Research plan project MOSAIC – working together to promote students' self-regulated learning

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Abstract

Being able to 'learn how to learn' increases the chances of success for children and young people throughout their entire school career. Furthermore, paying attention to this helps prepare them for lifelong learning in a knowledge-based society where boundaries between traditional professional groups are blurring, work is increasingly versatile and multidisciplinary, and changing jobs more than ever is common. These insights have led to increasing attention in education to promote self-regulated learning (SRL), which means that students take initiatives, show perseverance, and adaptively shape their own learning process to achieve their goals.

However, research shows that available scientific knowledge on effectively promoting SRL only slowly translates into classroom practice. This results in a lack of practical and well-founded tools for teachers. From this bottleneck, within the consortium MOSAIC, education professionals and researchers join forces with a shared ambition to bring about change in this regard. MOSAIC stands for MOtivation (as the primary driver of higher-order (meta)cognitive processes), Self-regulation (as the central focus), ACtivating didactics (aimed at activating SRL in students), and Interaction (between teachers-students; practice-science). Our focus is on strengthening teachers' actions by developing and researching concrete, applicable solutions for SRL-related practical issues.

We shape this development process as a layered design-oriented research. Cross-sectoral design groups of teachers from primary and secondary education, and researchers collaborate in an iterative process of evidence-informed (re)designing, trying out, and methodically-systematically evaluating, ensuring maximum benefit for

all participating parties. Additionally, we conduct a comparative case study on these design groups, leading to a set of generic design guidelines for SRL-promoting didactics illustrated with practical examples. Knowledge dissemination takes place through the delivery of both practical and scientific publications and presentations. Furthermore, insights gained flow back into the curricula of participating teacher training programs.

Introduction

'Learning to learn' is of great importance for the academic success of students in primary and secondary education (Bjork et al., 2013). Additionally, to align with the job market of tomorrow, students need to be prepared for 'lifelong learning' (WRR, 2013). To achieve this ambition, schools seek ways to equip students with strategies to self-regulate their learning process proactively (Education Council, 2014; OECD, 2017). Hence, there has been increasing attention in education on self-regulated learning (SRL). This entails students taking initiatives, demonstrating perseverance, and adaptively shaping their own learning process to achieve their goals (Boekaerts et al., 2005; Winne, 2011; Zimmerman, 2013).

Research shows that SRL can be taught. For example, students can benefit from the modeling of strategy use by the teacher, explicit instruction about and practice with SRL strategies, and explicit reflection on task approach (Dignath & Veenman, 2020; Donker et al., 2014). However, in primary and secondary education, there is a lack of evidence-informed tools available for teachers to effectively work on developing SRL in students. Consequently, they often get stuck in well-intentioned but ineffective guidance approaches (Moos & Ringdal, 2012). Several observational studies show that teachers often fail to explicitly teach SRL strategies to their students. Consequently, students do not receive the instruction they need to learn and practice SRL strategies, leaving them inadequately prepared for their future academic and professional careers. Students who are not familiar with these skills from home have even fewer opportunities to 'learn to learn'.

Schools and teachers, in turn, experience this issue as 'difficult' student behavior. PO and VO teachers observe that students struggle with motivation, planning skills, and strategic use of learning strategies. It is noteworthy that teachers often recognize

what students (do not do well), but do not connect these observations to factors they can influence such as lesson content, teacher-student interactions, didactics, and classroom management. The recent issues surrounding COVID-19 have further exacerbated the challenges in education delivery: students were not actively participating, turned off their cameras, or even disappeared entirely 'off the radar'. This raises the question more strongly than ever before how students' SRL can be addressed and further developed.

Teachers also have limited access to scientific knowledge on effectively promoting SRL. Additionally, this knowledge is often fragmented and challenging for them to translate into daily classroom practice (Askell-Williams et al., 2012; Bjork et al., 2013). Therefore, we are not only dealing with a knowledge problem: promoting SRL in teaching also requires behavioral change. This calls for a professional learning process involving practice, feedback, and reflection (cf. Su & Reeve, 2011).

