Bridging Classroom and Home Learning: A Seamless Learning Framework for Elementary Students

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Abstract

Promoting Self-Regulated Learning (SRL) is pivotal to enhancing student achievement within contemporary educational contexts. Traditional classroom methodologies often hinder the cultivation of self-regulated learning, leading to inconsistent academic outcomes. This study examines the Seamless Learning framework, which synthesises formal and informal learning environments, to foster self-regulated learning among primary school students. In a quasi-experimental design, ninety-two fourth-year primary school pupils were divided into experimental and control groups. The experimental group engaged in Seamless Learning interventions across domestic, community, and classroom settings, whereas the control group received conventional classroom instruction. A variety of validated instruments were employed to evaluate self-regulated learning (SRL). In comparison to the control group, the experimental group demonstrated significant enhancements in self-regulated learning (SRL) and academic outcomes. The Seamless Learning framework proved effective for both high- and low-SRL pupils, underscoring its versatility. The efficacy of this approach was contingent upon robust teacher facilitation and active parental engagement; (The findings indicate that incorporating the Seamless Learning framework into curricula significantly enhances the development of lifelong learning competencies. This approach not only elevates academic performance but also fosters learner autonomy by addressing diverse educational needs.

INTRODUCTION

Background of the Study

A central challenge in 21st-century education lies in fostering meaningful and continuous learning opportunities. The integration of digital technologies has revolutionised traditional pedagogical paradigms, enabling innovative teaching methodologies that transcend the classroom and enhance pupil engagement (Firssova et al., 2020; Wong et al., 2015). Seamless Learning, which harmonises formal and informal educational contexts, has emerged as a compelling approach to cultivating pupils' self-regulated learning (SRL) capabilities (Godinez, 2024). Research indicates that pupils who exhibit self-regulation, underpinned by robust cognitive and metacognitive skills to plan, monitor, and evaluate their learning, attain superior academic outcomes (Marulis & Nelson, 2021).

However, in primary education, where structured learning predominates, the adoption of Seamless Learning remains inconsistent (Wong et al., 2023).

Problem of the Study

One of the most pressing challenges within contemporary educational systems lies in the variability of pupils' self-regulated learning (SRL) capabilities. Students exhibiting underdeveloped SRL competencies face more pronounced challenges in knowledge acquisition, goal formulation, and sustaining motivation relative to peers with advanced SRL proficiency (Cumming et al., 2020; Hoyle & Dent, 2017). This disparity is further compounded by the rigid demarcation between formal and informal educational contexts, which restricts opportunities for independent inquiry and the contextual application of knowledge (Setyosari et al., 2020). Conventional classroom environments, predominantly reliant on didactic teaching methodologies, frequently lack adequate provision to cultivate SRL skills, consequently limiting opportunities for inquiry-based exploration and self-directed learning (Godinez, 2024).

Research's State of the Art

Modern educational systems are implementing various strategies to overcome these challenges by connecting different learning settings. Seamless Learning has emerged as a promising approach, defined as a pedagogical method that integrates self-directed learning in home or community settings with structured classroom instruction (Sharples et al., 2016). Research indicates that learners engaged in Seamless Learning demonstrate higher levels of metacognitive awareness and independence, factors associated with improved academic outcomes (Safiah et al., 2020; Schunk, 2012). Despite existing research, a significant gap exists in understanding the specific ways Seamless Learning enhances self-regulated learning (SRL) and how its principles are systematically integrated into educational planning (Fegter & Kost, 2023; Vula et al., 2017).

Recent scholarship has been expanding upon these insights, with a growing focus on how Seamless Learning is implemented in primary education, especially in terms of digital mediation and parental involvement. Research indicates that integrating mobile and ubiquitous technologies into educational settings enables learners to maintain continuity of learning experiences, facilitating a more seamless transition between academic and real-world problem-solving scenarios (Cohen et al., 2022; Hakeem et al., 2025). The socio-pedagogical aspects including teacher scaffolding, family involvement, and culturally responsive teaching methods have received relatively little research attention (Hasnine et al., 2024; Zhou & Goh, 2025). The disparity is particularly significant in elementary education, where youngsters' cognitive and socio-emotional growth necessitates interventions that strike a balance between fostering independence and offering directed assistance. In consequence, frameworks are urgently required that leverage technological resources while integrating relational and developmental elements, ensuring Seamless Learning is both pedagogically sustainable and contextually adaptable.

