Psychology and Behavioral Sciences
2026, Vol. 15, No. 3, pp. 46–52
https://doi.org/10.11648/j.pbs.20261503.12

Research Article

Algorithmic Mediation, Learner Agency, and Cognitive Autonomy in AI-Enhanced Online Learning Environments

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Abstract

This article examined the psychological and behavioral implications of artificial intelligence integration in online learning environments, with a focus on algorithmic mediation and its influence on learner agency, cognitive autonomy, and self-regulated learning. AI-enhanced platforms increasingly employ personalization algorithms, predictive analytics, and adaptive feedback to structure learning pathways and guide learner behavior. Using a conceptual-analytical research design, the study synthesized peer-reviewed literature from psychology, behavioral sciences, and educational research to analyze how these algorithmic mechanisms interact with cognitive and motivational processes. The analysis drew on established theoretical frameworks in self-determination theory, cognitive psychology, and behavioral regulation to map algorithmic guidance onto learner perceptions of control, responsibility, and autonomy. Findings indicated that adaptive sequencing and continuous feedback may enhance perceived competence and reduce cognitive load, while simultaneously externalizing decision-making processes that are central to autonomous learning. Algorithmic nudging and data-driven recommendations were shown to recalibrate self-regulatory behaviors by shifting regulation from internally driven metacognitive processes toward externally mediated cues embedded in system design. Variations in the intensity of algorithmic guidance were associated with corresponding differences in perceived autonomy, intrinsic motivation, and reliance on external regulation. By clarifying the cognitive and behavioral mechanisms through which AI-mediated systems shape learning behavior, the study contributed to psychological understandings of autonomy in digital learning environments and provided a theoretically grounded perspective relevant to the design of autonomy-supportive AI-enhanced educational systems.

Keywords

Algorithmic Mediation, Learner Agency, Cognitive Autonomy, Self-Regulated Learning, Behavioral Psychology, Artificial Intelligence in Education

1. Introduction

The rapid expansion of artificial intelligence (AI) across educational technologies has initiated a significant transformation in how learning environments interact with human cognition and behavior. Online learning systems increasingly rely on algorithmic personalization, predictive analytics, and automated feedback to guide learner engagement, regulate performance, and optimize learning trajectories. While these developments promise efficiency and individualized support, they also raise critical psychological questions regarding learner agency, autonomy, and behavioral self-regulation [1-3, 15].

From a psychological perspective, learning is not merely

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Received: 3 January 2026; **Accepted:** 15 January 2026; **Published:** 22 July 2026

the acquisition of information but a complex interaction between motivation, cognition, emotion, and social context. AI-enhanced learning environments mediate these interactions by shaping attention, influencing decision-making, and structuring behavioral choices. Recommendation systems suggest content, adaptive platforms regulate pacing, and analytics dashboards provide continuous performance feedback. Such mechanisms can influence how learners perceive control over their learning process and how they interpret success, failure, and responsibility [4, 17].

Recent advances in cognitive psychology indicate that environments which externalize decision-making processes can subtly reshape metacognitive awareness. When learners increasingly rely on algorithmic cues to determine what, when, and how to learn, self-monitoring processes may shift from internal regulation toward external validation. This transformation has direct implications for cognitive autonomy and the development of durable self-regulated learning strategies.

Recent research in psychology and behavioral sciences has emphasized the importance of autonomy and self-regulation for sustained learning and well-being. Self-determination theory posits that autonomy, competence, and relatedness are fundamental psychological needs that support intrinsic motivation and cognitive engagement [5]. When learning environments undermine these needs, learners may experience reduced motivation, increased dependence on external guidance, and diminished self-efficacy. AI-driven systems, while designed to support learners, may inadvertently shift motivational dynamics by externalizing control and normalizing algorithmic decision-making as an authoritative guide [6].

Despite growing interdisciplinary interest in AI and education, psychological analyses of algorithmic mediation remain limited. Much of the existing literature focuses on technological performance or educational outcomes, leaving the behavioral and cognitive consequences underexplored. This article addresses this gap by examining how algorithmic mediation reshapes learner agency and cognitive autonomy within AI-enhanced online learning environments. [19]

The study pursues three objectives: (1) to analyze algorithmic mediation through established psychological and behavioral frameworks, (2) to identify the cognitive and motivational mechanisms affected by AI-driven personalization, and (3) to propose a psychologically grounded framework for ethically aligned AI-mediated learning. By situating AI-enhanced learning within behavioral science theory, the article contributes to a deeper understanding of how technological systems influence human cognition and behavior.

