Bridging Education and Psychology: An Interdisciplinary View on Developing Self-regulated Learning

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ABSTRACT

Thesis. Self-regulated learning is defined in policy documents as one of the core transversal skills students must develop, and psychology theories offer clear theoretical definitions about constructs related to these skills. However, research indicates

that implementation of classroom-level activities aimed at developing self-regulated learning is not clear for all teachers, leading to vast differences in practice. Therefore, the aim of this paper is to offer an interdisciplinary mapping of concepts that are related to self-regulated learning and lead to development of self-regulated learning – executive functions and self-regulation, based on research in psychology and education; and to offer an output – practical guide of specific teachers' actions for developing students' self-regulated learning in the classroom.

Concept. This study is designed as a conceptual theory-synthesis article with an embedded secondary analysis of classroom observation data used to contextualise the problem of implementing self-regulated learning in Latvia. Conceptual mapping of three important constructs – cognitive executive functions, self-regulation and self-regulated learning – is presented. A practical material for developing self-regulated learning at the classroom level is offered, including specific activities that teachers can implement in every lesson.

Results and conclusions. Based on the authors' conceptual model that represents how three constructs (executive functions, self-regulation and self-regulated learning) interact, we conclude that effective implementation of SRL development should be interdisciplinary by involving professionals from psychology and education fields. The support for teachers should be grounded in theory, as well as offer clear practical steps of actions for teachers, such as the output material of the current research.
Keywords: self-regulated learning, classroom level activities, policy implementation, interdisciplinary, self-regulation, executive functions, conceptual theory-synthesis

Introduction

Self-regulated learning (SRL) and various social, cognitive and emotional skills related to SRL are defined as an important outcome for students, and education systems should focus on developing them, as outlined in OECD Learning Compass 2030 (OECD, 2019). The latest international PISA study focused on self-regulated learning as one of core skills in the context of digital learning (OECD, 2023). In addition, the skills to plan, manage and implement the process of acquiring new knowledge will be increasingly necessary for adults in the currently rapidly changing world (WEF, 2018). Self-regulation is also defined as a crucial skill to foster students' higher-order thinking (Hague, 2024). SRL is included in curriculum in various countries, including in the recently updated competency-based curriculum of Latvia where it is one of core transversal skills project "School2030"; www.skola2030.lv, a country taken as an example of an education system where major changes in curriculum and policy documents have been recently implemented. The ability to regulate and manage one's learning process is thus defined as important at the policy level, but are the methods for development of these skills properly implemented at the classroom level? Furthermore, it is important

to understand whether these skills are conceptualised and described precisely, based on an interdisciplinary analysis. Therefore, the main aim of this paper is to interdisciplinarily map and break down what the concept of SRL contains based on the notions of Education and Psychology sciences, with a further aim to offer how teachers can sustainably foster the development of self-regulated learning at the classroom level.

The Latvian education curriculum, a country taken as an example for this article, stipulates that students develop several essential transversal skills, including self-regulated learning. The direct translation of how SRL is defined in Latvia would be "self-managed learning" or "self-directed learning", and it is described as a competency when "the student is aware of oneself as an individual, is aware of one's aims, needs and interests" and "manages emotions, thoughts and behaviour, forms positive relationships, is motivated to develop oneself", also "sets goals, plans their actions, implements the plan and evaluates the achieved result, uses appropriate thinking strategies and follows one's learning progress" (Cabinet of Ministers Republic of Latvia, 2018; www.Skola2030.lv). In addition, the state rules define achievable results for these transversal skills, at the level of grades 3, 6 and 9. For example, at the end of grade 3 (about 9–10 year-olds): "...with the support of the teacher, the student monitors the fulfilment of previously set performance criteria and evaluates his/her own learning work and learning experience" (Cabinet of Ministers Republic of Latvia, 2018). By the end of grade 9 (approximately 16 year-olds), a student: "Uses one's strengths in thinking and situation-appropriate thinking strategies to develop one's abilities and improve performance".

It can be seen that the definitions and descriptions of what needs to be taught regarding SRL in the law are comprehensive and cover the important aspects as defined in SRL theories, however it has to be taken into account that the law does not change once new theories are developed, and current formulation of the mentioned SRL requirements are based on the research, theories and understanding current at the time of formulating the law (Cabinet of Ministers Republic of Latvia, 2018). Policy developers understand that it is necessary to embed SRL in teaching. The question arises, however, if the ideas that are theoretically clear to scientists and policymakers, are explained in enough detail for implementation in everyday practice for teachers. Therefore, the aim of this paper is to offer an interdisciplinary mapping of concepts that are related and lead to self-regulated learning – executive functions, self-regulation – based on Psychology and Education fields, and to offer a practical guide of specific teachers' actions for developing students' self-regulated learning in the classroom.

Methodological Approach

To reach the aims of the study, several approaches were combined. Conceptual theory synthesis approach was implemented (Jaakkola, 2020), targeting and mapping the important constructs (Torraco, 2005) that are related to SRL and its development, considering an in-

terdisciplinary view based on both Psychology and Education, that was the primary aim of the authors. In addition, secondary analysis of classroom observation data is used to contextualise the problems of implementing self-regulated learning in Latvia. In next section, we start with presenting the secondary analysis to support the idea of issues related to proper implementation of SRL. It is followed by separate sections covering the concepts of self-regulation, executive functions, self-regulated learning, and a section that offers an integrated conceptual model based on this interdisciplinary view. The source materials included in the theory synthesis were selected to represent seminal SRL theories, developmental and cognitive psychology accounts of self-regulation and executive functions.