Comparative analyses across different cultural and educational settings indicate that the effectiveness of Seamless Learning heavily relies on its specific context. In East Asian countries, for example, family participation and after-school learning environments are crucial in supporting traditional teaching methods, whereas in Western settings, more emphasis is placed on individual independence and project-based learning (Kristanto et al., 2025; Migallón et al., 2025). Any Seamless Learning framework must be adaptable to local sociocultural values, technological infrastructure, and curricular mandates, as these contrasting approaches suggest. Despite these findings, research into primary-level learners is still fragmented, typically consisting of pilot projects or small-scale interventions that lack long-term perspectives (Bhagwat et al., 2024; Moon et al., 2024). There is a pressing need for thorough, cross-cultural studies into how Seamless Learning methods can be systematically integrated within school systems while respecting various educational customs.

In response to these gaps, emerging research calls for integrative models that combine theoretical rigour with practical applicability. One promising direction is the articulation of Seamless Learning frameworks that incorporate self-regulated learning theories, ecological systems perspectives, and digital pedagogy (Kholidya & Bachri, 2024; Safiah et al., 2020). These models must also account for teacher professional development, as educators play a central role in orchestrating the continuity between classroom and home learning. Lack of adequate teaching skills can result in

technology-based Seamless Learning becoming disjointed or worsening the disparities among students with varying levels of access to resources (Hendrowibowo & Kristanto, 2023; Riniati, 2024). Therefore, moving forward with the current state of knowledge necessitates a dual approach: refining theoretical bases to explain the mechanisms of Seamless Learning, and creating scalable practices that guarantee equity, inclusivity, and sustainability in elementary education.

Gap Study and Objective

Prior research has proposed various frameworks for integrating formal and informal learning experiences. Wong et al. (2023) developed a Seamless Learning framework for primary science education, demonstrating that pupils engaged in continuous learning cycles exhibited enhanced knowledge retention and autonomous learning capabilities. Similarly, Sun and Looi (2019) employed a boundary activity-based learning approach to facilitate transitions between school-based and experiential learning, thereby improving pupils' ability to synthesise information across diverse contexts. While these models offer valuable insights, they do not explicitly elucidate the mechanisms through which Seamless Learning cultivates self-regulated learning (SRL) competencies, such as goal-setting, time management, and self-monitoring (Looi et al., 2019). Moreover, existing research predominantly focuses on secondary and higher education, with insufficient exploration of self-regulation development among young learners in primary education settings through Seamless Learning methodologies (Vandenbroucke et al., 2018).

The purpose of this study was to investigate the impact of a formal-informal instructional design, grounded in the Seamless Learning framework, on the development of self-regulated learning (SRL) among primary school pupils. It seeks to evaluate how structured learning continuity across multiple environments influences pupils' capacity to self-regulate their learning processes. This study assesses the effectiveness of instructional strategies that integrate school, home, and community learning experiences, thereby contributing to the scholarly discourse on Seamless Learning and its role in fostering self-regulated learners. By systematically examining the interplay between instructional design and the development of SRL, this research offers practical insights for educators and policymakers aiming to enhance pupil autonomy and cultivate lifelong learning competencies.

METHOD

Type and Design

This study employed a quasi-experimental design to assess the efficacy of a Seamless Learning instructional framework in developing self-regulated learning (SRL) competencies among primary school pupils. Utilising a quantitative research paradigm, the investigation was structured to maintain methodological rigour while permitting practical implementation in authentic educational settings. The following section elaborates on: (1) research design; (2) participant selection criteria; (3) measurement instruments; (4) data collection protocols; and (5) analytical techniques. This comprehensive methodological exposition ensures both the reliability of findings and the potential for scholarly replication.

Given the impracticality of randomisation in educational research, a quasi-experimental design specifically, a non-equivalent control group design—was employed (Setyosari, 2016; Creswell & Creswell, 2017). This approach facilitates the examination of causal relationships between the instructional intervention and the development of self-regulated learning (SRL) while controlling for confounding variables. The study incorporated an experimental group, which engaged with a Seamless Learning framework, and a control group, which followed a conventional science learning model. The four-week intervention comprised structured educational activities that effectively integrated formal and informal learning environments.