From these challenges, our consortium MOSAIC is working on addressing the question: How can teachers in the upper grades of primary education and the lower grades of secondary education be equipped to effectively support their students in developing and activating self-regulated learning? MOSAIC focuses on co-creating SRL-promoting didactics. We do this by conducting design-oriented and/or action-oriented research addressing SRL-related practical issues in cross-school and cross-sector design teams of teachers and researchers. The outcomes of these endeavors are compared in an overarching comparative case study (Hutjes & Van Buuren, 1992; Yin, 2018) to derive transferable insights. Within our design groups, the emphasis is on developing practical design principles concerning teacher actions in the classroom. These are grounded in existing educational research (what we already know but need to translate into applications in concrete educational contexts). The overarching research emphasizes theory formation by finding generic design guidelines arising from the various practices developed in the design groups.

MOSAIC involves three secondary school boards, two primary school boards, four universities of applied sciences, and two universities. In our consortium, research-oriented professionals (from schools and school boards), professional researchers, and teacher educators (from knowledge centers and teacher training institutes)

collaborate with equal input. Our work is critically monitored regarding practical relevance and feasibility, methodological rigor, and ethics by a steering group comprising representatives from universities, knowledge centers, and school boards.

Problem statement

MOSAIC stems from a knowledge and research need of schools under three secondary school boards and two primary school boards in the South Holland and Zeeland regions. In early 2019, schools brought forward practical issues they found problematic. Subsequently, we organized three meetings with representation from six supra-school foundations for secondary education to discuss and consolidate these practical issues. We also conducted targeted discrepancy analyses among 22 teachers from three high schools. Consortium partners conducted analyses in subgroups comparing 'ideal student behavior' against the behavior of 'the actually average student'. Our question articulation resulted in all consortium partners identifying the promotion of SRL as the central objective. We then jointly wrote the application with fourteen administrators, teachers, and applied researchers, leading to preliminary research questions such as:

- *How can teachers teach and guide their students in the lower grades of secondary education in developing planning skills?*
- *How can teachers in the upper grades of secondary education teach their students to choose the information processing strategy that aligns with the task demands?*
- *How can teachers in secondary education monitor student progress to prevent test pressure and develop and maintain learning motivation?*
- *How can teachers in the upper grades of secondary education engage students' autonomy perception to promote SRL?*

The consortium partners agreed that all our research questions are related to motivational and/or (meta)cognitive aspects of SRL. The past school year, during which COVID-19 forced students to follow education more remotely, makes SRL support (in an online environment) more important than ever. Leading up to this application, we jointly determined the substantive and methodological focus during

nine online meetings last school year with 22 teachers from ten primary schools in our consortium.

Firstly, we focus on teacher actions because there is a lack of action regarding the promotion of SRL. Teachers express a desire to learn to explicitly teach SRL strategies integrated into the curriculum. They typically teach SRL implicitly, an approach that is ineffective in promoting students' SRL. In short: self-regulated learning cannot be self-taught but must be taught! Secondly, we focus on the upper grades of primary education and the lower grades of secondary education for three reasons: 1) the education field experiences SRL-related problems during the transition from primary to secondary education – it seems like the independence built in primary school quickly dissipates in the first years of secondary education; 2) 40% of lower secondary teachers indicate that they are not proficient in motivating their students (Education Inspection, 2015); 3) development of SRL is desired for lower secondary students as preparation for upper secondary education and further studies. Thirdly, within MOSAIC, equality between education professionals and professional educational researchers is paramount. We achieve this by letting research start from practical questions. Furthermore, schools prefer research approaches that align with daily educational practice. In addition to expertise in SRL, we also have ample experience in collaborative research with design teams on educational quality. For instance, we have already started a pilot this school year, where three design groups of eight to twelve teachers from a total of eleven primary schools are addressing SRL-related issues.

Based on the aforementioned principles, the following central research question has been formulated, on which we will collaboratively conduct research in this project: *How can teachers in the upper grades of primary education and the lower grades of secondary education be equipped to effectively support their students in developing and activating self-regulated learning?* Our activities will result in a set of SRL-promoting practical design principles, educational materials, and interventions with examples from the practice of participating schools.

Research plan

The amount of information and knowledge is growing today at a much faster pace than ever before. As a result, the primary goal of learning has shifted from being able to memorize and repeat information to being able to effectively find, evaluate, and use it oneself. This means that students need to be made aware of strategies that contribute to achieving (learning) goals, they need to be able to practice these strategies, and learn to critically reflect on them. This is to eventually enable them to deploy and manage these strategies themselves in a targeted manner.

