

*A Conceptual Framework for Self-Regulated Learning and Assessment in
Pre-service Teacher Education*

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Abstract

Learning Analytics (LA) is a growing trend used to understand how students manage their learning with self-regulation to achieve learning objectives by combining their aptitude with classroom engagement. These involve collecting, analyzing, and reporting student data to optimize learning processes and achievement. By leveraging student data, LA empowers higher education to enhance teaching effectiveness, personalize learning experiences, and address educational challenges. This study investigates the role of LA in supporting Self-Regulated Learning (SRL) among undergraduate pre-service teachers. By analyzing online trace data, we aimed to identify indicators of effective SRL strategies and develop a conceptual framework for assessing SRL. Our systematic review of literature from 2013 to 2023 examined existing research on LA and SRL in higher education. Results indicate that LA can provide valuable insights into students' learning behaviors, enabling the identification of distinct learner profiles. By prioritizing educational measurements aligned with specific SRL stages, we propose to enhance teaching and learning practices for pre-service teachers.

Keywords: Self-Regulated Learning, Learning Analytics, Systematic Literature Review

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Introduction

Education highlights the need for innovative strategies to equip pre-service teachers with the necessary skills to foster effective learning environments. Self-regulated learning (SRL) is a critical competency in this attempt, enabling individuals to take charge of their educational processes by setting goals, monitoring progress, and reflecting on outcomes (Winne, 2005; Zimmerman, 2002). For pre-service teachers, mastery of SRL is vital for their academic success, as well as modeling and instilling these practices in their future learners. (Michalsky & Schechter, 2013). Learning analytics (LA) has emerged as a transformative tool in higher education, offering insights into student behaviors and learning patterns through the analysis of digital trace data (Clark & Tuffley, 2024). By leveraging these insights, educators can better understand how pre-service teachers engage with learning tasks, identify SRL strategies, and tailor interventions to support their development (Leitner et al., 2017). Recent studies have emphasized the potential of LA to reveal patterns in planning, monitoring, and reflection as the key components of SRL to enable targeted support for learners (Kleimola et al., 2024).

LA examines the temporal aspects of learning and offers valuable insights into constructs. It presents unique possibilities for connecting theory and practice. Researchers can identify strategies for effective SRL by analyzing how pre-service teachers engage with online learning platforms, submit assignments, and participate in discussions. However, there are challenges in implementing LA effectively. These include the need for frameworks that solve LA findings into actionable interventions, such as personalized feedback or adaptive learning resources efforts to align LA with the phase of SRL (Saint et al., 2020).

This study explores the role of LA in enhancing SRL among pre-service teachers to examining the indicators as the strategies in engagement and self-regulation, it seeks to develop a conceptual framework for assessing and fostering SRL in pre-service teachers. The findings aim to inform strategies for embedding SRL principles into pre-service teachers' preparation, ultimately contributing to the professional growth of educators and the success of their future students.

Self-Regulated Learning in Pre-service Teacher

Self-regulation is a crucial self-directed process that enables learners to transform their mental strengths into concrete academic performance with effort. Self-regulation includes thoughts, feelings, and individual actions, all aimed at reaching significant goals, which empowers students to take charge of their own (Winne, 2005; Zimmerman, 2002). The structure of self-regulatory processes can be comprehended through three cyclical phases. The forethought phase involves the task analysis and beliefs that occur before learning. The performance phase consists of the processes during the implementation, while the self-reflection phase encompasses the processes that occur after learning (Zimmerman, 2000; Zimmerman, 2002).

Another perspective, in self-regulated learning processes, learner efforts to monitor and control individual aspects of learning throughout four phases: defining tasks, setting goals and plans, using strategies and tactics, and making adaptations (Matcha et al., 2020; Winne, 2005). *Defining task*, the initial phase involves learners understanding the task directions and available resources. *Goals and plans*, setting clear goals and engaging in thoughtful strategic planning to achieve the lesson is essential. *Studying tactics*, learners enact various strategies to

process and transform information, which they should be able to recall during class. *Adaptations*, the final phase involves long-term changes of learners based on the results of their efforts.