Currently Identified Challenges with the Implementation of SRL at the Classroom Level Based on the Secondary Analysis of Class Observation Study

There are several small-scale studies published since the recent curriculum changes in Latvia that have already indicated challenges that teachers face to successfully implement SRL approaches in the classroom (e.g., Hačatrjana & Linde, 2023; Linde et al., 2024). In addition, teachers have rated their understanding of SRL concepts as average (Linde et al., 2022). Therefore, this raises the question of whether the descriptions of SRL, as they are stated in the policy documents, are clear enough for teachers to have a practical plan of what exactly needs to be done in class to develop students' SRL.

Further in this section, we provide a secondary analysis of lesson observation data, validating our assumptions about the challenges that teachers in Latvia have with training students' SRL in classes. Previous research with lesson observations of teachers' practices during lessons in Latvian schools shows that there is a huge variation among teachers in their actual performance in the classrooms (UL ICEI, 2023), including how they implement training and development of students' SRL. To determine the opportunities Latvian students have for self-regulated learning development during their lessons, a secondary analysis of lesson observation study data was implemented based on the previous study (Čakāne et al., 2025) on blended learning in primary STEM lessons. In the study "opportunities for self-regulated learning" was one of the categories used to determine similarities and discrepancies in teaching. The authors looked similarly at the data with a more detailed focus and using a different sample according to the aims of this paper – broadening the age group and subject coverage to all available data, but narrowing the time period to lessons observed after the education reform that intends self-regulated learning to be implemented as a transversal skill. The analysis was based on observations in 186 lessons (grades 1 to 12; subjects – Latvian, English, German, Russian, literature, biology, science, physics, geography, chemistry, mathematics, technologies, music, art, sports, social science and history). Lessons were observed, transcribed, and evaluated on a scale from 0 to 4 based on multiple criteria (as seen in Table 1) by experienced and specially trained teaching experts between 2022 and 2024, the time period

when the changes in education approach in Latvia were already formally started. These observations were conducted in collaboration with local municipalities to assess teaching quality and identify professional development needs for teachers in schools under their jurisdiction.

For the evaluation of teaching practices, a previously developed and validated category-criteria framework for assessing teaching and learning practices in support of students' 21st-century skills was used (Bērtule et al., 2019). This framework consists of 17 criteria that define teaching practices that foster the acquisition of 21st-century skills within the country's educational context. Each criterion is assessed on a five-level scale, where level 0 indicates the practice was not observed in the teacher's performance, and level 4 represents expert practice based on the latest evidence for that criterion. As an example of this, Table 1 provides level descriptors for the criterion "Feedback to students".

Table 1

Example of a Criterion for Evaluating a Teacher's Performance During the Lesson with Level Descriptions

Level Descriptions					
Criteria	**0 (Not Observed)**	**1 (Beginner)**	**2 (Developing)**	**3 (Proficient)**	**4 (Expert)**
Feedback tostudents	Teacher does not ascertain(objectively, surely) thelearning outcomes (LOs) students have achieved or ascertains whathasbeen learned inthelessonbut does not use theinformationtogive feedback tostudents. *Students do not receive feedback.*	Teacher checks whathasbeen achieved but not always against theformulated LO. *Students receive ananswer asto whether theresult iscorrect or incorrect (howthetask was completed) from theteacher, classmates, or themselves.*	Teacher checks performance against planned learning outcome, but feedback isnot precise or feedback isabout whathasbeen achieved but only about theresult or process. *Students receive answers to Questions – whatIknow/cando, whatIdo not know/cannot do – from theteacher, classmates, or themselves inrelationtotheplanned LO or learning process.*	+ provides feedback onprogress towards theplanned LO. *Students understandwhether theLO hasbeen achieved andreceives an answer tothequestion–whatto do going forward–regarding not only results but thelearning process aswell.*	+ feedback ispersonalized. *+ Student also receives constructive feedback onhowtomonitor their own actions andresults (regulate their learning).*

Note. "+" means that the level description includes what is in the previous level and is supplemented by the following entry.

Source. Based on secondary analysis of lesson observation study (Čakāne et al., 2025).

Four criteria together form the category "Student self-regulated learning opportunities": criterion Clear learning objectives (A); criterion Feedback to students (B); criterion Opportunities for metacognition (C); criterion Differentiation and support for learning (D). A profiling approach was used to describe opportunities for self-regulated learning provided to students, where lessons with similar ratings in the four criteria form a profile that can be qualitatively described. A decision tree approach (Gomes & Almeida, 2017) was used to identify distinctive teaching profiles, leading to four distinct teaching profiles. For teaching profile descriptions and median performance levels in each criterion see Table 2.

