Available on: https://jsshrs.ep-journals.org/ E-ISSN: 3051-3561, P-ISSN: 3051-3553

Journal of Social Science and Human Research Studies

Volume: 02 Issue: 05 May-2026

Developing Self-Regulated Learning Capabilities in Digital Environments for Upper Elementary Students

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Published Date: May 25, 2026 **Article DOI: 10.65150/EP-jsshrs/V2E5/2026-16**

ABSTRACT: In the context of digital transformation in education, elementary students are increasingly engaging in digital learning environments. This shift necessitates the development of self-regulated learning (SRL) capabilities as a foundational requirement for academic efficacy. Drawing on cognitive psychology and self-regulated learning theory, this article analyzes the nature of SRL in digital contexts and clarifies the relationship between executive functions and student learning behaviors. Utilizing a mixed-methods approach—combining surveys with qualitative analysis—the study evaluates the current state of self-regulation among upper elementary students. Results indicate that while students have begun to form initial planning skills, significant limitations remain in behavioral control and sustained attention within digital environments. Consequently, the paper proposes educational orientations aimed at fostering self-regulation in technology use, thereby enhancing learning outcomes and adaptability in the digital era.

KEYWORDS: self-regulation, digital learning, elementary students, executive functions, cognitive psychology.

1. INTRODUCTION

The implementation of the 2018 General Education Program marks a pivotal shift in pedagogical orientation, moving from a content-based approach toward the development of student qualities and competencies. Within this framework, self-study and digital competencies are identified as core pillars, providing the foundation for students to adapt to a knowledge-based society and rapid technological advancements. This evolution has led to a significant transformation of the learning environment, where educational spaces are no longer confined to traditional classrooms but have expanded into digital realms supported by technological devices and online learning platforms.

In digital learning environments, learners are not merely passive recipients of information; instead, they must actively participate in the knowledge construction process through interactive engagement with digital content and technological tools. However, the digital environment is characterized by its openness, diversity, and high stimulus density, forcing learners to navigate multiple simultaneous information sources, including factors unrelated to the primary learning task. This increases the risk of attentional fragmentation and cognitive disruption, particularly for elementary students whose executive functions are not yet fully developed.

From a cognitive psychology perspective, effective learning in digital environments depends significantly on a learner's self-regulated learning (SRL) capability, which encompasses goal setting, behavioral control, time management, and sustained focus during task execution. Zimmerman (2000) posits that self-regulation is the central mechanism through which learners coordinate cognitive and behavioral activities toward learning goals. Meanwhile, Diamond (2013) emphasizes the role of executive functions—specifically attentional control and inhibitory control—in maintaining intentional cognitive activity. When these mechanisms are underdeveloped, learners are easily influenced by external stimuli, leading to a decline in learning efficiency.

For upper elementary students, although there is a degree of development in cognitive abilities and intentional attention, self-regulation remains in a formative and unstable stage. These students may begin to define learning objectives and perform tasks according to instructions, yet they struggle to maintain focus, control their behavior, and adjust their learning activities in environments rich with distractors. This challenge becomes more pronounced when students utilize technological devices, where multimedia elements and entertainment content can easily interrupt the learning process.

Practical evidence suggests that developing self-regulation in digital learning is not only an essential requirement of modern education but also a critical condition for improving the learning outcomes of elementary students. However, current educational practices often fail to place sufficient emphasis on organizing activities that foster this capability, particularly regarding the integration of technology into teaching. Consequently, researching the theoretical foundations and proposing orientations for developing self-regulated learning capabilities in digital environments for upper elementary students is of great significance, contributing to the enhancement of educational quality and meeting the demands of the digital transformation process in education.

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2. THEORETICAL FRAMEWORK

In educational psychology, self-regulated learning (SRL) is recognized as a core competency that determines academic efficacy, particularly in open and flexible learning environments such as digital platforms. According to Zimmerman (2000), self-regulation is a process in which learners proactively set goals, select appropriate strategies, monitor their progress, and adjust their behaviors to achieve desired learning outcomes. This process is cyclical, comprising closely interconnected phases: planning, performance control, and self-reflection/adjustment. This approach positions learners not merely as passive recipients of knowledge but as active subjects capable of orchestrating their entire cognitive and behavioral learning activities.

