ReguLA: A Self-Regulated Learning Component for Online Learning Systems

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Abstract. *This work describes the development of ReguLA, a technological component that encompasses Self-Regulated Learning (SRL) theory, aimed at empowering students to take an active role in their learning processes within online educational environments. SRL emphasizes the student as the protagonist by encouraging goal-setting, strategic monitoring, and reflective evaluation. Recognizing the challenges in applying SR particularly its voluntary adoption by learners ReguLA is designed to provide flexible support, allowing students to choose their level of engagement with self-regulatory practices. This approach fosters critical thinking and autonomy while respecting individual decision-making in learning. As a first phase, this study presents the theoretical foundations, the design of the components aligned with the SRL phases, and the prospects of integrating data mining techniques to refine personalized learning suggestions.*

1. Introduction

Self-Regulated Learning (SRL) is an educational process in which students set goals, monitor their own progress, and adjust their strategies to achieve the planned academic outcomes [Marini and Boruchovitch 2014]. This approach aims to foster critical thinking, autonomy, and adaptability throughout the learning process.

SRL development tends to be more effective in higher education [Edisherashvili et al. 2022], where students usually demonstrate greater maturity and experience with different educational methods, and deal with the absence of direct supervision by teachers. These factors contribute to greater receptivity and adherence to the SRL technique, being intrinsically related to the development of critical thinking, since it involves components such as metacognition, motivation, and strategic action. These elements enable students to analyze, evaluate, and adjust their learning approaches into a reflective and autonomous manner [Brenner 2022].

Although its effects depend on the student's profile and the way it is applied, the continuous and structured practice of SRL tends to foster an expanded sense of responsibility for one's own learning process [Zimmerman and Schunk 2013]. This systematic self-reflection can even be transferred to contexts beyond the educational environment. Recognizing the importance of SRL in enhancing student agency in their relationship with knowledge, the challenge arises of how to abstract this technique into a plugin for an already functional online activity environment. The goal is to allow students the freedom to choose whether or not to use it, thus contributing to strengthening their decision-making role in the learning process.

This work is structured as follows: Section 2 presents related work, highlighting initiatives that integrate SRL theory and combinations with other educational technology artifacts; Section 3 describes the methodology used for the development of the proposed component; Section 4 details the characteristics of the developed component and how its parts relate to the theoretical foundations of SRL; finally, Section 5 discusses the final considerations and possibilities for future research.

2. Related Work

The authors in [de Souza Castro and Oliveira 2024] have performed a statistical study that compared the performance of different active methodologies such as flipped classroom, quizzes, problem-based learning (in pairs and groups), hands-on laboratory activities, and project-based learning in the Systems Analysis and Design course in a Computer Science program. The results indicated that project-based learning and flipped classroom approaches provided superior performance compared to other methods, highlighting the potential of these strategies to promote better academic outcomes. However, the study also points out challenges to the implementation of these methodologies, such as increased preparation time and the need for adequate resources, thus suggesting the importance of institutional support for broader adoption.

The authors in [Borges and outros 2024] have proposed a tool based on a questionnaire adapted from the literature was developed to diagnose self-regulation profiles and send personalized recommendations to 43 students from two institutions. The analysis revealed critical aspects such as test anxiety, learning control, time management, and study environment quality, indicating that individualized technological interventions can improve SRL indicators. However, the research involved only a limited sample and did not include longitudinal evaluation, indicating the need for more studies in different institutional settings.

The authors in [Neo et al. 2024] have proposed NeoAVA, a virtual learning environment integrated with Google Classroom, aimed at promoting self-regulated learning (SRL) through personalized educational recommendations based on SRL strategies and Big Five personality traits. The system was evaluated using the Design Science Research methodology and the Technology Acceptance Model (TAM), with experiments involving a small group of participants. The results indicated positive acceptance, ease of use, and potential to improve students' academic performance through personalized interventions. However, the evaluation was limited to a small group and did not explore large-scale application or different educational contexts, indicating the need for broader future studies.

The authors in [Lima et al. 2024] investigated the impacts of a pedagogical architecture supported by Artificial Intelligence (AI) on engagement and the development of self-regulated learning (SRL) in virtual environments. The solution was implemented in an introductory Python extension course using Moodle and analyzed through educational data mining techniques. The results indicated that the architecture helped identify patterns of student interaction and their relationship with academic performance, highlighting the potential of AI to foster self-regulation skills. However, the study was limited to a specific context and did not evaluate application in different subjects or institutional settings, suggesting the need for broader future investigations.