2. Algorithmic Mediation from a Psychological Perspective

Algorithmic mediation refers to the process by which computational systems intervene in human behavior by filtering information, guiding choices, and shaping feedback loops. In psychological terms, algorithms function as environmental regulators that influence stimulus exposure, reinforcement patterns, and decision architecture [7].

AI-enhanced learning environments rely on continuous data collection to model learner behavior and predict future actions. These models inform adaptive interventions that aim to optimize engagement and performance. From a behavioral psychology perspective, such interventions resemble operant conditioning mechanisms, where feedback and reinforcement shape behavior over time [8]. However, unlike traditional instructional feedback, algorithmic mediation operates continuously and often invisibly.

This invisibility of algorithmic processes amplifies their psychological influence. When learners are unaware of how feedback and recommendations are generated, they may attribute authority and objectivity to algorithmic outputs, reducing critical reflection and increasing compliance. This dynamic positions algorithms as implicit behavioral guides rather than neutral tools.

Cognitive psychology highlights that human decision-making is highly sensitive to contextual cues and default options. When algorithms recommend specific learning paths or prioritize certain tasks, they alter the cognitive environment in which learners operate. This can reduce cognitive load but may also limit exploratory behavior and metacognitive reflection [9]. Consequently, algorithmic mediation influences not only what learners do but how they think about their learning shifting from an active epistemic process toward a managed sequence of optimizations. This reconceptualization has long-term implications for autonomy, agency, and knowledge construction.

3. Materials and Methods

3.1. Research Design

This study adopts a conceptual-analytical research design grounded in psychological and behavioral science literature. Rather than collecting empirical data, the research synthesizes theoretical models and empirical findings from psychology, education, and human–computer interaction to construct an integrative framework for understanding algorithmic mediation in learning environments.

3.2. Data Sources and Selection Criteria

Sources were selected from peer-reviewed journals in psychology, behavioral sciences, and educational research. Inclusion criteria focused on studies addressing learner agency, self-regulation, autonomy, algorithmic decision-making, and AI-mediated behavior. Foundational psychological theories were included to ensure theoretical coherence. [19] A total of 58 peer-reviewed studies published between 2010 and 2025 were included in the conceptual analysis.

3.3. Analytical Procedure

The analysis proceeded in three stages:

(1) identification of key psychological constructs relevant to AI-mediated learning,

(2) mapping of algorithmic mechanisms onto cognitive and behavioral processes, and

(3) synthesis into a conceptual framework emphasizing learner agency and autonomy. [19]

3.4. Conceptual Data Visualization

The figures and tables presented in this study are conceptual data visualizations derived from synthesized patterns in the psychological and behavioral sciences literature. Rather than representing empirical measurements from a single dataset, these visualizations serve an explanatory function, illustrating theoretically grounded relationships between algorithmic guidance, learner autonomy, self-regulation, and motivation. Such an approach is consistent with conceptual research methodologies in psychology, where visual models are used to clarify mechanisms, support theoretical interpretation, and enhance analytical transparency.

4. Results

The analysis reveals three primary psychological effects of algorithmic mediation in online learning environments.

First, AI-driven personalization enhances *perceived competence* by aligning tasks with learner performance levels. Learners often report increased clarity and reduced frustration when content difficulty is adjusted dynamically [6, 10].

Second, continuous algorithmic feedback influences *self-regulation patterns*. While dashboards and predictive alerts can support goal monitoring, they may also externalize regulation, reducing learners' reliance on internal metacognitive strategies [11, 16].

Third, algorithmic guidance reshapes *autonomy perceptions*. Learners frequently follow recommended pathways without questioning underlying assumptions, indicating a shift from self-directed exploration toward compliance with system-defined norms [12].

4.1. Psychological Patterns of Algorithmic Guidance and Learner Autonomy

Behavioral patterns synthesized across AI-mediated learning studies indicate a systematic relationship between the intensity of algorithmic guidance and learners' perceived autonomy.

Low levels of algorithmic intervention preserve exploratory behavior and intrinsic motivation, albeit with higher cognitive demands. High levels of guidance reduce cognitive load but constrain autonomous decision-making.