Owing to the practical constraints inherent in classroom-based research, this study involved a sample of 92 Year 4 primary school pupils, selected from four classes through cluster sampling. The cohort was systematically allocated into two groups: an experimental group, which participated in the Seamless Learning intervention, and a control group, which received conventional science instruction. To ensure parity between groups, the allocation process accounted for students' prior academic

achievement and baseline self-regulated learning (SRL) capabilities, thereby mitigating potential confounding variables and strengthening the validity of the comparative analysis.

Data and Data Sources

This study evaluated the efficacy of two instructional frameworks: the Seamless Learning model and the Scientific Learning model. These frameworks are compared based on their impact on engagement-related variables, specifically pupils' self-regulated learning (SRL) competencies and academic performance. The population comprises all pupils enrolled at Sidoarjo Islamic Primary School. The sample consists of 92 pupils, distributed across four classes: two experimental classes and two control classes, each containing 23 pupils. The experimental classes were instructed using the Seamless Learning model, while the control classes adhered to the Scientific Learning model.

The study was conducted across three clearly defined phases: pre-test, intervention, and post-test. To establish baseline measurements of participants' self-regulated learning (SRL) capabilities, all pupils in both the experimental and control groups completed a validated SRL questionnaire prior to the commencement of the intervention. This preliminary assessment enabled a robust comparative analysis of initial SRL competencies, providing an empirical foundation for evaluating the intervention's efficacy during the subsequent post-test phase.

The experimental group participated in an instructional framework based on Seamless Learning principles, which systematically incorporated learning experiences across school, home, and community environments. The intervention comprised carefully structured pedagogical activities implemented across these three complementary contexts:

1. Classroom learning (Formal Context): Teachers delivered environmental science content through digital presentations and facilitated participatory debates. Students then reinforced their understanding by completing mission-based activities and guided problem-solving tasks.
2. Laboratory learning (Semi-Formal Context): Students transitioned to dedicated learning spaces including the library, science laboratory, and computer suite - to conduct independent research, gather supplementary data, and engage in collaborative problem-solving tasks.
3. Home and community learning (Informal Context): Students extended their learning beyond the classroom through applied assignments focusing on environmental science in practical contexts. Parents assumed a facilitative role, supporting engagement, while learners systematically recorded their experiential learning using digital platforms.

The control group received instruction through conventional teaching methodologies, with all educational activities confined to formal classroom settings. This traditional pedagogical approach emphasised teacher-directed instruction complemented by textbook-based learning tasks. Following the intervention phase, all participants completed the SRL questionnaire for a second administration. A rigorous comparative analysis of pre-intervention and post-intervention results was then conducted to evaluate the pedagogical efficacy of the seamless learning framework in fostering self-regulated learning capabilities.

Data Collection Technique

This quasi-experimental study employed a pre-test/post-test design using validated questionnaires. The primary instrument was a standardised Guttman scale questionnaire assessing self-regulated learning (SRL) through 14 items across six dimensions: goal-setting, environment structuring, task strategies, time management, help-seeking, and self-evaluation (Moon et al., 2024). The binary response format of the Guttman scale enabled clear differentiation between high and low SRL pupils while reducing response bias. The Guttman scale criteria were used to conduct a thorough evaluation of measurement instruments, with a particular focus on the scalability and reproducibility coefficients. The established thresholds necessitated a scalability coefficient above 0.60 and a reproducibility coefficient that exceeded 0.90. The minimum threshold was exceeded by the reproducibility coefficient of 0.91 obtained through computational analysis using Skalo software (version 3). This indicates a high level of consistency among scale items. In the same vein, the instrument's hierarchical scalability and unidimensionality were confirmed by the calculated scalability coefficient of 0.81, which surpassed the required benchmark. The psychometric results of this study

conclusively establish the validity and reliability of the research instruments employed, as they substantiate that both coefficients fully meet the Guttman scale requirements.

Data Analysis

The study employed Multivariate Analysis of Variance (MANOVA) to simultaneously evaluate multiple dependent variables, including self-regulated learning (SRL) competencies and academic performance outcomes (Dignath & Veenman, 2021). This approach examined the effects of the Seamless Learning framework across varying levels of SRL proficiency. MANOVA was selected for its ability to detect interaction effects between instructional approaches and SRL development. Mean scores and standard deviations were calculated for both cohorts, enabling systematic comparison of pre- and post-intervention SRL performance. All analyses were conducted using SPSS software (version 25.