Finally, the authors in [Leite and Silveira 2024] proposed and validated a computational system to support self-regulated learning and monitor knowledge acquisition in Computer Science courses in higher education. The system is developed as a mobile application and allows students to perform self-assessments and visual and textual reflections on their learning objectives, while teachers monitor individual and collective progress through graphs and reports. Validation with teachers indicated feasibility and potential to make assessment more humanized and identify students' needs, although the application was limited to a specific context and did not evaluate large-scale use or in different areas, suggesting the need for future studies.

Unlike previously presented solutions in the literature, which focus primarily on automatic recommendations, integrated virtual environments, or monitoring systems based on general self-assessment, the component proposed in this work offers a more personalized and flexible approach to self-regulated learning. In the developed system, the user can create specific study subplans for topics in their course, autonomously defining the amount of time, study days, and desired level of understanding for each content. This granularity allows the student to adapt planning according to their needs and individual goals, promoting greater engagement and a sense of responsibility for their own learning.

Furthermore, the system encourages continuous reflection by requiring the completion of reflection or success forms whenever the plan is edited or completed, stimulating the development of metacognitive skills. The integrated dashboard provides visual feedback on progress, facilitating performance monitoring and the identification of improvement points. This proposal differs from previous approaches by combining autonomy, personalization, and structured reflection in a single component, increasing the potential for positive impact on self-regulated learning in different educational contexts.

3. Methodology

This research adopted Developmental Research as a methodological approach, as defined by [Richey and Klein 2014], aiming at the creation of an educational component grounded in a consolidated educational theory. In this case, the development was guided by the principles of Self-Regulated Learning theory, which sees the student as an active agent in their learning process, capable of planning, monitoring, and evaluating their cognitive, motivational, and behavioral actions [Zimmerman 2002].

Based on this theoretical foundation, the ReguLA component was conceived to promote self-regulation strategies in the educational context, especially aimed at supporting students in organizing their goals and monitoring their own performance. The component was designed based on pedagogical principles derived from SRL, articulating aspects such as defining study strategies, goals, and self-reflection on the learning process during the course.

This stage of the work corresponds to the first phase of the research, focused on the conceptual and technical development of the component, not yet involving direct practical application with students. However, the tool's development process was based on criteria of theoretical validity and pedagogical coherence of SRL, guided by continuous analysis between the component's objectives and the adopted theory's foundations.

3.1. Self-Regulated Learning

With the student as the protagonist of their own learning process, the Self-Regulated Learning (SRL) approach is a field of study within Educational Psychology dedicated to investigating the personal, behavioral, and contextual aspects that influence autonomous and self-guided learning [Zimmerman 2002].

In addition to being a theoretical field, SRL can be understood as a conceptual framework that encompasses different domains, such as cognitive, behavioral, affective, and motivational [Boekaerts 1999]. This approach assumes that the student is capable of setting clear goals, defining action strategies, and continuously monitoring their own progress, adjusting as necessary.

As a cyclical process, self-regulated learning is generally organized into three main phases [Zimmerman 2000]:

- **Planning:** In this stage, the student analyzes the tasks to be performed, sets goals, and defines the strategies to be used. It is also at this moment that deadlines and success criteria are determined, guiding what will be done, how it will be done, and for what purpose.
- **Execution:** Based on the planning, the student puts the defined actions into practice, seeking to follow the previously established strategies. During this phase, constant progress monitoring is essential, focusing on discipline and achieving objectives.
- **Evaluation:** In the final phase, the student reflects on the learning process, identifying successes, difficulties, and opportunities for improvement. Based on this self-reflection, adjustments can be made to strategies and goals, strengthening the continuous cycle of self-regulation.

4. ReguLA Component

The ReguLA plugin was developed to operate on the [OMITTED FOR REVIEW] platform, a learning environment that allows students to personalize their experience by activating different components and plugins. As soon as the component is activated, a general immutable plan is automatically created for the user. From there, ReguLA provides functionalities focused on planning, monitoring, and reflecting on the study process, allowing the creation and management of personalized subplans. The component's workflow, illustrated in Figure 1, involves accessing the dashboard, creating subplans, managing existing subplans, and viewing the details of each subplan, promoting greater autonomy and student engagement.