From a cognitive psychology perspective, self-regulation is grounded in executive functions (EFs), which include attentional control, working memory, and inhibitory control. Diamond (2013) asserts that executive functions play a central role in goal-directed behavior, enabling individuals to maintain focus, control impulses, and flexibly adjust strategies as needed. Within the learning process, especially in digital environments, these functions assist learners in selecting relevant information, filtering out distractors, and maintaining a continuous flow of information processing. When executive functions operate effectively, learners can better manage their learning behaviors, thereby enhancing concentration and knowledge acquisition efficiency.

Another critical component within the structure of self-regulation is working memory, defined as a system for temporary storage and processing of information during cognitive tasks. Baddeley (2012) argues that working memory is central to maintaining information and supporting complex cognitive operations. In digital learning, where learners must process multiple information sources simultaneously, working memory is susceptible to overload without proper control. This overload leads to diminished concentration and adversely affects learning performance. Consequently, self-regulation not only aids in behavioral control but also contributes to optimizing the utilization of a learner's cognitive resources.

For upper elementary students, self-regulatory capabilities have begun to emerge but have not yet reached stability. At this stage, students are capable of setting simple learning goals and performing tasks under guidance; however, they still face difficulties in maintaining focus and controlling behavior over extended periods. This can be attributed to the developmental characteristics of executive functions, as inhibitory control and attentional focus are still in the process of maturation during this period (Diamond, 2013). Furthermore, according to Sweller's (1988) Cognitive Load Theory, when learners are required to process excessive information or are exposed to numerous irrelevant stimuli, working memory becomes overloaded, leading to split attention and disruption of the cognitive process.

In the context of digital learning, these limitations become more pronounced as the environment contains many competing stimuli, ranging from multimedia content to entertainment activities. In the absence of self-regulation skills, students are easily drawn to factors outside their learning objectives, which reduces the efficacy of knowledge acquisition. Conversely, when supported in developing self-regulation, students can proactively control their behaviors, maintain focus, and utilize technological devices more effectively.

The aforementioned analysis indicates that self-regulation is not merely a learning skill but a complex competency structure formed on the foundation of cognitive processes and executive functions. Therefore, educating this competency for upper elementary students requires a systematic approach that is aligned with the psychological developmental characteristics of this age group and the demands of digital learning environments, aiming to facilitate the development of independent and sustainable learning capabilities.

3. RESEARCH METHODOLOGY

The study employed a mixed-methods approach, integrating quantitative and qualitative techniques to comprehensively assess the self-regulated learning (SRL) capabilities of upper elementary students in digital environments. This approach also aimed to elucidate specific behavioral characteristics of students when utilizing technological devices. The integration of these methods allowed for both the measurement of competency levels and a deep analysis of the contexts and mechanisms underlying self-regulation in practical learning scenarios.

Participants: The quantitative survey involved 120 students in grades 4 and 5 from two elementary schools. Convenience sampling was utilized, ensuring relative representation across genders and academic performance levels to reflect the diverse characteristics of the target population. Additionally, 10 primary teachers were selected for semi-structured interviews to provide contextual insights into students' learning behaviors and their degree of self-regulation during technology-enhanced learning activities.

Instruments: The primary quantitative instrument was a questionnaire developed based on Zimmerman's (2000) self-regulated learning model, focusing on three core components: planning, performance control, and self-reflection. Items were designed using a 5-point Likert scale to measure the frequency and intensity of self-regulatory behaviors in digital settings. To ensure validity and reliability, the questionnaire underwent expert review and pilot testing before formal administration.

Qualitative Data Collection: Qualitative data were gathered through direct observation of classroom activities involving technological devices and semi-structured interviews with teachers. The observation method allowed for the direct recording of behavioral indicators, such as concentration levels, task persistence, and responses to external distractors. Meanwhile, teacher interviews clarified professional assessments regarding students' self-regulatory capabilities in actual teaching practice.