The assumption of multivariate normality was evaluated by systematically analysing the correlation between Mahalanobis distances and their corresponding chi-square values. The resulting scatterplot demonstrated a statistically significant linear relationship between these variables, as indicated by a Pearson correlation coefficient of $r = 0.780$ ($p < 0.001$). This strong correlation suggests that the Mahalanobis distances closely conform to the theoretical chi-square distribution, thereby supporting the assumption of multivariate normality. These findings are consistent with established statistical criteria, which state that a significant linear association between Mahalanobis distances and chi-square quantiles, accompanied by a strong correlation, indicates that the data are likely drawn from a multivariate normal distribution. Confirmation of this assumption satisfies a key prerequisite for the application of multivariate analytical techniques, including MANOVA.

RESULTS

This chapter presents the findings of the study investigating the impact of a Seamless Learning instructional framework on the enhancement of Self-Regulated Learning (SRL) among primary school pupils. The results are organized into three main sections: descriptive statistics, inferential analysis, and a comparative evaluation of pupils with high and low levels of SRL. All statistical analyses employed Multivariate Analysis of Variance (MANOVA) to ensure methodological rigor and to validate the effectiveness of the Seamless Learning approach.

Descriptive statistical analysis was conducted to summarize the distribution of pupil learning outcomes across the two instructional models. Table 1 reports the mean scores and standard deviations of SRL performance for both the experimental group (Seamless Learning) and the control group (Scientific Learning).

Table 1. Mean and Standard Deviation of SRL Scores

Learning Approach	Low SRL Mean (SD)	High SRL Mean (SD)	Total Mean (SD)
Scientific Learning	0.09 (0.11)	0.23 (0.10)	0.12 (0.12)
Seamless Learning	0.17 (0.14)	0.34 (0.15)	0.31 (0.16)

As shown in Table 1, notable differences in average SRL scores between the two instructional approaches are evident. Within the low-SRL group, the mean SRL score for the Scientific Learning approach is 0.09 (SD = 0.11), whereas the Seamless Learning approach yields a higher mean of 0.17 (SD = 0.14). In the high-SRL group, the Scientific Learning approach produces a mean score of 0.23 (SD = 0.10), while the Seamless Learning approach achieves a higher mean of 0.34 (SD = 0.15). When considering the overall means, the Seamless Learning approach again demonstrates a superior average SRL score (0.31) compared to the Scientific Learning approach (0.12).

These findings suggest that the Seamless Learning approach is generally more effective in enhancing pupils' SRL performance, irrespective of their initial SRL level. The observed differences in mean scores imply that Seamless Learning may exert a more pronounced positive impact on pupils' self-regulatory abilities throughout the learning process. The reported standard deviations reflect the extent of variation in SRL scores within each group. The relatively small standard deviations across

both approaches indicate limited dispersion around the mean, suggesting that the average values are reasonably representative of the respective groups.

Figure 1 demonstrates that students exhibiting high levels of self-regulated learning (SRL) attain superior academic outcomes compared to their peers with lower SRL proficiency. The integration of a coherent instructional framework with elevated SRL competencies produces the most advantageous results. Moreover, the data substantiate that the Seamless Learning approach is more effective in cultivating SRL development than the Scientific Learning approach, irrespective of students' initial SRL levels. These findings advocate the adoption of Seamless Learning as a more efficacious pedagogical strategy within the context of this study.