Table 2

Teaching Profile for Student Self-Regulated Learning Opportunities Descriptions and Median Performance Levels

Profile No.	Profile description	Median performance levels			
		A	B	C	D
1	There is a specific, relevant and achievable learning outcome defined in the lesson. The teacher checks student performance against the planned learning outcome; students receive information on what they know and can do, and what they do not know yet know and cannot do. Teacher involves students in reflection on the purpose of the learning tasks and organizes a discourse on how to use the skills or strategies. Differentiation of tasks or support is provided for some pupils.	2	2	1	1
2	Teacher states everything that will be done in the lesson without highlighting the essential or states a formal Learning outcome, which does not provide students with a clear understanding of what they have to learn. Teacher checks what has been achieved but not precisely against the learning outcome, students receive information on whether their tasks are done correctly or incorrectly. Teacher involves students in reflection on the purpose of the learning tasks and organizes a discourse on how to use the skills or strategies. Differentiation of tasks or support is provided for some pupils.	1	1	1	1
3	Teacher states everything that will be done in the lesson without highlighting the essential or states a formal learning outcome, which does not provide students with a clear understanding of what they have to learn. Teacher checks what has been achieved but not precisely against the learning outcome, students receive information on whether their tasks are done correctly or incorrectly. Teacher does not organize a reflection on how or why learning takes place and does not involve students in setting goals, monitoring or evaluating their performance. There is no differentiation, students have no choice.	1	1	0	0

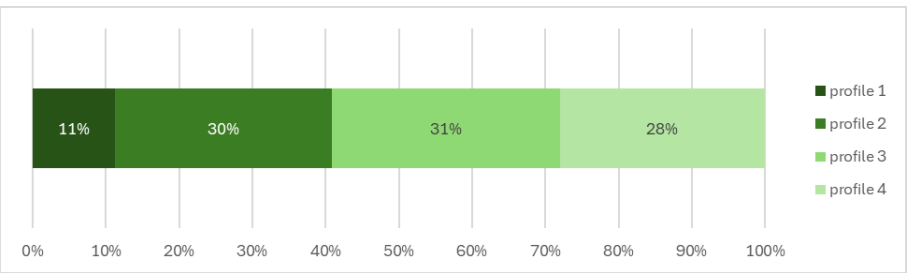
Profile No.	Profile description	Median performance levels			
		A	B	C	D
4	Teacher tells the topic of the lesson but not the learning outcome or does not tell student anything about what they have to learn this lesson. Students do not receive feedback. Teacher does not organize a reflection on how or why learning takes place and does not involve students in setting goals, monitoring or evaluating their performance. There is no differentiation, students have no choice.	0	0	0	0

Source. Based on secondary analysis of lesson observation study (Čakāne et al., 2025).

Out of all the observed lessons only 11% fit Profile 1 and can be characterised as providing effective conditions and opportunities for students to use or develop self-regulated learning skills. The profile distribution is depicted in Figure 1. Thus, we conclude based on the presented secondary analysis that a great proportion of teachers do not have sufficient classroom-level tools to foster development of SRL in their students.

Figure 1

Distribution if Teaching Profiles for Student Self-Regulated Learning Opportunities Based on Lesson Observations in Various Subjects and Grade Levels



Source. Based on secondary analysis of lesson observation study (Čakāne et al., 2025).

To conclude, the currently available studies implemented with teachers in Latvia clearly indicate challenges with how SRL is implemented in the classroom by teachers, compared to definitions in policy papers. We conclude that in general, the policy papers are grounded in a scientific approach, based on the theories in Psychology and Education sciences. The problem, however, arises in the further process of insufficiently operationalising the theory and definitions "from the law to the classroom", as well as from the burden of constant change and reforms in education in general (Briede et al., 2024). In addition, it is necessary to develop, pilot-test and teach specific and clear techniques for teachers, adapting internationally accepted methods to the national context, and involving teachers' sharing of good practices (Brandisauskiene et al., 2020), to provide effective professional development (Dacholfany et al., 2024).

Based on the challenges reported so far, including the embedded secondary analysis, we justify the need for an interdisciplinary conceptual mapping of self-regulated learning using theory synthesis design (as described in Jaakkola, 2020), to further provide a clear perspective and materials for teachers from theory to practice. The interdisciplinary view on SRL that is offered further is based on the review of self-regulation concept in general (based on psychology theories) and how cognitive development is related to learning (based on psychology studies). The second aim is to offer a clear structure for practical implementation of the teacher's activities for developing SRL in the classroom. To reach the goal of offering an integrated and classroom-level-ready conceptualisation of SRL development, we first explain the main theoretical concepts – self-regulation, cognitive executive functions and self-regulated learning, followed by mapping of these concepts. Then we offer an approach for an integrated development of SRL in the classroom level, including examples of specific actions that teachers can implement in every lesson.

Self-Regulation as a Foundation For SRL

First, it is important to define the concept of self-regulation in general, based on the psychological perspective, before focusing on self-regulated learning skills, a concept that is more typical to the field of educational sciences. Self-regulation forms the foundation of self-regulated learning, and skills of self-regulation are present before an individual becomes involved in official educational processes (e.g., Bailey & Jones, 2019). Self-regulation is a complex construct that represents an individual's ability to purposely plan and regulate one's behaviour, operating on the motor and physiological, behavioural, social-emotional, cognitive and motivational levels (Gross & Thompson, 2007; McClelland et al., 2010; Schunk & Zimmerman, 1997).

Several theoretical perspectives contribute to the understanding of self-regulation. Developmental approaches suggest that self-regulation evolves over time through experience and interaction with the environment, whereas social-cognitive theories highlight the role of self-efficacy, motivation, and received feedback in regulating behaviour (Bandura, 1991; Boekaerts et al., 2005). Cognitive developmental theories focus on how individuals actively construct meaning from experiences, adjusting their understanding through continuous interactions with their environment, but metacognitive models emphasise the ability to monitor and control one's own cognitive processes, which is essential for effective self-regulation in learning and problem-solving (Newman & Newman, 2020).