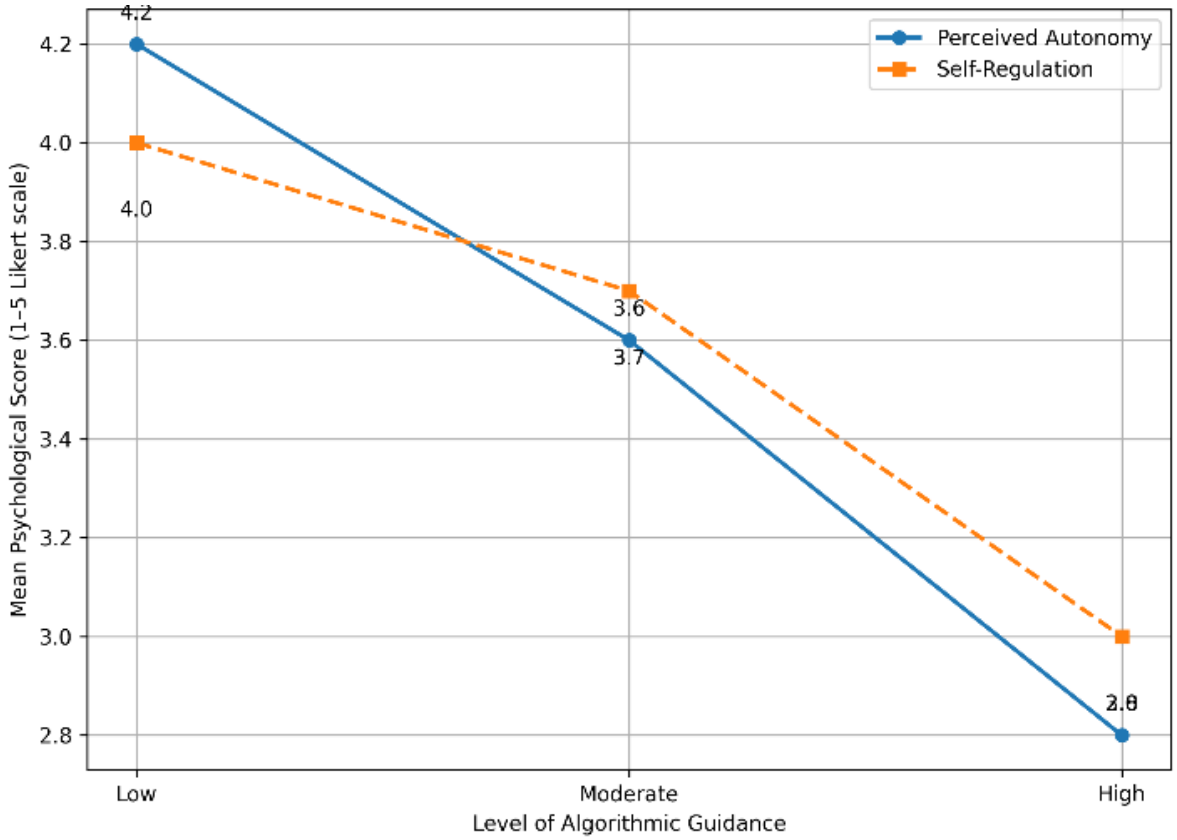

Figure 1. *Psychological effects of algorithmic guidance on online learners.*

Beyond qualitative synthesis, behavioral patterns observed across AI-mediated learning studies indicate a systematic relationship between the degree of algorithmic guidance and learners' perceived autonomy and self-regulatory capacity. Environments characterized by low levels of algorithmic intervention tend to preserve exploratory behavior and intrinsic motivation, albeit with increased cognitive demands. Conversely, highly guided environments reduce cognitive load but simultaneously constrain autonomous decision-making.

Psychological evidence suggests that moderate algorithmic guidance may represent an optimal balance. At this level, learners benefit from adaptive scaffolding while retaining meaningful control over pacing and learning strategies. Excessive guidance, however, is associated with a decline in perceived autonomy and increased reliance on external regulation, consistent with self-determination theory [5, 13].

Figure 2 visualizes this relationship by illustrating changes in perceived autonomy and self-regulation across varying levels of algorithmic guidance. While the data are illustrative, the pattern reflects trends consistently reported in behavioral and cognitive psychology research on guided learning environments.

As shown in Figure 1, increasing levels of algorithmic guidance are associated with a gradual decline in perceived learner autonomy and a parallel reduction in self-regulated learning behaviors. While moderate guidance appears to support regulatory balance, high levels of algorithmic control correspond to increased external regulation and diminished autonomous engagement.