Table 2 reveals a substantial increase in learning completeness for the experimental group, rising from 39% in the pre-test to 74% in the post-test. In contrast, the control group exhibited a significantly smaller improvement, advancing from 21% to 37%. The findings indicate that, within the Seamless Learning group, students with high levels of self-regulated learning (SRL) demonstrated the most substantial improvements in learning outcomes. Nevertheless, the Seamless Learning approach proved highly effective for students with low SRL proficiency as well, suggesting its adaptability to learners with varying degrees of self-regulatory capacity. A multivariate analysis of variance (MANOVA) was conducted to determine the statistical significance of the observed differences in SRL scores. Table 3 presents a summary of the multivariate test outcomes.
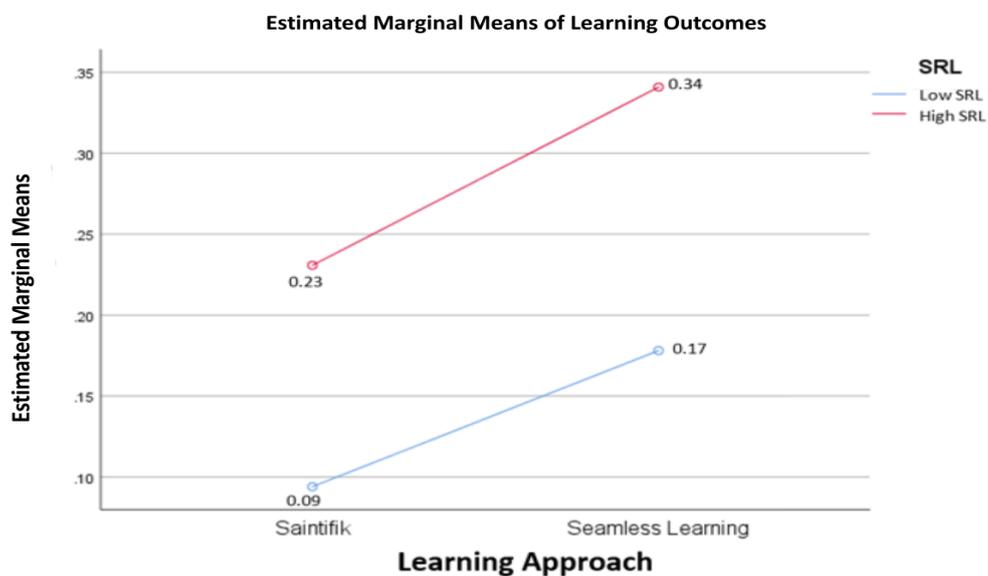

Figure 1. Means of Learning Outcomes

Table 2. Pre test and Post Test

Group	Pre-test (%)	Post-test (%)
Experimental	39	74
Control	21	37

Table 3. Multivariate Test Results (MANOVA)

Effect	Value	F	Hypothesis df	Error df	Sig.
Learning Approach	.125	6.236	2	87	.003
SRL Level	.143	10.300	2	87	.000

The findings confirm that the Seamless Learning approach had a statistically significant impact on the development of self-regulated learning (SRL) ($p = 0.003$). Furthermore, SRL proficiency was found to exert a significant influence on students' academic performance ($p < 0.001$). These results align with existing research, which indicates that instructional strategies integrating formal and

informal learning environments can effectively foster self-regulation and enhance academic achievement.

This study offers robust empirical evidence for the effectiveness of Seamless Learning in promoting self-regulated learning (SRL) development. The key findings are summarised as follows:

1. Students exposed to the Seamless Learning approach exhibited markedly higher self-regulated learning scores than their counterparts in the Scientific Learning cohort.
2. The experimental group demonstrated a substantial improvement in learning completeness, with post-test scores increasing by 35% compared to pre-test scores.
3. MANOVA confirmed the statistically significant effect of Seamless Learning on both self-regulated learning (SRL) development and academic outcomes.
4. Although the Seamless Learning approach yielded the greatest benefits for students with high initial self-regulated learning (SRL) proficiency, those with lower SRL proficiency also demonstrated substantial improvements.

These findings indicate that integrating Seamless Learning strategies within instructional design constitutes an effective strategy for fostering SRL development in primary education. The following chapter examines in greater depth the implications of these findings.

DISCUSSIONS

This study provides robust empirical evidence that Seamless Learning effectively promotes self-regulated learning (SRL) among primary school students. The findings indicate that students in the Seamless Learning group achieved significantly higher SRL scores and demonstrated greater learning completeness than those in the Scientific Learning group. These results contribute to the growing body of research highlighting the value of integrating formal and informal learning environments to enhance students' self-regulation skills (Dignath & Veenman, 2021; Dilger et al., 2019; Utami et al., 2024). Notably, students exposed to Seamless Learning showed significant improvements in learning completeness, suggesting enhanced ability to manage tasks across varied contexts. This aligns with previous studies that underscore the role of continuous learning experiences in fostering student engagement and knowledge retention (Song & Wen, 2018; Sun & Looi, 2019). The elevated post-test scores further imply that the integration of school, home, and community learning contexts enabled students to apply concepts more effectively, thereby strengthening both their cognitive and metacognitive skills (Gambo & Shakir, 2021).

