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From Print to Pixels to Prompts: Stage-Switching as a Critical Competence for AI-Mediated E-Learning

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Abstract: ***This perspective article argues that digital reading within e-learning environments should not be conceptualized as a static shift from print to screen, but as an evolving continuum spanning three overlapping modalities: print reading, e-reading (pixels), and prompt-mediated reading (prompts). In this third stage, generative AI systems dynamically synthesize, curate, or interpret text on behalf of the learner. Drawing on digital literacy frameworks, cognitive load theory, and recent scholarship on generative AI in education, this paper introduces a conceptual model of this reading continuum. It systematically examines the pedagogical affordances and cognitive trade-offs of each stage regarding comprehension, sustained attention, and learner autonomy. Rather than framing AI-mediated text engagement as an academic threat to be restricted or an uncritical tool to be adopted passively, this article calls for an explicit curricular reframing around stage-switching the deliberate pedagogical capability to navigate across these modalities. The paper concludes by outlining concrete implications for e-learning instructional designers, curriculum developers, and future empirical research into digital reading behaviors within AI-saturated educational ecosystems.***

Keywords: E-Learning; Reading Continuum; Digital Literacy; Generative AI; Textual Engagement; Instructional Design.

I. INTRODUCTION

In contemporary digital learning environments, the phrase doing the reading has undergone a profound transformation. Consider two distinct e-learning scenarios: in the first, a student interacts with a digital text, annotating a PDF on a tablet while managing internal hyperlinks and cross-references. In the second, the student inputs a complex prompt into a large language model (LLM), requesting a thematic synthesis and cross-textual comparison of the assigned chapters. Although both students may arrive at an online seminar prepared to discuss the material, the cognitive architectures, interpretive workflows, and autonomous processes they engaged with are fundamentally disparate. This divergence highlights a significant critical gap in current educational technology research: the vocabulary used to define digital reading within e-learning has failed to keep pace with algorithmic advancements.

For the past two decades, educational technology scholarship has largely operated within a binary paradigm: print versus digital text engagement. Researchers have extensively debated whether digital reading on screens compromises text comprehension relative to paper (Mangen et al., 2019), whether scrolling erodes linear attention, and how the loss of tactile spatial anchoring affects working memory. While these inquiries remain vital, their foundational premise that digital reading is a homogenous, singular activity is no longer theoretically or empirically sufficient.

Between standard digital text navigation and interactive collaboration with generative AI tools, a distinct third educational practice has emerged: prompt-mediated reading. When a learner directs an AI system to summarize, restructure, or evaluate an academic text, they are no longer merely reading digitally. Instead, they are delegating the initial phase of textual interpretation to an algorithmic agent, receiving a curated synthesis rather than encountering the source material directly. Consequently, treating a linear PDF interaction and an LLM prompting session as identical instances of digital learning introduces more theoretical ambiguity than clarity.

To address this ambiguity, this paper proposes a tripartite conceptual model: the Print-Pixels-Prompts Continuum.

- Print represents linear, physically anchored, and algorithmically unmediated text engagement.
- Pixels encompasses the transition to digital screens, characterized by non-linear hyper-reading, network connectivity, and unique cognitive processing demands.
- Prompts defines an emergent modality wherein the learner operates as an editor or director of an AI agent, shifting the educational task from direct information extraction to algorithmic interrogation and synthesis evaluation.

Crucially, these stages do not sequentially replace one another; rather, they coexist recursively within a learner's daily workflow. The objective of this paper is to map this continuum, evaluate the pedagogical trade-offs inherent to each stage, and introduce "stage-switching" as a vital digital competence that must be intentionally integrated into contemporary e-learning curricula and instructional design frameworks.

II. CONCEPTUAL BACKGROUND

To understand the necessity of a three-stage reading continuum within e-learning, it is essential to trace how educational research has historically conceptualized screen-based textual interaction. Prior literature can be organized into three dominant theoretical paradigms, each identifying a specific cognitive or behavioral variable within digital learning environments.