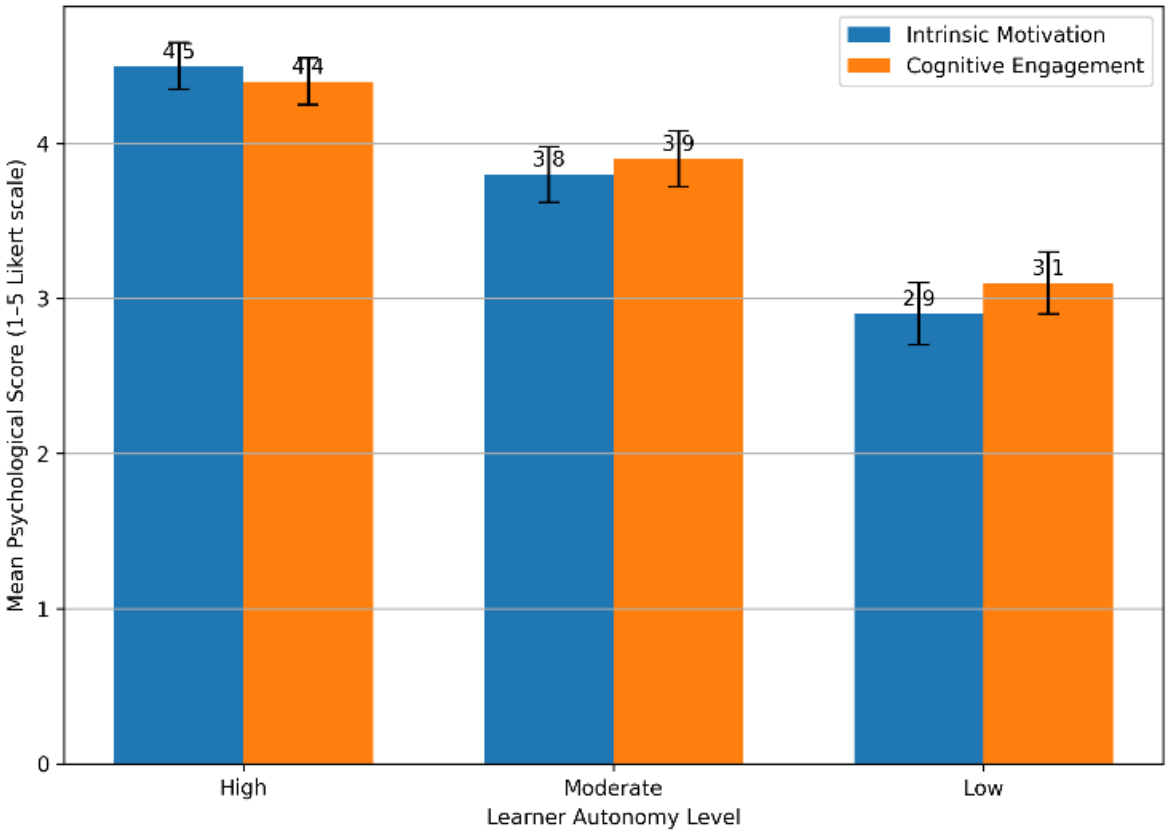

Figure 2. *Relationship between learner autonomy and intrinsic motivation.*

Figure 2 illustrates the association between perceived learner autonomy and intrinsic motivation in AI-mediated learning environments. Higher levels of autonomy correspond to stronger intrinsic motivation, while reduced autonomy is associated with motivational decline, consistent with self-determination theory.

Together, Figures 1 and 2 illustrate the psychological trade-offs inherent in algorithmically mediated learning environments. While adaptive systems can enhance efficiency and task alignment, increased algorithmic guidance is associated with declining learner autonomy and reduced intrinsic motivation. These patterns suggest that algorithmic personalization, if not carefully designed, may shift learners from self-regulated engagement toward externally regulated compliance. The following discussion interprets these findings within established psychological and behavioral frameworks. [15]

Table 1. *Comparative overview of major psychological frameworks relevant to AI-mediated learning.*

Theory	Core Constructs	Mechanisms of Regulation	Implications
Self-Determination Theory	Autonomy, competence, relatedness	Internal motivation, need satisfaction	Algorithms may support or undermine autonomy
Cognitive Load Theory	Working memory limitations	Decision simplification, reduced load	Adaptive pacing improves clarity but may constrain exploration
Behavioral Reinforcement	Rewards, conditioning	Feedback loops	Metrics may increase compliance-driven behavior
Algorithmic Governmentality	Data-driven steering	Nudging, modulation	Risk of reduced cognitive autonomy