Self-regulated learning

SRL comprises a learner's planning, monitoring, and evaluation of the learning process, involving learners' self-generated thoughts, feelings, and actions that serve to pursue their own goals (Schunk & Zimmerman, 1994). There are multiple conceptualizations of the construct of SRL, however, most researchers agree that SRL refers to an interplay between cognitive, metacognitive, motivational and behavioral processes that are oriented toward goal attainment (Panadero, 2017; Pintrich, 2004; Zimmerman, 2013). Next to the aforementioned synthesis of component models that describe the strategies involved in SRL, process models focus on the phases of events that comprise the ideal SRL process. Zimmerman's (2013) cyclic model of SRL is one of the most predominant process models in research on SRL (Panadero & Alonso-Tapia, 2014; Puustinen & Pulkkinen, 2001). This model is grounded in social cognitive theory and describes SRL in terms of three cyclical phases: a forethought phase, a performance phase and a self-reflection phase. The first phase involves orienting on the task, goal setting and strategic planning. During the forethought phase, the learner examines his/her learning goals and motivation, activates prior knowledge, monitors which SRL strategies and tools are necessary to achieve these goals and assesses the time required. In the performance phase, the learner deploys specific SRL strategies that were selected during the forethought phase, monitors the extent to which learning goals are realized, decides whether adjustments in the learning process are needed and acts accordingly. The final self-reflection phase focuses on the evaluation of the learning process. The learner examines to what extent the learning goals have been achieved according to their initial planning, evaluates the effectiveness of the SRL strategies

used and judges whether the used tools and support contributed to achieving their learning goals. While these three phases suggest a chronological sequence, there is no assumption that these phases follow a linear sequence. Different phases can take place simultaneously, depending on individual differences of the learner, feedback given during different phases or the change of planning to achieve the learning goal (Zimmerman, 2013). For instance, feedback does not only occur in the final phase but can be provided in each of the cyclical phases. Likewise, adjusting a plan of approach can also be applied in every phase.

In his seminal paper, Pintrich (2004) combined both component and process models of SRL. This model mostly holds on to the different phases suggested by Zimmerman (2002), but in addition integrates cognitive, metacognitive, motivational and behavioral SRL processes, clearly categorizing the different strategies that are involved during the different phases of SRL. This framework delineates the processes involved in the SRL phases for each of the four different SRL components, adding more detail to how SRL operates in the classroom.

Based on the SRL-strategies discerned in the seminal works of Pintrich (2004) and Zimmerman (1989; 2002; 2013), reviews of these SRL models (Panadero, 2017; Puustinen & Pulkkinen, 2001), instruments used to assess SRL strategies (Dignath et al., 2008b; Vandevelde et al., 2013) and on practical adaptations that are based on these frameworks (Kostons et al., 2014; Peeters, 2022; Sins et al., 2023), we composed an overview of the most stated cognitive, metacognitive, motivational and behavioral SRL strategies in Table 1. We do not contend that this involved an exhaustive list of SRL strategies and that some researchers mention other strategies or use other terms for similar strategies (Panadero, 2017; Sins, 2023).

Table 1. Overview of the cognitive, metacognitive, motivational and behavioral SRL strategies stated in relevant SRL frameworks.

Cognition contains the mental process involved in learning knowledge and skills and in the completion of learning tasks

Elaborating	Strategies that involve retrieving or using knowledge students already have: • Summarizing relevant information • Rephrasing given instructions • Drawing conclusions • Retrieval of important information (e.g. concepts, relationships, formulas) • Finding explanations and coming up with explanations yourself • Discovering similarities and making connections • Applying own knowledge • Self-testing
Organizing	Strategies that concern the arranging, revising or structuring the learning material so that information can be stored more easily: • Reducing information by grouping and visualizing the lesson material • Structuring the learning content by underlining relevant texts and making connections • Dividing problems into sub-tasks • Taking notes • Making rough calculations (when calculating) • Identifying relevant information that needs to be remembered
Problem-solving	All strategies that are necessary for understanding and performing a task: • Applying solution strategies in math, such as: rules of divisibility, numerical mathematics and decomposition of fractions • Applying reading skills to decipher and understand texts • Applying spelling rules • Using word learning strategies for (new) words to be learned