In context of examining the literature and related works on Winne-Hadwin, comparing it with Zimmerman's model to identify indicators (strategies) and approaches for evaluating pre-service teachers. This investigation aims to study effective strategies to encourage their development. Additionally, we explore the application of LA to analyze the behavior of pre-service teachers. To continue on this point, we focus on the following three research question:

1. What are the models on Self-Regulated Learning in Pre-Service Teachers?
2. What are the Learning Analytics trends on Self-Regulated Learning in Pre-Service Teachers?
3. What are the indicators (Strategies) of Self-Regulated Learning in Pre-Service Teachers?

Methodology

We used the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) methodology, which was proposed by (Page et al., 2021) to conduct this systematic review. To investigate the findings, we searched related articles from these databases: Science Direct, Google Scholar, JSTOR, IEEE Xplore, ACM, and Springer, which are recognized as significant reliable sources of publications in various areas, including, educational technology.

Identification of Search Terms

Based on the literature and our expertise, we did not include articles that mentioned other SRL model except Zimmerman and Winne-Hadwin that related with LA and pre-service teacher. Moreover, we also excluded the terms In-Service Teacher or Post-Service Teacher, since they have already learned and gained experience in real classrooms. In contrast to pre-service teachers, who have limited experience. Most of the online searches made use of Boolean operators. To accommodate the databases 'search options, some operators needed to be modified. The general method for locating relevant articles is as follows: (“Self-Regulated Learning” OR “Self-Regulation”) AND Assessment AND “Learning Analytics” AND “Conceptual Framework” AND Indicator AND (“Pre-Service Teacher” OR “Preservice Teacher”).

The Screening Process

PRISMA procedures are identification, screening, and inclusion. Following three main steps to make the selection – see Figure 1. The screening process involved three procedures: First, remove the duplicated articles. Second, read the titles, keywords, and abstracts to remove the articles according to the inclusion and exclusion criterion - see Table 1. Third, read the full texts to remove the articles that do not conform to inclusion criteria. Data were extracted from the articles that match the criteria. All selected articles were imported into Zotero, which authorized the removal of duplicate entries, filtering the results, and exporting the information to a spreadsheet.

Table 1: Inclusion Exclusion Criterion

Inclusion Criteria (IC)	Exclusion Criteria (EC)
published between January 2013 and December 2023	published before January 2013 and after December 2023
from peer-reviewed journals	from conference proceedings, book chapter, posters
write in English	write in other languages
focus on Pre-Service Teacher	focus on In-Service and Post-Service Teacher
full-text available	not accessible