4.1. Create Subplan

Figure 2 shows the "Create Subplan" page, where the student defines goals, priorities, and desired skills, exercising strategic planning—a fundamental stage of self-regulated learning (SRL). The choice of topics and the definition of parameters such as study time and dedicated days favor process personalization, aligning the plan with individual needs and

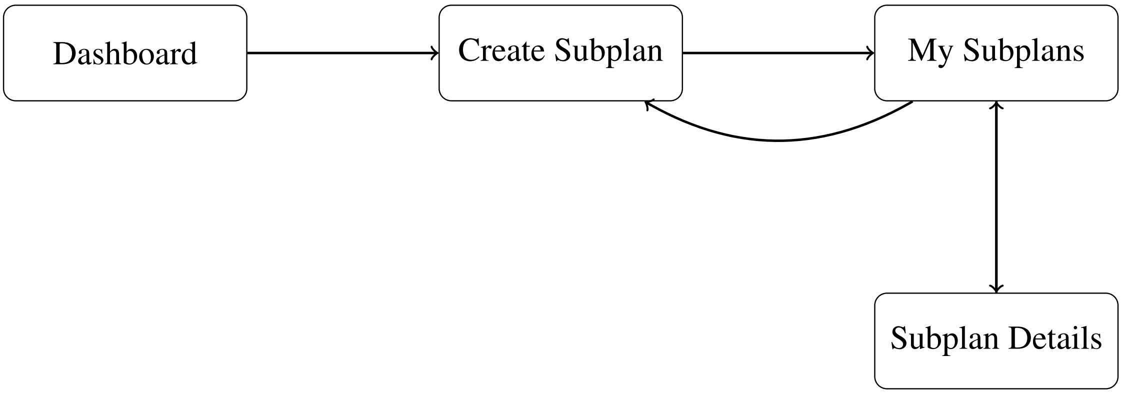

Figure 1. Main flow of the ReguLA component.

promoting engagement. This page corresponds to the **planning** phase of the SRL cycle, in which the student analyzes tasks, sets goals, defines strategies, and success criteria for their learning journey.

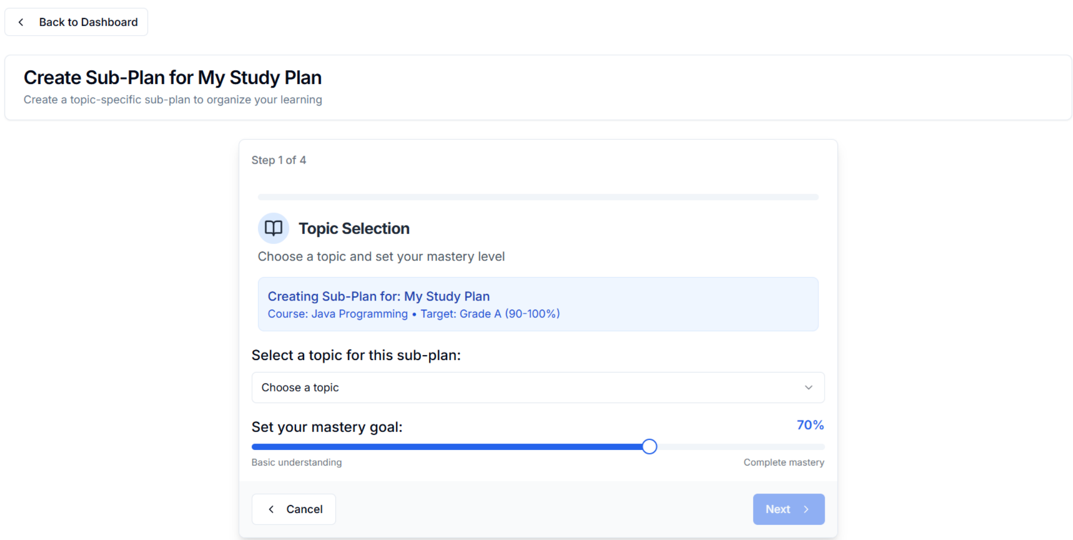

Figure 2. Page "Create Subplan"

4.2. Dashboard

Figure 3 presents the "Dashboard" page, which serves as the starting point for the student, offering an overview of existing subplans and facilitating access to the component's main features. In addition to encouraging active planning and the definition of new learning objectives, the page includes a "Sub-plan History" tab, which presents the student with the history of changes made to their subplans, promoting the monitoring of their own organization and adaptation process. Another relevant feature is the "WorldCloud", which displays a word cloud generated from the reflections entered by the student throughout the system's use, allowing a synthetic visualization of the most recurring themes and feelings in their learning journey. Thus, the "Dashboard" page is related to the **planning**, **monitoring**, and **reflection** phases of the SRL cycle, enabling both the initiation of new plans and the monitoring of progress and qualitative analysis of study experiences.

