

## A SYSTEMIC APPROACH TO AI-SUPPORTED ACADEMIC READING STRATEGY FORMATION

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### Abstract

This study presents a systemic approach to understanding the formation of academic reading strategies in AI-supported learning environments. Drawing on systems theory and educational research, we develop a comprehensive model that conceptualizes reading strategy formation as an emergent property of interactions between learners, AI tools, and contextual factors. Through qualitative analysis of student-AI interactions and expert interviews, we identify key system components and their dynamic relationships. The findings reveal that effective strategy formation depends on the alignment of AI affordances with learner characteristics, instructional design, and institutional support structures. The proposed systemic model offers a framework for designing and evaluating AI-supported reading interventions that promote sustainable strategy development.

**Keywords:** systems theory, academic reading, strategy formation, artificial intelligence, learning ecology

### 1. Introduction

The integration of artificial intelligence into educational contexts has prompted a fundamental rethinking of how learning processes are conceptualized and supported [1]. Academic reading, as a complex cognitive activity essential for knowledge acquisition in higher education, stands to benefit significantly from AI-powered tools that can provide personalized scaffolding and feedback [2]. However, the question of how reading strategies develop and can be effectively supported in AI-enhanced environments remains insufficiently understood from a theoretical perspective [3].

Traditional approaches to reading strategy instruction have often focused on individual skill development, treating reading as a primarily cognitive activity occurring within the mind of the learner [4]. While this perspective has yielded valuable insights, it may be insufficient for understanding learning in technology-rich environments where human cognition is increasingly distributed across biological and technological systems [5]. A systemic approach offers an alternative framework that conceptualizes reading strategy formation as emerging from the dynamic interactions among multiple components of a learning ecology [6].

Systems theory, with its emphasis on wholeness, interdependence, and emergence, provides a powerful lens for examining how AI-supported reading strategies develop [7]. From this perspective, effective strategy formation is not simply a matter of transferring knowledge from AI systems to learners but rather involves the co-evolution of practices, tools, and understandings within a complex adaptive system [8]. This study applies systemic principles to develop a comprehensive model of AI-supported reading strategy formation.

### 2. Methods

This study employed a mixed-methods research design combining qualitative analysis of student-AI interactions with expert interviews to develop a grounded systemic model. The research was conducted in two phases: first, an exploratory phase involving observation and analysis of naturalistic reading activities; second, a model refinement phase incorporating expert feedback and theoretical synthesis.

#### 2.2. Participants



Participants included 45 undergraduate students enrolled in academic reading courses at a research university and 12 experts in educational technology, reading instruction, and AI system design. Student participants were selected using purposive sampling to ensure diversity in academic majors, year of study, and prior experience with AI reading tools. Expert participants were identified through their publications and professional involvement in relevant fields.

### 2.3. Data Collection

Data collection involved multiple sources to enable triangulation and comprehensive understanding. Think-aloud protocols were used to capture students' cognitive processes while engaging with AI-supported reading tasks. Screen recordings and interaction logs provided detailed data on how students utilized AI features. Semi-structured interviews explored students' perceptions of strategy development and the factors influencing their reading approaches. Expert interviews focused on identifying critical system components and their relationships.

### 2.4. Data Analysis

Qualitative data were analyzed using a grounded theory approach, with initial coding followed by axial and selective coding to identify core categories and their relationships. System dynamics modeling techniques were employed to represent the interactions among system components and their effects on strategy formation outcomes. Member checking and peer debriefing were used to enhance the credibility of findings.

## 3. Results

The analysis identified five interconnected subsystems that collectively constitute the AI-supported reading strategy formation system: the learner subsystem, the AI tool subsystem, the instructional context subsystem, the social environment subsystem, and the institutional infrastructure subsystem. Each subsystem comprises multiple elements that interact both internally and across subsystem boundaries.

The learner subsystem encompasses cognitive characteristics (prior knowledge, working memory capacity, metacognitive awareness), motivational factors (self-efficacy, interest, goal orientation), and prior experiences with technology and academic reading. The AI tool subsystem includes technical capabilities (natural language processing, adaptive algorithms, user interface features), pedagogical design (scaffolding mechanisms, feedback types, strategy prompts), and integration with other learning tools [10].

The instructional context subsystem comprises curriculum structures, assessment practices, and instructor facilitation approaches that shape how AI tools are used in educational settings [11]. The social environment subsystem involves peer interactions, collaborative learning opportunities, and social norms around technology use. The institutional infrastructure subsystem includes technical support, professional development resources, and policies governing AI adoption.

The analysis revealed several critical dynamics that influence strategy formation within the system. Feedback loops, both reinforcing and balancing, play essential roles in shaping learning trajectories. Reinforcing loops occur when successful strategy use leads to improved comprehension, which increases confidence and motivation, leading to further strategy engagement. Balancing loops emerge when challenges or failures prompt strategy adjustment or help-seeking behaviors.

Time delays in the system were found to significantly impact strategy development. The benefits of reading strategies often manifest after a lag period, which can lead to premature abandonment of effective approaches if learners do not receive appropriate support during the initial learning phase. Similarly, AI system adaptations may not immediately align with learner needs, creating temporary mismatches that require patience and persistence from both learners and instructors.

Strategy formation was found to be an emergent property of the system rather than a direct output of any single component. Effective reading strategies emerged when the interactions



among subsystems created conditions conducive to exploration, practice, reflection, and refinement [30]. The quality of these emergent strategies depended on the degree of alignment among subsystem elements and the presence of mechanisms supporting adaptive adjustment.

#### 4. Discussion

The systemic model developed in this study offers a more comprehensive framework for understanding AI-supported reading strategy formation than approaches that focus exclusively on individual learners or technological features. By conceptualizing strategy development as emerging from complex interactions among multiple system components, the model highlights the importance of attending to contextual factors and systemic alignment in designing educational interventions.

The findings suggest that effective AI-supported reading instruction requires attention to all five subsystems identified in the model. Interventions that focus solely on improving AI tool capabilities without addressing learner preparation, instructional integration, social support, or institutional infrastructure are unlikely to produce sustainable strategy development. Conversely, even well-designed AI tools may fail to achieve their potential if other system components are not adequately supportive.

The concept of emergence has important implications for how we evaluate AI-supported reading interventions. Traditional outcome measures may not capture the full complexity of strategy formation processes, which unfold over time and across multiple contexts. Evaluation approaches that attend to system dynamics, including feedback loops and time delays, may provide more useful information for improving practice.

Several limitations of this study should be acknowledged. The research was conducted in a single institutional context, which may limit the generalizability of findings. Additionally, the rapidly evolving nature of AI technologies means that specific tool features and capabilities described in this study may become outdated. Future research should examine the applicability of the systemic model across diverse contexts and track how system dynamics evolve as AI technologies advance.

#### 5. Conclusion

This study has presented a systemic approach to understanding AI-supported academic reading strategy formation. The proposed model conceptualizes strategy development as an emergent property of interactions among learner, technological, instructional, social, and institutional subsystems. The findings highlight the importance of systemic alignment and the need for comprehensive approaches to designing and implementing AI-supported reading interventions. As AI technologies continue to transform educational landscapes, systemic perspectives will be essential for realizing their potential to support meaningful learning.

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