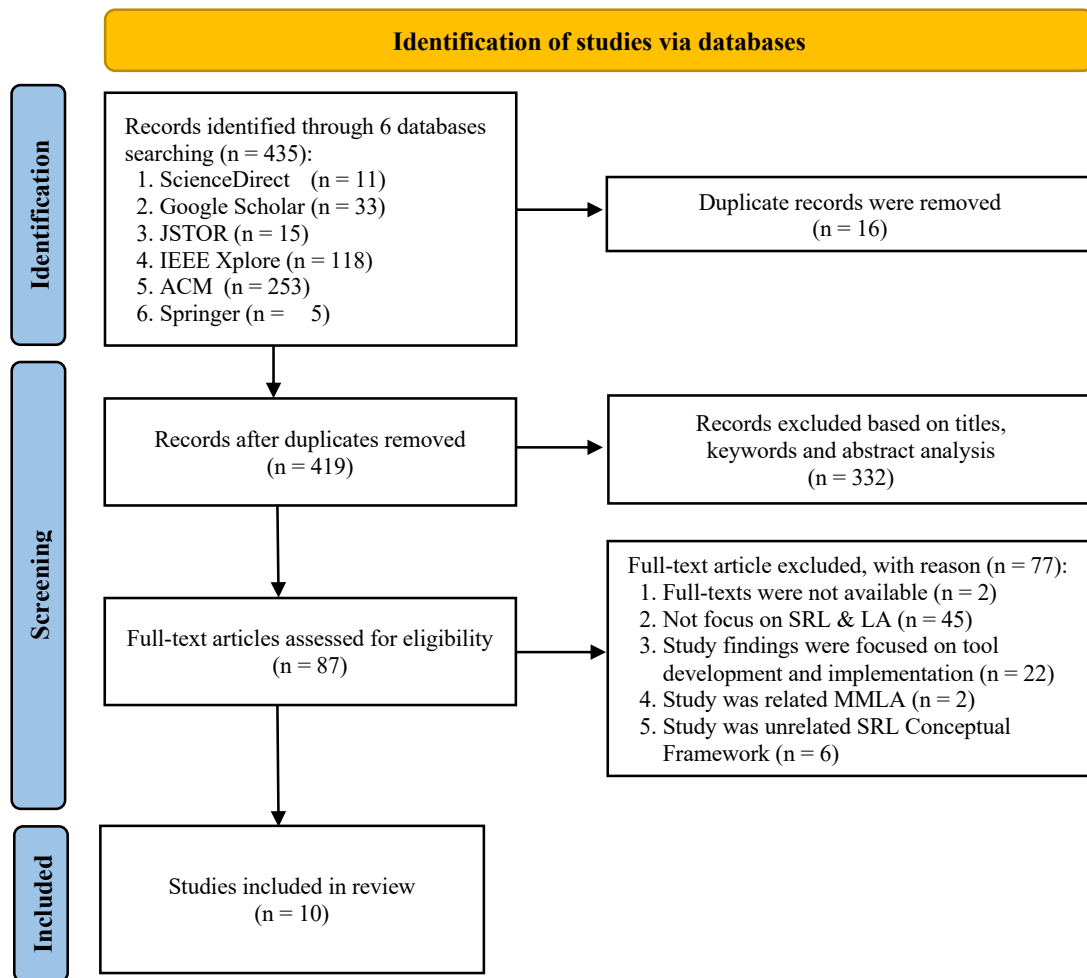


Figure 1: PRISMA Process

Results and Discussion

There were ten included articles. They closely related LA supporting on SRL in pre-service teachers. To address the first question: *What are the models on Self-Regulated Learning in Pre-Service Teachers?* this systematic review attempted to answer. There are five articles were investigated on SRL. Two main articles focused on Winne-Hadwin's SRL model. Saint et al., (2020) mentioned that the Process Mining (PM) algorithm is influenced by Winne-Hadwin and emphasizes conditional probabilities with SRL processes. The process consists of three phases: planning, engagement, and evaluation with reflection. Various evaluation methods, such as active agile, summative approaches, active cohesion, and semi-engagement, have revealed that more successful students consistently engage in more SRL behaviors than their less successful students. The four phases outlined by Winne-Hadwin are: Task

Definition, Goal Setting and Planning, Enactment of Tactics and Strategies, and Adaptation. Various evaluation methods are used, including grading criteria, students' workloads, goals set by students, group progress on tasks, levels of engagement, time spent, and the writing habits of individual students. These methods reflect the impact on both learning and teaching (Matcha et al., 2020).

Lu & Yu (2019) applied Zimmerman's model, which consists of three phases: mForethought, mPerformance, and mReflection. This model has been used in LA to analyze online data, enhancing semantic understanding and metacognitive self-monitoring. LA measures factors such as learning strategies, time and resource management, self-monitoring, and self-confidence. The findings are presented as self-regulation profiles to identify students' strengths and weaknesses, helping in the improvement of learning habits (Liz-Dominguez et al., 2022). Additionally, concerns have been raised about the lack of regulation, particularly related to task avoidance, anxiety, and boredom (Sointu et al., 2022).

Winne-Hadwin and Zimmerman's studies highlight effective indicators and processes for tracking SRL in the classroom through LA data. However, the crucial distinction lies in Winne-Hadwin's adaptation, which plays a necessary role in establishing the application of knowledge for future classroom teaching. It may necessary to present LA as a report of indicators (strategies) to understand the learners and how they affect SRL.

To address the second question: *What are the Learning Analytics trends on Self-Regulated Learning in Pre-Service Teachers?* this systematic review attempted to answer. The studies were categorized into two main types of data for LA. The first type is self-reported data collected through questionnaires, which gather information about learning events (Gewerc et al., 2016; Merikko et al., 2022; Tempelaar et al., 2017). This data provides weakly contextual data that suffers loss and bias due to defects of human memory. On the other hand, the second type is system-reported data, which includes several timestamped traces of learners' activities (Knobbout & Van Der Stappen, 2020; Moreno-Marcos et al., 2020; Tempelaar et al., 2017). This data reflects learners' behaviors and other influencing strategies that may affect SRL.