	• Parsing sentences • Working with legends, identification cards and timelines
Metacognition involves the monitoring or checking and goal-oriented regulation of the learning process	
Planning	Strategies that determine student' goals and the steps to accomplish these goals: • Setting goals and sub-goals • Orienting on how to start or how to proceed • Determining the time needed to work towards a goal • Keeping a schedule
Monitoring	Strategies to track the learning process, the extent to which goals are achieved and/or whether adjustments are needed: • Keeping track of learning objectives and monitoring the progress of the learning process • Self-questioning to check understanding and to adjust the learning process • Deciding to read or calculate something again, in case of misunderstanding or if students noticed a mistake in the learning process
Reflecting	Strategies that are used to think about the learning process: • Reasoning about the learning process (e.g. "was it effective?"; "what did you learn?") • Reflecting on the SRL strategies used • Finding out which experiences have contributed to the learning process
Behavior is what students do to direct their actions in the learning process	
Resource management	Strategies involved in making adaptive use of the knowledge and skills of others or other resources during learning: • Strategies for stimulating collaborative learning • Seeking help from teachers or classmates • Organizing the learning environment

	• Selecting learning material
Feedback	Strategies for getting information from others about students' learning: • Asking for clear, comprehensive and useful feedback • Talking about the learning process
Motivation concerns the willingness to learn. Motivational strategies help to positively influence the beliefs and emotional reactions towards oneself in relation to the learning task	
Self-motivation	Strategies that students use to optimize the learning process: • Enhancing self-efficacy: the belief of being able to handle challenges while learning • Achieving a positive learning attitude • Attributing success and failure to invested effort, rather than to a (lack of) talent or to external factors
Action control	Strategies students use to optimize the learning process: • Avoiding or removing distracting factors • Performing concentration or relaxation exercises • Stimulating students' interests • Self-rewarding when achieving a learning goal • Avoiding negative thoughts about learning • Dealing productively with failure by seeking new learning opportunities or by adjusting goals that have proven to be unattainable • Analyzing and directing emotional responses following performance

In MOSAIC we capitalize on component and process models of SRL and strategies enlisted in Tabel 1 which provides us with a tool to collectively identify the learning process and the experienced problems within it: in which phase and regarding which components do the SRL issues manifest in student behavior? Such diagnostics provide direction for the development of practical design principles, educational materials, and interventions for identified practical issues within our design teams and increase the likelihood of success in practice (e.g., Prenger et al., 2020).

Promoting SRL

You cannot learn self-regulated learning (SRL) on your own; it needs to be taught. Overview studies indeed show that interventions effectively contributing to students' SRL in the classroom are characterized by an integrative approach where cognitive, metacognitive, and motivational strategies are explicitly taught (Boekaerts & Corno, 2005; Dignath & Büttner, 2008; Dignath et al., 2008; Dignath & Veenman, 2020; Hattie et al., 1996; Perry et al., 2004). An integrative approach refers to teachers not providing 'stand-alone' study lessons but integrating the teaching of SRL into the curriculum (Vrieling, Sins, & Besselink, 2019). This enables students to directly apply strategies within concrete learning tasks. Teachers can create task situations where they respond to students' SRL strategies and provide clear feedback (see Hattie & Timperley, 2007; Voerman & Faber, 2020). Additionally, research indicates that teachers should focus on fostering connections among students, for example, through cooperative learning (Kagan, 2007), and encouraging and practicing peer feedback and peer teaching. The importance of explicitly teaching and practicing strategies (Dignath & Veenman, 2020; Hattie et al., 1996; Muijs & Bokhove, 2020; Veenman, 2011) means that teachers teach their students how (meta)cognitive strategies are applied, under what conditions these strategies are most effective, and the benefits they offer to students (Dignath & Büttner, 2008; Moos & Ringdal, 2012).

Explicit instruction involves the teacher demonstrating the use of an SRL strategy and explicitly explaining when and how the strategy can be used and why employing this strategy contributes to better learning outcomes (see Dignath & Veenman, 2020; Zohar & Peled, 2008). This way, students not only learn how a particular strategy is applied but also receive explanations on when to use this strategy and its advantages. Sometimes, students 'discover' or learn a learning strategy that works for them, and once such a strategy leads to success, it can quickly become ingrained (Winne & Hadwin, 1998; Winne, 2011). This occurs even if it is an ineffective strategy or one that is hardly applicable in other situations or domains of knowledge. When students receive explicit instruction, they find out whether and when the strategy they are using is genuinely effective. Through practice and autonomy support (Ryan & Deci, 2020) from the teacher by adjusting the task situation, as well as by making motivation and motivational strategies an explicit subject of reflection, students can gradually develop motivational self-regulation as well. A concrete example of this is

creating a poster with 'if-then' scripts based on student experiences, which they can use when facing obstacles during the learning process (see Boekaerts & Corno, 2005).

