBL and flow and use of digital games in learning GBL	<ul style="list-style-type: none"> – How could flow antecedents and experience lead to flow consequences in the context of GBL? – To address the key flow antecedents in GBL among university students – To delineate flow antecedents from the proposed framework that demonstrate direct and indirect effects on learners' attitudes toward flow consequences in GBL, particularly GBL acceptance and SRL in the higher education context 	Questionnaires	275 students
Cao et al. (2022)	Self-regulated learning, time management and online learning Clickstream	<ul style="list-style-type: none"> – To utilize clickstream data to reveal the time management of SRL in higher education online learning environment 	Clickstream data	8019 students
Hadwin et al. (2022)	Self-regulated learning, online leaning and academic success Online learning environment	<ul style="list-style-type: none"> – To examine the role of SRL practices and SRL intervention in mitigating the impact of Covid-related psychological distress on academic success during fully online pandemic teaching 	Questionnaires and average grade (GPA)	496 students
Klimova et al. (2022)	Self-regulated learning, factors of SRL, Covid-19 Online learning environment	<ul style="list-style-type: none"> – To investigate whether Central European (Slovak and Czech) students (were able to perform self-regulated learning during their online classes during the period of the Covid-19 pandemic to achieve their learning goals and improve academic performance – Are there any differences between these students as far as the year of study is concerned, gender or nationality? 	Questionnaire	268 students

Table 8.
Analyzed studies

Source: Developed by the author (2023)

Conclusion

The present review study summarizes several studies providing empirical evidence of the relationship between self-regulation of learning and modern technologies and new ways and trends in the use of modern technologies in connection with self-regulation of learning. The

Study	Concept and technologies involved in learning	Aim/question	Tool	Samples size
Li et al. (2019)	Self-regulated learning and learning motivation Online learning environment	– Three essential constructs of online learning (self-regulated learning, perceived presences and learning motivation) based on a national survey in China	Questionnaire	12,826 students
Meşe and Mede (2022)	Self-regulated learning, differentiated Instruction (DI) and online education DI	– To examine the impact of DI on students' speaking proficiency and SRL in an online EFL module and explore students' opinions of their experiences with DI	The quantitative data collected using a speaking test and Turkish OSRLQ whereas the qualitative data gathered in a semi-structured focus group interview with students from the experimental group	31 students
Rizki et al. (2022)	Self-regulated learning and clickstream data (CSD) Clickstream	– To investigate the SRL of Indonesian students in underdeveloped areas when using a learning management system (LMS), namely, SPADA, initiated by the Indonesian government	Focus group and clickstream data	Secondary data based on a survey of 697 students

Note: OSRLQ = online self-regulated learning questionnaire

Source: Developed by the author (2023)

Table 9.
Analyzed studies

findings indicate a correlation between self-regulation of learning, modern technology and academic success, which is very closely related to the use of metacognitive strategies. Studies have shown that the support of metacognitive strategies can be provided by modern technologies, specifically by new learning platforms designed and built for this purpose or by different teaching methods such as FCs or GBL.

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