To address the third question: *What are the indicators (Strategies) of Self-Regulated Learning in Pre-Service Teachers?* – see Table 2. Thirteen specific indicators (strategies) significantly influence SRL.

Table 2: Indicators (Strategies) Self-Regulated Learning

Indicators (Strategies)	Number of studies
Goal setting: (Beatriz Ortega-Ruipérez & Almudena Castellanos-Sánchez, 2023; Huang & Lajoie, 2021; Liz-Dominguez et al., 2022; Saint et al., 2020)	4
Motivational Factors & Orientation: (Gewerc et al., 2016; Liz-Dominguez et al., 2022; Matcha et al., 2020; Sointu et al., 2022)	4
Strategic Planning: (Liz-Dominguez et al., 2022; Saint et al., 2020; Tempelaar et al., 2017)	3
Time Management: (Liz-Dominguez et al., 2022; Matcha et al., 2020; Sointu et al., 2022)	3
Social context: (Gewerc et al., 2016; Liz-Dominguez et al., 2022; Matcha et al., 2020)	3
Self-monitoring: (Huang & Lajoie, 2021; Liz-Dominguez et al., 2022)	2
Reflection: (Huang & Lajoie, 2021; Saint et al., 2020)	2
Transfer: (Huang & Lajoie, 2021; Liz-Dominguez et al., 2022)	2
Choosing informational sources: (Beatriz Ortega-Ruipérez & Almudena Castellanos-Sánchez, 2023; Matcha et al., 2020)	2
Working on a task: (Matcha et al., 2020; Saint et al., 2020)	2
Self-evaluation: (Liz-Dominguez et al., 2022; Saint et al., 2020)	2
Instructional cue: (Liz-Dominguez et al., 2022; Matcha et al., 2020)	2
Acquired (tactic & strategies): (Liz-Dominguez et al., 2022; Matcha et al., 2020)	2

Goal setting is regarded as one of the most important indicators (strategies) influencing SRL. Goals created by students and teachers are defined as specific goals relevant to the task of achieving learning. Another is *motivational factors and orientation*, which reflects establishing and pursuing learning goals to consider the value of tasks. *Strategic planning* also tends to have an impact on SRL, by predicting personal course goal achievements. *Time management* refers to a student's ability to effectively manage and allocate their time, directly impacting their achievement As well as *social context* described involves learners seeking help and information from others.

Moreover, several studies demonstrate that *self-monitoring, reflection, transfer, choosing informational sources, working on a task, self-evaluation, instructional cue, and acquired (tactic & strategies)* are proven to be prominent in affecting SRL. Additionally, some studies suggest more indicators (strategies). They were identified as one of the indicators (strategies) that affect to SRL as follows: task analysis, search, using tools to create and assess task solutions, applying appropriate strategy change, domain knowledge, beliefs, disposition & style, knowledge of study tactic and strategies, primitive, keeping, environmental structuring, rehearsing and memorizing, self-, effort, anxiety.

Conclusion

This systematic literature review has critically reviewed papers related to LA support SRL to enhance pre-service teacher. By reviewing the most recent studies from January 2013 to December 2023, to identify indicators of effective SRL strategies and a conceptual framework for assessing SRL. We proposed some implications related research based on these findings. The framework is based on Winne-Hadwin's model, which emphasizes *Adaptation*, and several indicators (strategies) have been validated in various areas for SRL. Additionally, LA serves as a guideline for us in designing and choosing appropriate algorithms to evaluate and report on student improvement. Moreover, we discovered that the number and quality of studies have been increasing. At the same time, the scope of research

on the framework, measurement, and LA method has been expanding to understand a more particular model of SRL. More research will be required in the future. Although we explored the most well-known scholarly databases for keywords related to LA support SRL for pre-service teachers, some biases may exist in the searching and screening. Exploring additional journals and databases is consequential, as they may contain helpful, relevant studies that could enhance this study. However, the findings from the studies contribute significantly to our understanding of SRL, particularly regarding the indicators (strategies) that support pre-service teacher education.

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