In line with the explicit teaching of SRL strategies, it is essential for teachers to consider differences between students and tailor their teaching accordingly (Boekaerts & Cascallar, 2006). Differences among students determine whether and to what extent certain interventions are effective for students' SRL. Effectively supporting SRL involves adjusting instruction based on a careful assessment of the student's knowledge and skills. Moreover, it is crucial that the provided support decreases as students' knowledge and skills increase (scaffolding; see Van de Pol et al., 2010). For example, Veenman and colleagues (2005) distinguish between students with availability or production deficiencies. Students with an availability deficiency lack sufficient knowledge and skills. Instruction for these students should primarily focus on imparting and training the knowledge and skills needed for SRL. Students with a production deficiency already possess a certain level of knowledge and skills but are (still) unable to use them at the right time for SRL. This may be because the task is too difficult, due to a lack of motivation, or because they are not yet able to assess the extent to which certain strategies need to be used in a particular situation.

SRL and Academic Achievement

Various studies show that intervening in SRL pays off. In the context of primary and secondary education, we see this in, for example, the meta-analyses of Donker et al. (2014) and Hattie et al. (1996) concerning explicit instruction in metacognitive knowledge, and of Dignath and Büttner (2008) and Dignath et al. (2008) regarding instruction in motivational strategies and metacognitive reflection. Based on a systematic review of seventeen observation studies, Dignath and Veenman (2020) conclude that there is a significant positive relationship between explicit SRL instruction by the teacher and the use of SRL strategies by students. Additionally, Kistner et al. (2010) demonstrate that explicit SRL instruction significantly contributes to students' academic achievement. Intervention studies also show that education that explicitly addresses the instruction of SRL strategies positively influences students' academic achievement and motivation (see also Askell-Williams et al.,

2012; Kostons et al., 2014). For instance, the Self-Regulated Strategy Development (SRSD) is a well-researched approach in the domain of writing skills (Harris & Graham, 2017). SRSD focuses on explicit instruction of various SRL strategies to students in both primary and secondary education. Three separate meta-analyses demonstrate that SRSD has a strong effect on improving students' writing skills (Graham, 2006; Graham & Harris, 2003; Graham & Perrin, 2006). Furthermore, Graham and Perrin (2006) show that SRSD has the greatest impact of all writing interventions for students from primary to secondary education. In the domain of science and technology education, Ben-David and Zohar (2009), Zohar and Peled (2008), and Zohar and Ben-David (2008) examined the effects of explicit instruction on inquiry learning strategies. The results of these studies show significant improvements in students' learning over the long term. SRL interventions in higher education are also effective in contributing to students' cognitive learning outcomes (see De Bruijn-Smolders et al., 2016; Jansen et al., 2019). Additionally, the meta-analysis by Dent and Koenka (2016) demonstrates that various components of SRL are positively associated with students' learning in both primary and secondary education. In addressing the issues we tackle, we incorporate insights from both correlational research and intervention studies, explicitly focusing on motivational, cognitive, and metacognitive SRL components.

Impact on Educational Practice

While various review studies show that students effectively learn SRL skills through explicit instruction, studies indicate that teachers in primary and secondary education typically implicitly instruct these skills (Dignath & Veenman, 2020). Essentially, this involves a form of blind training, where students are not informed about the intentions of the teacher providing the instruction. This means that students in the classroom are currently not or barely informed about the existence, use, and importance of SRL strategies (Dignath-Van Ewijk & Van der Werf, 2012; Kistner et al., 2010; Kramarski & Michalsky, 2009; Perry et al., 2004; Van Beek, 2015). Bolhuis and Voeten (2001) argue that the essence of the problem is that students need to be more independent without the teacher explicitly teaching them how to handle this increased autonomy. A study by Askell-Williams and Lawson (2015) demonstrates the potential consequences of a lack of explicit instruction in SRL skills. Their longitudinal study revealed that students' use of SRL strategies in secondary education hardly develops

over five years. In another study by Askell-Williams et al. (2012, p. 421), where students from three consecutive years were surveyed, the researchers even observed a "falling response pattern." The consequences of this are that students with inadequate 'learning to learn' competencies enter further education.