While the magnitude of improvement differs, this study establishes that the Seamless Learning framework effectively facilitates self-regulated learning (SRL) development among primary school pupils across varying proficiency levels. Learners exhibiting advanced baseline SRL competencies demonstrated the most pronounced progress, consistent with previous studies underscoring their capacity to capitalise on diverse learning opportunities (Backers et al., 2024). Crucially, pupils with lower initial SRL proficiency also demonstrated measurable improvement, suggesting the approach offers essential scaffolding for those struggling with self-regulatory capacities (Hoyle & Dent, 2017; Setyosari et al., 2020). These outcomes substantiate scholarly arguments emphasising structured pedagogical support to cultivate self-regulated learning competencies (Nakayama et al., 2017).

The integration of formal and informal educational contexts relies significantly on seamless learning principles. Findings demonstrate that structured yet adaptable learning experiences enable students to develop self-regulated learning (SRL) competencies while maintaining continuity in their educational progression (Dalziel et al., 2020; Sha, 2015). This aligns with established research on contextualised learning, which enhances knowledge application across diverse environments (Mustaqim et al., 2024). By extending learning beyond traditional classroom boundaries, seamless learning facilitates the practical application of academic concepts, thereby fostering learner autonomy and engagement (Safiah et al., 2020; Sha, 2015).

The findings underscore the necessity of collaborative parental and educator engagement within Seamless Learning frameworks. Structured cross-contextual support significantly enhances the development of self-regulated learning (SRL) competencies, as demonstrated by empirical studies (Daniel et al., 2016; Howard & Melhuish, 2017). These findings corroborate the pivotal role of educators as facilitators in scaffolding self-directed learning beyond formal instructional settings

(Cumming et al., 2020; Dignath & Veenman, 2021). Furthermore, parental engagement in home-based learning tasks substantially augmented pupils' motivation and regulatory capacities, aligning with scholarship underscoring the mediating role of familial involvement in academic achievement (Dan et al., 2025; Vula et al., 2017).

While the findings are promising, certain limitations warrant acknowledgement. Firstly, the study's confinement to a singular educational context may constrain the generalisability of its outcomes. Subsequent research should investigate the efficacy of Seamless Learning across diverse pedagogical settings and developmental stages to establish its broader applicability (Fegter & Kost, 2023). Secondly, though the study offers robust quantitative evidence for Seamless Learning's effectiveness, incorporating qualitative methodologies could elucidate the mechanisms through which it fosters self-regulated learning (SRL) development (Sharples et al., 2016). Future studies employing mixed-methods designs would yield a more nuanced understanding of the processes underpinning SRL enhancement.

This study substantiates Seamless Learning as a pedagogically effective strategy for cultivating SRL competencies in primary school pupils. By integrating formal and informal learning experiences, the approach strengthens self-regulatory capacities, leading to enhanced academic performance and learner autonomy. These findings underscore the value of embedding Seamless Learning principles within curricular frameworks to foster adaptive, learner-centred environments. Further research is imperative to explore the longitudinal impacts of such interventions on lifelong learning skills and to refine pedagogical practices that maximise SRL development.

CONCLUSION

This investigation provides robust empirical evidence for the efficacy of Seamless Learning instructional design in cultivating self-regulated learning (SRL) competencies among primary school pupils. By systematically integrating formal and informal educational environments, this pedagogical approach facilitates the development of autonomous learning habits, self-regulatory capacities, and knowledge retention, thereby fostering continuous, contextually embedded learning experiences. Quantitative analyses revealed that pupils in the Seamless Learning cohort demonstrated markedly higher SRL scores and post-test learning completeness compared to peers in the Scientific Learning group. These findings underscore the critical role of structured yet flexible instructional strategies in nurturing metacognitive awareness and self-directed learning behaviours in young learners. The study advances scholarly understanding by demonstrating the universal applicability of Seamless Learning across varying SRL proficiency levels. While prior research has predominantly emphasised the benefits of SRL for pupils with established self-regulatory competencies, this work illustrates how meticulously designed instructional frameworks can equally support learners who initially struggle with self-regulation. The results posit that Seamless Learning bridges the gap between formal pedagogy and independent knowledge construction, cultivating essential lifelong learning skills through sustained, contextually enriched educational experiences. Notwithstanding these contributions, the study presents several methodological constraints. Implemented within a singular educational context, its generalisability to broader settings remains circumscribed. Additionally, the temporal focus on short-term SRL development necessitates longitudinal investigations into the sustained impacts of seamless learning on academic attainment and self-regulatory capacities. Subsequent investigations should additionally explore the integration of digital tools to augment seamless learning experiences, particularly within remote and hybrid educational models.

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