Theoretical models conceptualising self-regulation include areas of cognitive regulation, emotion regulation, and social regulation interrelated with key cognitive functions – inhibitory control, attention control, set-shifting, and working memory. A recent conceptualisation (Bailey & Jones, 2019) has integrated these perspectives on self-regulation namely effortful control and executive function, proposing that effective regulation in cognitive, emotional, and social domains are related to these underlying cognitive mechanisms, consequently supporting adjustment. These authors

emphasise that the key processes of executive functions such as inhibition, attention, working memory, and cognitive shifting evolve over time. As individuals acquire domain-specific knowledge, skills, and experiences, these core processes increasingly become more refined, leading to more sophisticated regulatory behaviour. The integrated model of regulation clarifies how regulatory behaviour manifests in children at different ages, developmental stages, and across all three regulatory domains.

Research on self-regulation has been applied across multiple fields including education, health, and workplace settings. In education, self-regulation has been often addressed in connection to self-regulated learning linked to better school readiness and improved academic performance, as students who effectively plan, monitor, and adjust their learning strategies tend to achieve better outcomes (e.g. Liew, 2011). In health psychology, self-regulation is crucial for managing chronic conditions, maintaining healthy behaviour, and coping with stress (Bandura, 2005; Hagger, 2010). In the workplace, individuals with strong self-regulation skills demonstrate better time management, productivity, and resilience under pressure (Boekaerts & Corno, 2005).

Various strategies can enhance self-regulation, focusing on cognitive, emotional or behaviour aspects. Cognitive approaches include practices such as goal setting, planning, and problem-solving. Emotional regulation strategies, such as stress management and motivation control, also play a significant role. Behavioural techniques, including self-monitoring, habit formation, and seeking social support, contribute to effective self-regulation across different life domains. Self-regulation acts as a protective factor that helps to reduce risks for development (Montroy et al., 2016).

To sum up, self-regulation skills indicate to what extent an individual will be able to control and manage emotions (both positive and negative), behaviour and thoughts. A simple example of self-regulation during learning would be a six-year-old child who is learning to write and is not able to accurately write a specific letter in handwriting, which obviously may lead to feeling frustrated. However, the child manages to keep it together, not to cry over the failure of "not writing one letter properly" and tries to write the same letter again, thus demonstrating the ability to focus on the goal. This is a crucial set of skills and attitudes for an effective and smooth learning process.

The Importance of Executive Functions and Cognitive Abilities For SRL Development

SRL, and self-regulation in general, is related to the overall development of a child, including the cognitive maturing and the functioning of core cognitive functions, such as executive functions (Montroy et al., 2016). In addition, the development of cognitive abilities is important for the early development of literacy and arithmetic, laying the foundation for the further schooling process which will involve increasingly abstract knowledge in various study fields (Demetriou et al., 2024; Montroy et al., 2016).

Further, we briefly describe the relation between children's cognitive development and the development of self-regulation, leading to the ability to master SRL.

Human cognitive development can be divided into several stages, which correspond to typical educational stages: preschool (26 years), primary school stage (7–11 years), and elementary and secondary school stage (12–18 years) (Demetriou et al., 2024). In the early period or the preschool stage, significant development of executive functions and self-control abilities occurs. Therefore, the characteristics of SRL at this stage, especially in preschool, should focus on training and developing basic self-control and self-management mechanisms, for example, being able to focus attention on one task for a specific amount of time, and being able to finish the task.

Cognitive development and learning occur by shifting from basic to increasingly abstract higher-level mental operations (Demetriou et al., 2024). For example, there is a shift from perceiving quantity of things to the comprehension that quantity can be written down with an abstract symbol – a number. In this way, based on the initial ability to grasp and understand quantity, the child's ability to write down the number of items with an abstract symbol (a number) and then perform further actions with this abstract symbol develops. In turn, if there are early difficulties in this area (of understanding the quantity), this can lead to further specific learning difficulties in mathematics.

It has been repeatedly proven that the general level of intelligence is related to academic performance (Alves et al., 2017; Frey, 2019). But alongside the general level of intelligence also specific abilities are important (Beaujean, 2015; Kan et al., 2024). For example, it may be that the general level of intelligence is sufficient, but specifically spatial abilities are inhibited, which leads to difficulties in developing spatial understanding skills in learning. Typically, such specific cognitive domain impairments lead to specific difficulties, such as learning disabilities in the relevant domain. For example, difficulties in spatial comprehension may lead to difficulties in understanding the content of geometry as a subject.

Psychology researchers have concluded that there are qualitative changes occurring in self-regulation processes between the ages of three and seven, shifting from "the regulation from the outside" to "internal regulation", and in general advancing to more advanced and metacognitive forms of self-regulation (Montroy et al., 2016). During this development process, the importance of language development and an individual's executive functions (EFs), core cognitive control mechanisms, is highlighted. There are several theories defining the core EFs', and one of the most widely used is the model by Akira Miyake and colleagues that describes three major executive functions: inhibition, shifting of flexibility and working memory updating (Miyake et al., 2000). EFs are important because they serve as basic control and executive mechanisms (often performed automatically, without being highly aware of them) that allow to successfully implement goal-directed behaviour. Based on the development of executive functions and language, self-regulation skills develop very rapidly until the end of preschool, with a significant jump observed (Montroy et al., 2016). The development becomes moderate afterwards.