From this standpoint, in this project, design groups of educational professionals and researchers work through design-based research on the development of practical design principles that are an elaboration of an integrative and explicit SRL-promoting didactics. These principles form the basis for the development of concrete applicable teaching materials and interventions. At the same time, we conduct overarching research in the form of a comparative case study (Hutjes & Van Buuren, 1992; Yin, 2018) with the central research question 'How can teachers in the upper grades of primary education and the lower grades of secondary education be equipped to effectively support their students in developing and activating self-regulated learning'. Products, approaches, experiences, and collected data from the design groups, along with feedback from the practice partners, alongside additional observations, questionnaires, and interviews, constitute the data for this overarching research that will lead to generic SRL-promoting design guidelines.

Collaborative Research in Design Groups

Within this project, we form five design groups (consisting of at least six members each), including at least one teacher leader and educational professionals from different schools. Schools are allowed to expand these design groups using their own resources for professional development, up to a maximum of nine teachers per group. We choose to organize the design groups online (for example, via Teams) and across schools to allow educational professionals from various institutions and sectors to exchange experiences and learn from each other.

We begin our project by conducting three preparatory sessions to explain design-based research and the concept of SRL. Subsequently, based on this model, teachers make a focused selection of up to three SRL-related subthemes that they perceive as priorities in their educational practice (such as planning skills or promoting perseverance). Design groups are then formed based on this inventory. Ultimately, each design group commits to one SRL-related subtheme, which

everyone collectively feels is urgent. This means that while our project may not cover the entire construct, we focus on those aspects of SRL that are considered highest priority by the field.

Each design group then conducts design- and action-oriented research around the chosen theme. This research approach acknowledges the complexity of the educational context and the issues involved, combining aspects of design thinking (see, e.g., Van Aken & Andriessen, 2011) with participatory action research (see Migchelbrink, 2016; Ponte, 2012; Van Lieshout et al., 2017). Furthermore, this approach aligns with the explicit desire of participating schools to adopt a research approach that ecologically integrates with daily educational practice and produces tangible materials for that practice.

A central tool in the design process is the CIMO-logic (Weber, 2011; see Table 2). This practical tool allows plausible reasoning chains to be established between a practical problem specific to a context, the intended target situation, and the pathway to achieve these goals. The result is an initial version of a design principle in the form of a substantiated reasoning chain that is gradually optimized. In other words, following a preliminary investigation aimed at mapping out an initial situation and clarifying the practical problem related to an SRL subtheme, context-specific design principles and interventions are developed (see, for example, Harris & Graham, 2017) based on relevant scientific knowledge about SRL and experiences with previously described interventions for the integrated and explicit teaching of SRL in both primary and secondary education (see, for example, Askell-Williams et al., 2012; Harris & Graham, 2017; Sins, 2018; Zohar & Peled, 2008), ultimately leading to the desired outcomes.

Table 2. The CIMO logic and the thought process during the design process (from Context to Outcome, to Mechanism, to Intervention).

Question-in_Context		
What core problems are being addressed? *What conditions need to be addressed?*		
Intervention ←	**Mechanism** ←	**Outcome** ↻
What lesson materials and teacher interventions are needed and possible to initiate these direct processes in students?	*Which direct processes need to be initiated in students to achieve the intended outcome(s)? What does the final situation look like in terms of changed student behavior regarding SRL?*	*What does the final situation look like in terms of changed student behavior regarding SRL?*

After establishing a preliminary CIMO reasoning, a repetitive process of short cycles of trial, methodical-systematic evaluation, and evidence-informed (re)design follows. During and after the implementation, teachers collect data that provide insight into the extent to which the intervention-as-intended has been realized in practice, the extent to which intended mechanisms have occurred in students, and whether the intended outcomes have actually been achieved. For this purpose, the design team members employ provided, self-developed, or hybrid research instruments, which are not only aimed at determining whether the intended outcomes have occurred but also how and why the intended outcomes are or are not being achieved. This involves qualitative and experience-based (Mighelbrink, 2016) methods of data collection, in addition to quantitative methods.

In addition to the principles of design thinking, we also operate according to principles of participatory action research (PAR). While there is some overlap between these approaches, we add the following essential aspects:

- Issues are context-bound, and solutions primarily focus on improving teachers' actions in practice.