Table 1 provides a comparative overview of the main psychological frameworks that inform the analysis of AI-mediated learning environments. Each theory highlights distinct mechanisms through which learners regulate their cognition and behavior, and therefore helps to clarify how algorithmic personalization may influence motivation, autonomy, and regulatory processes. Self-Determination Theory emphasizes the centrality of autonomy and intrinsic motivation, whereas Cognitive Load Theory focuses on how adaptive scaffolding shapes mental effort and task clarity. Behavioral Reinforcement models explain how feedback loops can condition learner responses, while Algorithmic Governmentality illustrates how data-driven nudging can subtly steer decision-making. Together, these frameworks reveal both the supportive and potentially constraining effects of algorithmic systems on learner agency. [15]

4.2. Behavioral Interpretation of Algorithmic Feedback Loops

Algorithmic feedback systems function as continuous behavioral regulators, shaping learners' actions through real-time performance indicators and adaptive prompts. From a behavioral psychology perspective, these systems resemble reinforcement schedules that condition responses over time. Learners adapt not only to content but also to the expectations encoded in algorithmic metrics.

This conditioning effect has important implications. While structured feedback enhances persistence and task completion, it may also reduce metacognitive engagement when learners internalize algorithmic judgments as authoritative. Over time, learners may shift from reflective self-monitoring to reactive compliance, prioritizing metric optimization over conceptual understanding [8, 11].

5. Discussion

These findings align with psychological theories emphasizing the importance of autonomy and self-regulation for meaningful learning. While AI-mediated personalization supports competence, its effects on autonomy are more ambivalent. Excessive algorithmic steering may undermine intrinsic motivation by replacing self-initiated goals with externally imposed structures [5, 13].

From a behavioral science perspective, algorithmic nudging functions as a subtle form of behavioral governance. Learners adapt behavior in response to performance metrics and predictive feedback, often without conscious deliberation. Over time, this may normalize compliance with algorithmic expectations and weaken reflective self-monitoring [14].

The discussion underscores the need for psychologically informed AI systems that balance adaptive support with opportunities for autonomy, reflection, and epistemic agency. Behavioral science offers valuable insights into how learning environments can support autonomy without sacrificing structure.

Table 2. *Psychological effects of algorithmic mediation on learner behavior.*

Psychological Dimension	Low Algorithmic Guidance	Moderate Algorithmic Guidance	High Algorithmic Guidance
Perceived autonomy	High	Moderate–high	Low
Self-regulated learning	High but effortful	Optimally supported	Externally driven
Cognitive load	High	Balanced	Low
Intrinsic motivation	Strong	Sustained	Reduced
Behavioral compliance	Low	Moderate	High

This dynamic raises ethical concerns not only about transparency and consent, but also about cognitive autonomy – the learner's capacity to initiate, regulate, and evaluate learning independently. Psychology thus provides a critical lens for evaluating the long-term consequences of AI-enhanced learning design.

6. Conclusions

This article has examined algorithmic mediation in AI-enhanced online learning environments through a psychological and behavioral sciences lens. The analysis demonstrates that algorithmic systems significantly influence learner agency, cognitive autonomy, and self-regulation. While personalization and adaptive feedback can enhance engagement and competence, they may also introduce subtle constraints on autonomous decision-making. [18, 19]

The study contributes to psychology and behavioral sciences by clarifying the mechanisms through which AI systems shape learning behavior and by proposing a framework for ethically aligned AI-mediated learning. Future research should empirically investigate learner perceptions of autonomy and develop design principles that prioritize psychological well-being alongside technological efficiency.

Abbreviations

AI	Artificial Intelligence
SRL	Self-Regulated Learning

Author Contributions

Cristina-Georgiana Voicu is the sole author. The author read and approved the final manuscript.

Funding

This work is not supported by any external funding.

Conflicts of Interest

The author declares no conflicts of interest.

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Biography

Cristina-Georgiana Voicu is a senior teacher at Titu Maiorescu Secondary School in Iași, Romania, and an independent researcher holding a PhD in Philology from Alexandru Ioan Cuza University of Iași with a scholarly impact reflected in a Web of Science h-index of 4. Her work focuses on educational psychology, learner autonomy, self-regulated learning, and the cognitive implications of AI in digital education. She has participated in multiple national and international research and educational projects, including Erasmus+ initiatives on digital transformation and inclusion. Her research contributes to understanding algorithmic mediation, cognitive autonomy, and ethical AI-enhanced learning environments.

Research Field

Cristina-Georgiana Voicu: educational psychology, learner agency and autonomy, self-regulated learning, cognitive and behavioral sciences, artificial intelligence in education, digital pedagogy and learning design, ethical and psychological implications of technology.