It should also be taken into account that the frontal lobe of the brain continues to develop and mature after adolescence, and this part of the brain is traditionally associated with self-management, control, and planning functions.

Both intelligence (cognitive abilities) and executive functions are important for an individual (e.g., a student) to show one's maximum performance during learning and studying, as well as to regulate oneself. As Kristof Kovacs & Andrew Conway (2016) have discussed, decreased performance in executive functioning may act as a "bottleneck", thus the person may not show their best possible performance in the task. For example, a student has higher than average intelligence but also has extreme difficulties focusing on a task and completing it, thus not being able to show their true intellectual potential during the study process and learning. In summary, as the child develops, attention should be paid to whether cognitive development is proceeding typically according to age, in order to prevent risks to the further development of specific learning skills, as well as to the overall development of SRL.

The Concept of Self-Regulated Learning Based on Various Theoretical Perspectives

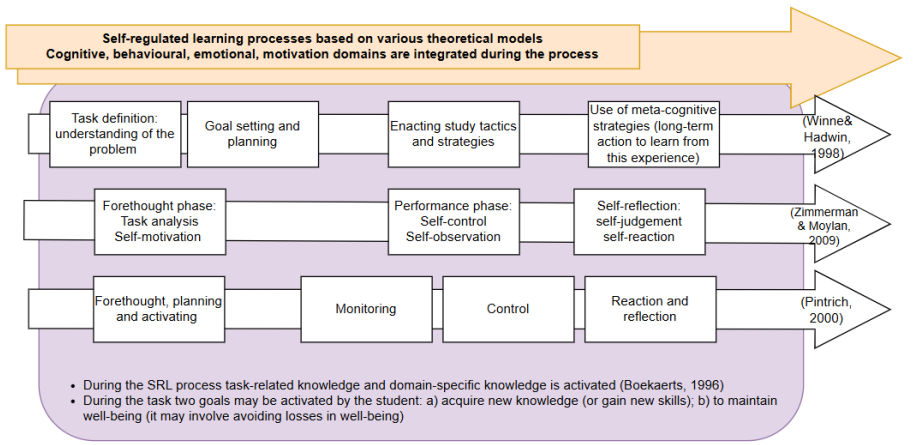
Various theoretical approaches to defining and conceptualising SRL are discussed in the literature (e.g., Panadero, 2017), and it is stressed that SRL includes cognitive, emotional, behavioural, metacognitive and motivational aspects of learning, making this construct multidimensional and complex. There has been an increasing number of scientific publications on various aspects of SRL since 1986 (Huang et al., 2023). Ernesto Panadero (2017) offers a thorough analysis of six different theoretical models of SRL (Boekaerts, 1996; Efklides, 2011; Hadwin et al., 2011; Pintrich, 2000; Winne & Hadwin, 1998; Zimmerman & Moylan, 2009) and, based on their content, similarities and differences. Furthermore, "The Education Endowment Foundation" has published a vast overview of the concepts of self-regulated learning and metacognition (Muijs & Bokhove, 2020).

The simple division of SRL into three main phases or processes – planning, observation and reflection - has been widely used, for example, this is how "self-regulated learning" as a transversal skill is described in the methodological materials of curriculum in Latvia, the "Competency-based school curriculum School2030" (Cabinet of Ministers Republic of Latvia, 2018; skola2030.lv). This division corresponds to the initial ideas of Barry Zimmerman (2000) about three main phases of SRL: forethought or planning, performance and reflection, however, this has to be considered as a very simplified view on SRL, not suitable for all age groups during various developmental stages (Demetriou et al., 2024; Panadero, 2017). For example, in the model by Monique Boekaerts (1996), the three mentioned aspects form only one of six components – cognitive regulatory strategies.

In addition, although SRL skills are usually associated with transversal skills, Boekaerts (1996) has emphasised domain-specific knowledge as one of the six components in her theory. This is especially important in school settings, where teachers typically offer SRL-stimulating tasks in the context of a specific study domain. Various authors have emphasised the importance of how domain-specific and task-related existing knowledge is being activated at the beginning of the learning process, and also being present during various phases of SRL. Following up the previous analysis by Panadero (2017), we offer a visual overview of SRL, based on several major conceptual models (Figure 2): processes involved in SRL are represented, as they are described in various theories (Pintrich, 2000; Winne & Hadwin, 1998; Zimmerman, 2008), and including the ideas from the conceptualization by Boekaerts (1996).

Figure 2

Overview of SRL Processes Defined in Several Theoretical Models as an Ouput of Conceptual Mapping



Source. Own research.

The wide variety and differences in how theoreticians conceptualise SRL processes and dimensions do not help practitioners (teachers) to implement SRL training into practice, as the theoretical frameworks do not offer a concrete methodology for this. Each theory has emphasised some specific aspects that may lead to confusion as to what are the essential parts for implementation in daily practises. In addition, the purposeful development of SRL for students must be aligned with the general development of a child, especially the developmental patterns of self-regulation. Several authors have indicated that, to develop the ability to regulate one's learning, the focus in early years has to be placed on attention control and attention span, increasing the child's ability to properly do one task at a time and understanding it (Demetriou et al., 2024). Only then gradually the focus of SRL development can be shifted towards more com-

plicated skills such as metacognition, the ability to apply the most appropriate strategies, and reflecting on one's strengths and weaknesses as a part of developing one's personality. This is in line with the idea that early on it is crucial to develop children's effortful control – the ability to focus and maintain attention (Bailey & Jones, 2019). These ideas, grounded in psychology theories, are scientifically valid and thus should be welcomed in the circle of educational experts. However, as mentioned previously, there must be some sort of "translation" from psychology science to practitioners, with clear suggestions of what teachers can do to develop students' SRL.