- All consortium partners are actively involved in the design, implementation, evaluation, reporting, and knowledge utilization of the research, not just as respondents but also as co-researchers. They actively give meaning to their own (renewed) reality.
- The process of collaborative research is also subject to investigation and reflection in our comparative case study.
- Design, research, implementation, and professionalization go hand in hand.
- Research quality is determined by balancing practical relevance, methodological thoroughness, and ethics. We also consider the consistency of reasoning within the research. Finally, we ensure that stakeholders can participate appropriately and that our research and its outcomes align with the specific context in which the research is conducted and where it should contribute.

Based on the above principles, we encourage the emergence of a joint professional learning process in each design group. This process involves the following general phases:

1. **Clarification of the Contextualized Issue**: Members of the design group conduct actions related to the chosen ZRL-related subtopic to clarify the ZRL practice issue in their own context. The outcome is a thorough understanding and concretization of what needs to be improved in students' ZRL.
2. **Formulation of Intended Student Behavior**: Based on the clarified issue, the group collectively formulates the intended student behavior ('outcome'). These outcomes are described as specifically as possible in observable or assessable terms, considering what can be expected of students regarding ZRL at a certain level. These outcomes should also be realistic given the starting situation and the project's duration.
3. **Identification of Mechanisms and Interventions**: The group then backward-maps from the intended outcomes to determine which mental/physical (learning) behaviors need to be initiated in students (mechanisms) to achieve the intended outcomes. They also consider how available scientific knowledge provides guidance for concrete action perspectives (interventions) for teachers in this regard.

4. **Development of Design Principles**: Based on the above, the design group formulates practical design principles that form the basis for developing concrete didactic interventions and educational materials. These interventions aim to explicitly instruct ZRL skills integrated into regular lessons.
5. **Data Collection and Reflection**: The group decides how to collect data on the functioning of these design principles in the classroom, helping to systematically determine and understand their effectiveness. This data collection occurs in regular classroom practice using methods that align as much as possible with the natural flow of the lesson.
6. **Implementation and Iterative Refinement**: The design group implements the developed design principles and data collection methods for a short period. They then share experiences and jointly analyze and interpret the collected data. Based on new insights, they critically review and, if necessary, adjust the practical issues, outcomes, mechanisms, interventions, and design principles.
7. **Documentation and Further Iteration**: The outcomes of this process are documented in filled CIMO schemas, tested educational materials and research instruments, and collected and analyzed student-level data. All considerations during this process are noted down. These data sources are also used as input for our overarching research.

This process emphasizes the importance of multiple short iterations to gradually gain a deep understanding of 'what works' in classroom practice. The researchers initially act as process initiators and facilitators, but ownership gradually shifts to the design group members, aligning with the PAR philosophy where increasing ownership is a key objective.

Overarching research

Our research is designed as a comparative case study with the central research question: "How can teachers in the upper grades of primary education and the lower grades of secondary education be equipped to effectively support their students in developing and activating self-regulated learning?" In a comparative case study, specific cases are compared based on a fixed analytical framework to find evidence for certain patterns in the collected data. The issue we face is complex, not only because of the SRL construct but also due to the complex reality of educational

situations in which many different actors and factors influence each other. A quasi-experimental research design is less suitable, partly because this design incorrectly assumes or overestimates the possibility of comparability between classes and students. Furthermore, practices differ in their initial situations, making a 'one size fits all' approach inadequate.

Our research aims at theory formation by identifying generic design principles proven to work in practice, illustrated by concrete examples from the participating educational professionals' classroom practices. Researchers from MOSAIC will search for transferable design principles for collaborating in schools to promote SRL-enhancing didactics. These design principles will provide practical guidance for designing and evaluating approaches in educational practice. Given the uniqueness of each educational context, these principles cannot be directly transferred to other contexts, but they are guiding for solving their own SRL -related practice issues. In this research, the cases are formed by the design groups and the insights and materials they produce. Their prioritized SRL -related themes, CIMO reasoning chains, (intermediate) products and minutes, teaching experiences, and collected student data constitute the initial input for the overarching study. Thus, the research outcomes of the design groups contribute both to the development of their own educational practice and to the overarching research.

For the analysis of the collected data, our conceptual model of SRL will be used to identify which (sub)topics the design groups prioritize and why, which interventions are designed and how, which mechanisms and outcomes are achieved, and what this says about promoting SRL in educational practice in terms of generic design principles (see Table 1). Again, we will use the CIMO logic, but this time as an analytical tool. Our analytical techniques include thematic ordering and open and axial coding of data.