Data Analysis: Quantitative data were processed using descriptive statistics to determine mean values and standard deviations. Furthermore, correlation analysis was conducted to examine the relationships between the components of self-regulation and various learning behavioral manifestations. Qualitative data were analyzed using thematic coding to identify behavioral patterns and trends within digital learning environments. The triangulation of these data sources enhanced the reliability and comprehensiveness of the research findings.

4. RESULTS AND DISCUSSION

The survey results regarding the self-regulated learning (SRL) capabilities of upper elementary students in digital environments are summarized in Table 1. The data indicate that the overall mean score for students' self-regulation reached 3.01 on a 5-point scale. This result suggests that while

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students have begun to manifest initial behaviors of self-regulation, the development of this competency remains unstable and lacks long-term sustainability within digital learning contexts.

Table 1. Levels of self-regulated learning in digital environments among upper elementary students

Components of Self-Regulation	Mean (M)	Std. Deviation (SD)	Level
Learning Planning	3.21	0.64	Upper Average
Performance Control	2.87	0.71	Average
Learning Self-Reflection	2.95	0.68	Average
Overall Average	**3.01**	**0.68**	**Average**

As illustrated in Table 1, among the three components of self-regulation, Learning Planning yielded the highest mean score (M = 3.21). This finding indicates that upper elementary students possess a certain degree of capability in defining learning objectives, identifying necessary tasks, and initially orienting their activities during digital learning participation. This aligns with the cognitive development characteristics of students in grades 4 and 5, who have begun to develop concrete logical thinking and can engage in purposeful learning behaviors. However, this score remains at an "upper average" level, suggesting a lack of high autonomy in constructing independent learning plans.

Performance Control recorded the lowest mean score (M = 2.87). This is a noteworthy finding, as performance control is the decisive phase in which students maintain learning behaviors consistent with established goals. The discrepancy between the scores for planning and performance control highlights a gap between learning intention and actual behavior. In other words, while students may identify what needs to be learned and the tasks to be performed, they face significant challenges in sustaining focus, controlling behavior, and completing tasks within a digital environment. From a cognitive psychology perspective, this result reflects the incomplete maturation of executive functions, particularly attentional control and inhibitory control (Diamond, 2013).

Learning Self-Reflection achieved a mean score of 2.95, which is higher than performance control but still within the "average" range. This suggests that students have begun to evaluate their own learning outcomes, yet self-reflection has not yet become a regular or systematic learning habit. According to Zimmerman (2000), self-reflection is a critical link in the self-regulatory cycle, as it enables learners to identify strengths and limitations and adjust their learning strategies for subsequent tasks. Therefore, the moderate score in this component indicates that students' self-regulation process lacks a cyclical nature and has not yet established a cohesive link between planning, execution, and post-learning adjustment.

To further clarify the relationship between self-regulated learning capabilities and the ability to concentrate in digital settings, a correlation analysis was conducted between the overall mean score of self-regulation and students' levels of focus. The results are presented in Table 2.

Table 2. Correlation between self-regulation and concentration in digital learning

Variable	Concentration ability in learning
Self-regulation in digital learning	r = 0.62**
Statistical significance	p < 0.01

Note: ***p < 0.01*.

The results in Table 2 indicate a moderate positive correlation between self-regulation and concentration in digital learning environments ($r = 0.62$; $p < 0.01$). This suggests that students with higher levels of self-regulation tend to maintain better focus when learning with technological devices. These findings reinforce the perspective that self-regulation serves as a critical psychological mechanism helping learners control attention, regulate behavior, and mitigate distractors during the learning process. Theoretically, this result aligns with Zimmerman's (2000) self-regulated learning model, in which behavioral control and process monitoring are considered prerequisites for maintaining goal-oriented learning activities.