Theory Synthesis Results: Interdisciplinary Mapping of Concepts Relevant to Self-Regulated Learning

The interdisciplinary theory-synthesis and concept mapping in this article was implemented by analysing literature streams across the predefined analytic dimensions: executive functions, self-regulation, and self-regulated learning. We see that there is a variation of the research focus, based on the scientific discipline, when it comes to studying concepts related to SRL. Psychology researchers attempt to scientifically summarise and investigate the extent to which various abilities and skills can be developed through interventions and specific training programmes (e.g., Birtwistle et al., 2025; Breitwieser et al., 2022). Another direction of psychology research is to understand the natural typical trajectory of skill development, as well as the factors that might influence the variation in trajectories (e.g., Montroy et al., 2016). In turn, from the perspective of educational science, it is important to research the most effective ways and methods to teach and develop specific SRL-related skills within the educational process and within a certain field of study (e.g., Benick et al., 2021; Ifenthaler, 2012), thus focusing on specific and practical methods for teachers – a domain on which psychology research rarely focuses. Effective development of social-emotional, self-regulation skills and SRL in everyday school life is essential for all children (e.g., Martinsone, 2016), but it is especially important in cases where it is suspected or diagnosed that a child has difficulties in this important area. Psychology and educational sciences often address these issues using different terminology and methods. Psychology is more focused on an individual (what it means for a student *to be* self-regulative), however, education science often focuses on teacher practices (what the teacher needs *to do*). These differences cause gaps in a joint interdisciplinary understanding and do not help the practitioner-the teacher to implement methods that should be scientifically grounded, but also clearly described for practical use.

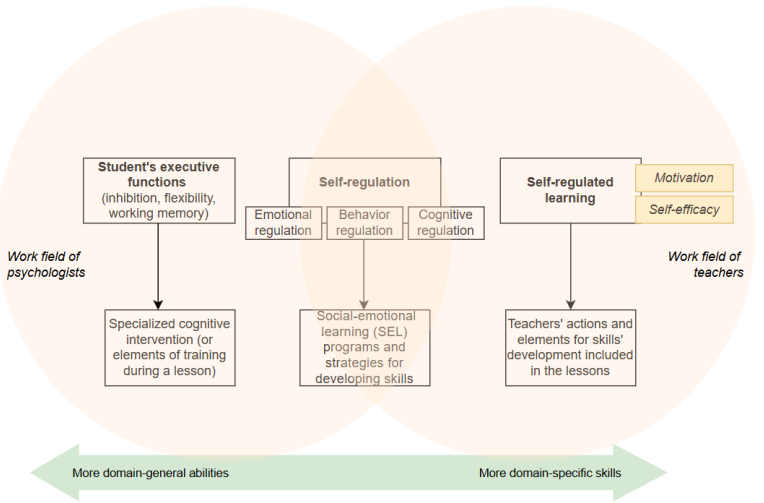
With the aim to develop students' skills, it is important to understand and precisely distinguish how these theoretical constructs are operationalised to practice, clearly identifying which ability or skill we want to improve. In addition, it is also important to distinguish who exactly is the group of specialists (e.g., a trained psychologist or a teacher) who work with the development of each skill or ability, and in what con-

text this development takes place. To interdisciplinary integrate the concepts related to self-regulation and SRL, we offer a conceptual visual mapping of these constructs that therefore represents the outcome of the conceptual synthesis, adding how they are typically trained in students (see Figure 3). The main concepts – executive functions, self-regulation, and self-regulated learning – were analysed and distinguished according to several categories: their theoretical definitions, developmental mechanisms, disciplinary grounding, typical professional support context, and degree of domain specificity.

In Figure 3, three major and separate theoretical constructs are shown in boxes in the upper row: 1) an individual's executive functions (core cognitive control mechanisms), 2) self-regulation (ability to manage one's emotions, thoughts and behaviour); and 3) self-regulated learning (SRL), sitting side by side with motivation and self-efficacy, two important, but theoretically separate constructs. Under each of the three constructs, a typical approach to training is shown. Further, we give a detailed explanation of this visual mapping.

Figure 3

An Outcome of Interdisciplinary Mapping of Concepts Related to SRL and Their Development in School and Broader Context



Source. Own research, based on conceptual theory-synthesis.

First, a student's executive functions (presented on the left side) are essential for the successful development of self-management and further academic skills. It is known that executive functions start to develop early in life (Birtwistle et al., 2025; Montroy et al., 2016), and typically targeted training under the guidance of a psychologist is carried out when a child is found to have disorders or risks in this area of development. This does not exclude that a trained teacher can include some EF-developing elements during the lesson, for example, the ability to switch attention or control and focus attention. A meta-analysis conducted on the effectiveness of interventions

for the development of executive functions concluded that, in general, interventions are more helpful at an early age compared to a later age (Birtwistle et al., 2025). Researchers also mention the improvement of mathematics and reading skills as positive benefits from such cognitive training, thus confirming the far-transfer potential.