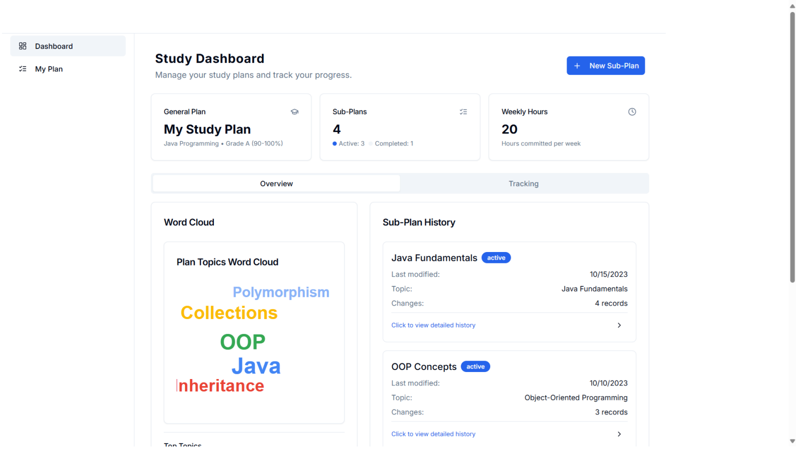

Figure 3. Page "Dashboard"

4.3. My Subplans

Figure 4 presents the "My Subplans" page, which offers the student an organized view of all created subplans, displaying the status of each and offering editing options. This environment facilitates continuous monitoring and self-assessment, allowing the student to review, adjust, and track the progress of their plans, identifying advances and challenges throughout the process. The possibility of editing or starting tasks reinforces adaptability, a central characteristic of self-regulated learning. This page is directly related to the **execution and monitoring** phase of the SRL cycle, as it is at this moment that the student inserts planned strategies into practice, monitors progress, and makes necessary adjustments to achieve their learning goals.

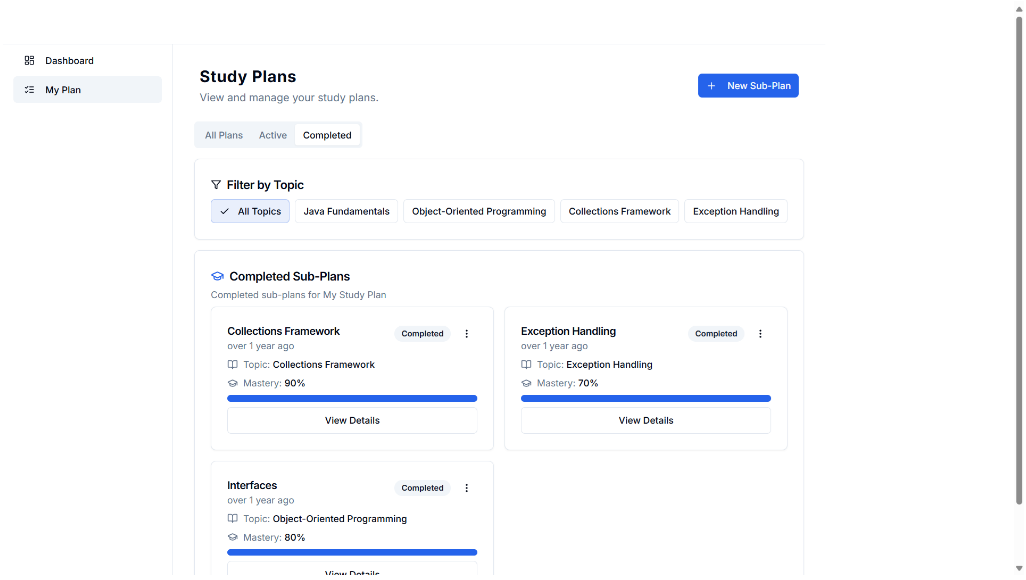

Figure 4. Page "My Subplans"

4.4. Subplan Details

Figure 5 presents the "Subplan Details" page, which allows the student to view complete information about a specific subplan, including objectives, progress, and change history.

At this stage, the student can mark the subplan as completed, edit information, and, most importantly, perform mandatory reflections on the learning process. This functionality stimulates critical analysis, the identification of successes and difficulties, and the continuous improvement of study strategies. This page is associated with the **evaluation and reflection** phase of the SRL cycle, as it promotes self-reflection and the closing of the self-regulation cycle, integrating planning, execution, monitoring, and evaluation.