Qualitative data from classroom observations and teacher interviews further elucidate the quantitative findings mentioned above. In lessons utilizing technological devices, many students demonstrated the ability to initiate tasks relatively quickly following teacher instructions; however, task persistence remained unstable. Some students tended to switch between learning content and off-task activities, particularly when devices offered multiple functions or when tasks were prolonged. This phenomenon reflects "pseudo-multitasking" in digital environments, where learners do not efficiently perform simultaneous cognitive tasks but instead continuously shift attention between different tasks, thereby disrupting the flow of information processing (Kirschner & De Bruyckere, 2017).

From the perspective of Cognitive Load Theory, the research results suggest that digital learning environments may increase extraneous load if students lack self-regulation skills. According to Sweller (1988), when learners must simultaneously process excessive unnecessary information, working memory is susceptible to overload, leading to a decline in concentration and learning efficacy. This is particularly evident in elementary students, whose working memory capacity and attentional control are still developing. Consequently, the fact that Performance Control scored the lowest among the three components indicates that students face challenges not only in behavioral terms but also in allocating and managing cognitive resources during digital learning.

In summary, both quantitative and qualitative results indicate that the self-regulated learning capabilities of upper elementary students in digital contexts have reached an initial stage but lack stability, especially regarding performance control. The imbalance between the components of planning, performance control, and self-reflection reflects the incomplete development of executive functions in elementary-aged children. Furthermore, the correlation results demonstrate that developing self-regulation has a direct significance in enhancing student concentration within

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digital environments. This provides an important empirical basis for proposing educational measures aimed at supporting students in time management, behavioral control, and sustained attention when utilizing technological devices for educational purposes.

5. CONCLUSION AND RECOMMENDATIONS

The research findings indicate that the self-regulated learning (SRL) capability of upper elementary students in digital environments is currently at an average level, characterized by uneven development across its constituent components. Specifically, while students demonstrate a relatively good capacity for learning planning, they face significant challenges in behavioral control and maintaining concentration during task execution. This discrepancy reflects a gap between cognitive intention and actual learning behavior, while also highlighting the immature development of executive functions—particularly attentional control and inhibitory control—at the elementary school age (Diamond, 2013).

The positive correlation between self-regulation and concentration in digital learning confirms the role of self-regulation as a primary psychological mediator. This mechanism enables learners to govern their cognitive processes and sustain goal-oriented activities. When self-regulation is well-developed, students can effectively mitigate the impact of distractors, optimize the allocation of cognitive resources, and enhance knowledge acquisition. Conversely, a deficit in this capability, coupled with the high stimulus density of digital environments, leads to cognitive overload and attentional fragmentation, thereby undermining educational quality.

Based on these results, it can be asserted that developing self-regulation in digital learning is not only an inevitable requirement of education in the context of digital transformation but also a critical condition for improving academic efficacy and fostering independent learning habits in elementary students. Therefore, the education of self-regulation must be approached as a comprehensive competency development process, closely aligned with age-specific psychological characteristics and specific learning contexts.

In light of these findings, several recommendations are proposed. First, self-regulation training should be integrated into the instructional process, particularly during activities involving technological devices, to help students establish goal-oriented habits and behavioral control. Second, teachers should serve as facilitators, gradually shifting control from external scaffolding to internal regulation, thereby enabling students to develop sustainable self-regulatory skills (Zimmerman, 2000). Additionally, the design of digital learning environments should prioritize minimizing distractors and optimizing cognitive load to facilitate sustained focus and efficient information processing (Sweller, 1988).

Furthermore, collaboration between schools and families is essential for forming and reinforcing students' self-regulation. When students are exposed to consistent rules and guidance regarding technology use across both settings, they are better positioned to develop stable learning behaviors aligned with their educational goals. This synergy is a vital factor in ensuring the sustainability of self-regulatory development in digital contexts.

In conclusion, fostering self-regulation in digital learning not only enhances immediate academic performance but also provides a foundation for lifelong learning in an increasingly digital world. This necessitates ongoing research to refine pedagogical measures that support elementary students in developing comprehensive cognitive and behavioral competencies within the modern educational landscape.

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