Second, if we look at self-regulation in general (presented in the middle), it can be successfully developed by both psychological interventions (with focus on managing one's thoughts, behaviour and emotions) and by curricula or specific whole-school social-emotional learning (SEL) programmes. Research confirms the effectiveness of evidence-based SEL programmes in schools and the main essence of this approach is to preventively develop all children's social-emotional and regulatory skills, rather than acting when some problems have already been identified (Berg et al., 2021). SEL can also be implemented indirectly through teaching strategies and formative assessment (Ferreira et al., 2020). Both psychology and education specialists work with the development of these skills.

Third, SRL (presented on the right), the central focus of the current article and an important goal of a student, as stated in the law, is typically developed at school, during daily lessons. However, in order to implement the content of policy papers, it is essential to provide teachers with adequate methodological support and guidelines that are specific enough for use in the classroom. As already indicated earlier, previous research suggests that teachers experience challenges and lack tools to develop students' SRL in their classes (Hačatrjana & Linde, 2023; Linde et al., 2024), indicating that there is still room for improvement in this area. The green double-headed arrow positioned at the bottom of Figure 3 indicates the extent to which each construct is either more domain-general or more domain-specific. For example, EFs as core cognitive functions are domain-general, however, SRL is typically embedded in a certain domain and learning content (for example, a teacher trains students' planning skills in mathematics) and not taught in general.

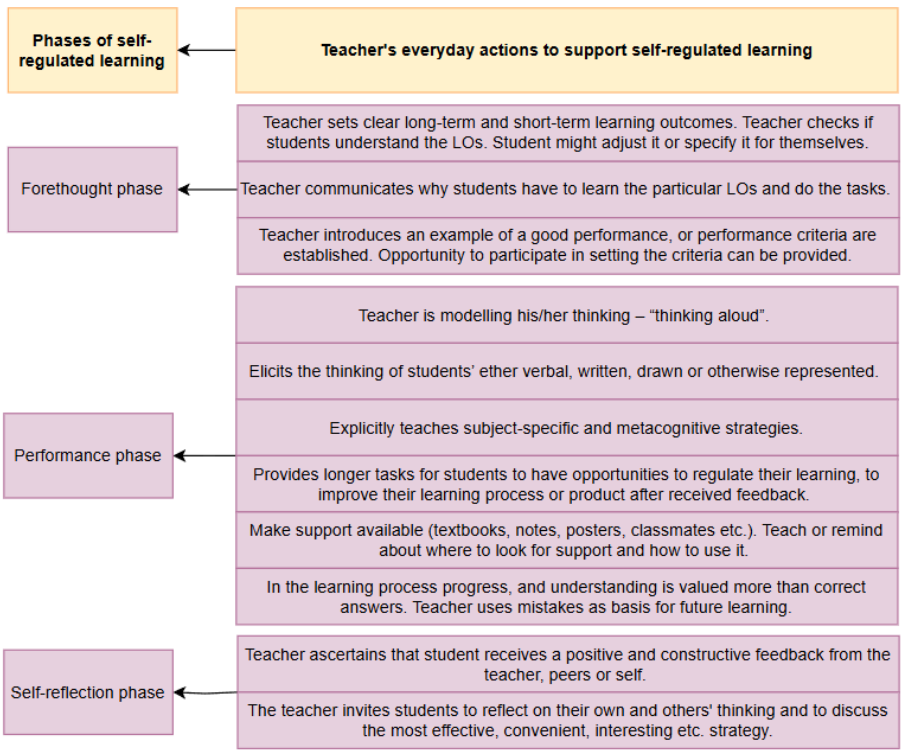
In Figure 3, two small boxes are positioned next to SRL: representing concepts of self-efficacy and motivation. Self-efficacy is a concept crucial during the process of self-regulated learning (e.g., Zimmerman & Moylan, 2009), however, a detailed analysis of the processes of self-efficacy and their importance during learning is out of the scope of the current article. Several authors have also emphasised the role of motivation, another important and vast concept, during SRL (e.g., Boekaerts, 1996). Aligning the ideas in SRL theories with the self-determination theory, it can be concluded that by giving students more responsibility for their learning and taking part in goal setting and planning, their need for autonomy is met, thus fostering motivation (Ryan & Deci, 2020). By giving students appropriate challenges and strategies to tackle these challenges and support they can feel competent and by emphasising strategy use and learning processes, students can express their thinking and feel that their ideas matter thus responding to their need for relatedness. By supporting student autonomy, competence and relatedness their motivation is fostered (Ryan & Deci, 2020). Based on the theoretical notions, self-efficacy and motivation are two broad and unique constructs embedded in psychology science, therefore we mapped them as close-to-SRL, but separate, factors in the visual conceptualization shown in Figure 3.

Practical Output of the Results: Approach for Effective Development of SRL in the Classroom

There are various approaches discussed to develop SRL in the classroom (e.g., Schuster et al., 2023; Vosniadou et al., 2024). Following the interdisciplinary conceptualisation of SRL-related concepts presented in Figure 3 that was based on theory synthesis approach (Jaakkola, 2020), the further focus is on training and developing students' SRL which is in direct responsibility of teachers. The classroom-level model was derived from the preceding synthesis and by defining which aspects of SRL can realistically be supported through everyday teaching practices. Zimmerman's (2000) cyclical phases of SRL were used as an organising structure. We offer clear suggestions for teachers' actions to be implemented during classes for a targeted, clear and focused development of students' SRL skills (see Figure 4). The contents of Figure 4 are explained further in detail.

Figure 4

Operationalising the Development of SRL Phases in Teacher Classroom-Level Activities



Source. Own research based on theory-synthesis (based on ideas by Zimmerman, 2000).