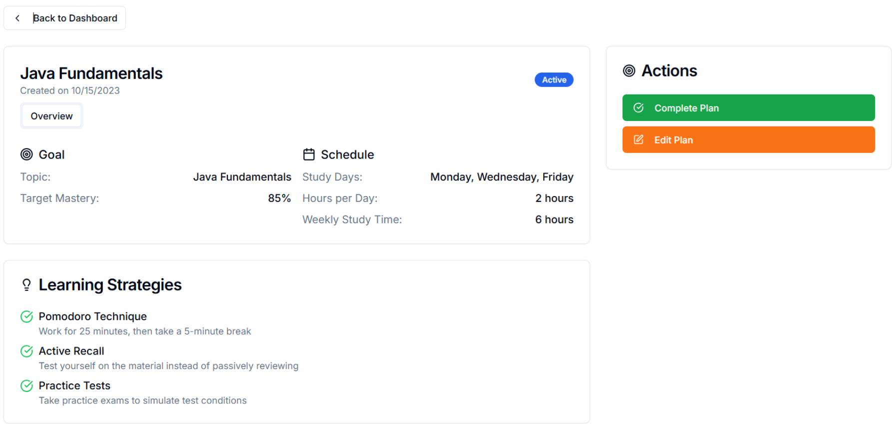

Figure 5. Page "Subplan Details"

4.5. Reflection

Figure 6 presents the "Reflection" tab, where the student records their reflections when editing or completing a subplan. In the ReguLA component, reflection is a central element of the self-regulated learning (SRL) process, being operationalized at two key moments: when editing a subplan, the student must fill out a reflection form, describing the reasons for the change, the challenges faced, and expectations for the new approach; when completing a subplan, a "success reflection" is requested, aimed at recording achievements, learning, and possible improvements for future experiences.

These moments of reflection not only promote the development of metacognitive skills but also strengthen the self-regulation cycle, allowing the student to understand the impact of their choices and continuously evolve in their academic journey. By making reflection a mandatory step for changing or completing plans, the component encourages student protagonism and the construction of more autonomous, critical, and meaningful learning, in line with SRL principles.

5. Conclusion

The implementation of self-regulated learning (SRL) as a teaching-learning methodology presents significant challenges, as it breaks with historically established paradigms in which the student was conceived as a passive subject in the educational process. By adopting this approach, the student assumes an active role: becoming a planner, executor,

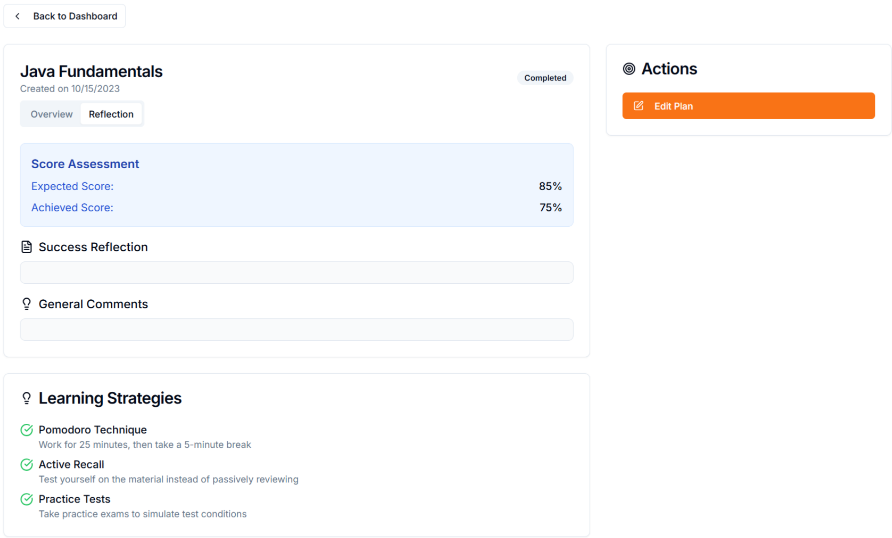

Figure 6. Tab "Reflection"

and, to some extent, an evaluator of their own performance. This transformation makes the process more demanding but also more empowering and rewarding [Boekaerts 1999].

The support of technologies that assist in monitoring this process can decisively contribute to overcoming the learning curve involved in implementing SRL [Panadero 2017]. In this context, the ReguLA component was developed to facilitate this monitoring. It offers the student the freedom to replan their goals and encourages critical reflection on the obstacles faced based on their own adopted strategy, further bringing critical thinking closer to the individual decision-making process.

As a development of this work, the application of educational data mining techniques is proposed to identify patterns of success and failure in the plans drawn up, through the analysis of feedback and strategies used. From these analyses, it becomes possible to improve the component itself, offering more effective and personalized suggestions. In a second stage, the processed, anonymized, and properly treated data can be used as a training base for intelligent systems capable of generating more assertive recommendations, adapted to reflection moments—both in successful situations and in the reformulation of subplans.

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