The premise that the activities of the design groups primarily serve their own practice may pose challenges for the comparability of the cases. We address this in two ways. Firstly, we ask the design groups to conduct peer classroom observations at the beginning, middle, and end of the project using the observation instrument developed by Dignath-van Ewijk et al. (2013), adapted to the Dutch context by Sins (2018).

Secondly, we will use a method of data analysis similar to meta-ethnography to make difficult-to-compare data comparable. This method involves creating preliminary (practice) theories regarding the research question, which are refined and validated with stakeholders in several rounds. The first step is to use a timeline method where each project year is concluded. Each design group contributes relevant generated products, reflections, and research data. These are placed on a timeline with an investigator. Above this timeline, there is space to draw two lines representing (1) how well or poorly the implementation of SRL-enhancing educational materials and interventions by the teacher progressed and (2) how well or poorly the students' ZRL progressed. As these lines are drawn, the design group articulates their narrative, focusing on notable increases or decreases in the drawn lines. Finally, the design group collectively answers the research question in the form of effective design principles based on their own process. This narrative and the preliminary answers to the research question are recorded and treated as one long interview. Five of these interviews, along with underlying data on a timeline, are available per project year.

In step two, the researchers analyze the initial set of interviews and integrate insights gained from the underlying data and observations into a preliminary, cross-case answer to our central research question. In step three, this preliminary answer is presented to all design groups, who are allowed to annotate it as a form of member check. At the end of the second project year, we repeat this procedure, further refining, correcting, and validating the answer to our research question based on practical insights. This process results in a set of generic design principles, which are illustrated in the final phase by all consortium partners using relevant practical examples. Participants choose which design principle they want to contribute to, making it transferable to others. Teacher trainers from the our institute also contribute to promoting this transferability to teacher training programs.

Activities Plan

Preparation

We have already initiated three pilot design groups with eleven primary schools this school year, each consisting of nine (online) sessions. The aim is to explore relevant SRL issues that we will address upon approval of this project. Specifically, we will commence this project before the summer of 2022 with preparatory work so that the

design groups can effectively start their first iteration after the summer. We will organize two online sessions on SRL and one on design-oriented action research before the summer of 2022. Based on prioritized SRL sub-themes, we will then form five design groups.

Project Year One

During the first project year, the design groups will meet monthly. Their initial activities will focus on clarifying the SRL-related practical question in their own context. Subsequently, they will go through multiple rounds of designing, testing, methodically evaluating, and (re)designing. They will produce completed and adjusted CIMO schemas, minutes with considerations, preliminary educational and research products, and self-collected data. Interim products and insights will be shared within and outside the project as indicated under 'Impact on education and the research community'. During this project year, questionnaires will be administered to students: one at the beginning of the project and one around May 2023. The project year will conclude with a timeline interview per design group. The implementation of the developed design principles, teaching materials, interventions, lesson observations, and data collection will take place in regular classroom practice. Regarding the overarching research, activities in the first project period will focus on getting the design groups started, clarifying concepts and methods, and supporting data collection. Interim insights will also be shared internally and externally. The steering committee will be continuously informed and consulted throughout the year. However, they will meet as planned at the start before the summer of 2022, midway through, and at the end of the project year. Organizational matters, practical relevance, feasibility, and methodological rigor will be discussed during these meetings.

Project Year Two

In the second project year, the design groups will meet monthly again. The activities facilitated within the project will focus on design-oriented action research related to SRL until February 2023. The implementation of the developed design principles, interventions, lesson observations, and data collection will take place in regular classroom practice. During this period, data collection from students (questionnaire) will occur in January 2024. In March, the concluding timeline interview per design

group will take place. The remaining months will be used to transfer the insights and products gained. After the project, the design groups will continue their design-oriented action research, which we will continue to support. However, this falls outside the funded time frame of this project. Where necessary, additional funding will be sought from other funds and/or school boards. Regarding the overarching research, data analysis will commence immediately after the first project year, and a preliminary answer to the central research question will be sought in the form of generic design principles and relevant practical examples. The second-order analysis will be conducted after February 2024. In the latter half of this project year, further knowledge utilization activities will be initiated. The actual execution of these activities will take place (partly) outside the project period, as we are also dependent on the schedules of conferences and journals. The steering committee will continue to be informed and consulted by the end of the 1st project year. They will also meet three times as planned in the 2nd project year. Similar to the first year, discussions will revolve around organization, practical relevance, and methodological rigor. However, throughout the year, the focus will shift more towards critically reviewing analyses and delivered products.

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