On the left side of Figure 4 the phases of SRL defined by Zimmerman (2000) are depicted and on the right side – suggested teacher actions corresponding to the particular phase. Only actions that are possible to implement in everyday practice are offered. For example, a teacher can model her thinking in a mathematics lesson: "When I saw the task, I didn't know what operation I had to use, so I decided to draw a schematic image of the problem". And elicit the thinking of students by asking them to share their thinking: "Did anybody think differently? Can you tell us how?". The suggested teachers' actions can be used to further develop specific and domain-embedded tasks for students' skills development, as well as to assess teachers' actions during the class, using this as a checklist. It is also equally important to reduce teachers' misconceptions about what SRL is (Lawson et al., 2019; Linde et al., 2022), by increasing daily use of proper actions. The approach offered can be complemented by other approaches aimed at students' SRL analysis and development such as microanalytic protocols (Cleary et al, 2012). The offered list has been used and validated in teachers' lesson study groups that have set their communal goals to improve student SRL opportunities in their practice. Specifically, it was used for lesson planning and structuring group discussion after lesson observation. In the discussion, teachers went through the potential activities provided and analysed the observed lesson – whether corresponding actions had happened in the lesson, what indicated that, how successful was it, and what could be improved for incorporating the action. Similarly, such material could be used during coaching practice (Manal et al., 2024) or professional learning communities (Meesuk et al., 2021). We provide the list in a convenient format used by teachers and professional development leaders in Appendix A, and it can be used further by practitioners in the field. The material presented in Appendix A is an output of the theory synthesis in this research, and ir should be understood as a theory-informed and practice-oriented professional learning tool, not as a psychometrically validated measurement instrument.

Conclusions

The current paper highlights and addresses the challenges in operationalising SRL at the classroom level, based on the Latvian curriculum as an example of a country with recently implemented changes that emphasise developing SRL among other transversal skills. We argue that while SRL is generally well-defined in policy documents, its practical implementation at classroom-level activities may be still unclear for teachers, leading to differences in practice, an issue also discussed in previous research (Mejeh et al., 2024). Challenges identified are both a variety of theoretical conceptualisations of what SRL means and how it emerges in students, and the operationalisation of the concepts. Previously, Panadero (2017) offered a detailed analysis of SRL theories for education, and Rebecca Bailey and Stephanie Jones (2019)

proposed to conceptualise self-regulation based on a distinctly cognitive psychology perspective. Our aim was to go further and map these concepts in an interdisciplinary way based on theory synthesis, as a result showing: 1) how all the constructs related to SRL connect conceptually (executive functions, self-regulation and SRL); 2) how each area is typically developed either by specialists in a specific field or interdisciplinary; 3) with what specific actions a teacher can promote the development of SRL in students. The interdisciplinary mapping of the constructs related to SRL integrates perspectives from psychology and education theories, thus striving to connect theory, policy definitions and classroom practice. By mapping the concepts of executive functions, self-regulation, and SRL and their connections, we further have provided a structured and practical approach to develop students' SRL in a sustainable way, by using concrete teacher actions that align with SRL theoretical phases, also offering a checklist that can be used by teachers. The current article has implemented a theory synthesis approach, and the conceptual model and Appendix A are outputs of this synthesis. Future studies in this field should focus on developing, testing and validating methodological support materials for teachers (such as the one offered in the appendix), and foster an interdisciplinary approach by involving specialists as well as practitioners in a co-creative approach.

Key points

- Challenges in "transferring" self-regulated learning teaching from how it is defined in the "policy-document level" to daily classroom practice of teachers are identified in the study.
- Based on the theory synthesis, the study integrates previous conceptualisations of SRL and regulation abilities from the fields of education and psychology to clearly map the concepts of cognitive executive functions, self-regulation and SRL, their relations and how they can be developed for students.
- As and output of the theory synthesis, the study offers a practical material for teachers to promote the development of SRL in the classroom, including specific teachers' actions and evaluation sheet, with an aim of sustainable and systematic development and teaching of SRL skills.

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Appendix A

Everyday actions to support self-regulated learning

Desirable actions	Yes/No	Actions observed in the lesson that support the evaluation
Forethought phase		
Teacher sets clear long-term and short-term learning objectives. Teacher checks if students understand the learning objectives. Student might adjust it or specify it for themselves.		
Teacher communicates why students have to learn the particular learning objectives and do the tasks.		
Teacher introduces an example of a good performance, or performance criteria are established. Opportunity to participate in setting the criteria can be provided.		
Performance phase		
Teacher is modelling his/her thinking – "thinking aloud".		
Elicits the thinking of students' ether verbal, written, drawn or otherwise represented.		
Explicitly teaches subject-specific and metacognitive strategies.		
Provides longer tasks for students to have opportunities to regulate their learning, to improve their learning process or product after received feedback.		
Make support available (textbooks, notes, posters, classmates etc.). Teach or remind about where to look for support and how to use it.		

Desirable actions	Yes/No	Actions observed in the lesson that support the evaluation
In the learning process progress, and understanding is valued more than correct answers. Teacher uses mistakes as basis for future learning.		
Self-reflection phase		
Teacher ascertains that student receives a positive and constructive feedback from the teacher, peers or self.		
The teacher invites students to reflect on their own and others' thinking and to discuss the most effective, convenient, interesting etc. strategy.		
Other notes		