The first paradigm is the screen inferiority hypothesis (Hakemulder & Mangen, 2024) which posits that reading complex, expository texts on digital screens frequently results in lower comprehension and retention scores compared to print media. This effect is largely attributed to the loss of spatial and tactile anchoring; physical pages provide fixed visual cues that facilitate the mental mapping of an argument. While meta-analyses indicate this deficit is mitigated during low-stakes, casual reading tasks (Ruffini et al., 2025), the hypothesis underscores a persistent challenge in online learning: ensuring deep processing when the physical architecture of text is removed.

The second paradigm, the shallowing hypothesis, shifts focus from immediate task comprehension to long-term neurocognitive habits (Lucciarini et al., 2025). Proponents argue that habitual engagement with interactive digital environments conditions learners to favor rapid skimming, multi-tasking, and frequent task-switching. Over time, this constant exposure is hypothesized to reduce the capacity for sustained, linear attention required by dense academic arguments. Although critics note that clear causal evidence linking digital media use to permanent attentional deficits remains limited (Wang et al., 2026), the framework remains highly influential among educators addressing student distraction in digital courses.

The third paradigm offers a more adaptive perspective, reframing digital reading through the lens of hyper-reading (Hayles, 2025). Rather than viewing screen interactions as inherently degraded forms of print literacy, this school of thought positions hyper-reading as a distinct, strategic cognitive skill optimized for information-dense environments. Hyper-reading involves non-linear navigation, keyword scanning, and strategic link-jumping, allowing learners to rapidly assemble meaning across fragmented online sources. This approach aligns closely with connectivist e-learning models, which prioritize the ability to navigate and synthesize nodes of information over the insular consumption of a single text.

As detailed in Table 1, even the hyper-reading paradigm assumes a direct interface between the human eye and the source text. When a student utilizes an LLM to pre-process a text, this assumption is broken.

Table 1: Theoretical Paradigms in Digital Reading and Learning Research

Paradigm	Core Claim / Focus	Primary Mechanism	Pedagogical Limitation in AI Era
Screen Inferiority	Digital screens reduce deep text comprehension versus paper.	Loss of tactile and spatial mapping cues.	Assumes direct human text processing; does not account for delegated reading.
Shallowing Hypothesis	Hypermedia usage erodes capacity for sustained linear focus over time.	Neurocognitive adaptation to rapid skimming and switching.	Focuses on attentional distraction rather than algorithmic mediation of source content.
Hyper-reading	Non-linear screen navigation is a distinct, legitimate research competence.	Selective scanning, filtering, and associative link-jumping.	Fails to address workflows where the learner never directly interfaces with the source text.

This theoretical gap necessitates the introduction of the Prompts stage into the e-learning vocabulary. Prompt-mediated reading does not merely accelerate hyper-reading; it fundamentally alters the locus of cognitive agency. The learner no longer skims the text; instead, they evaluate an algorithmic representation of the text. Consequently, the critical literacy challenges shift from navigating hypermedia to detecting machine hallucinations, evaluating algorithmic bias, and verifying synthesis accuracy against original source documents.

III. THE TRIPARTITE CONTINUUM MODEL: OPERATIONAL MECHANICS AND TRADE-OFFS

Print–Pixels–Prompts continuum does not represent a linear evolutionary trajectory where newer modalities obsolete older *ones*; rather, it functions as a recursive matrix of practices deployed dynamically within contemporary e-learning workflows. Each stage is defined by distinct cognitive *architectures*, technological affordances, and intrinsic trade-offs that redistribute the learner's cognitive load.

Table 2: The Tripartite Continuum Model

Modality	Primary Cognitive Affordances	Intrinsic Learning Risks	Educational Focus
Print	Deep semantic processing; high spatial-tactile memory consolidation; minimized attentional distraction.	Low information velocity; absent hypermedia connectivity; restricted searchability.	Deep linear comprehension and structural text analysis.
Pixels	Rapid horizontal information retrieval; non-linear hyper-reading; multi-source synthesis.	Cognitive fragmentation; split-attention effects; hypermedia-induced distraction.	Navigational literacy and strategic digital skimming.
Prompts	High-velocity information triage; cross-textual macro-synthesis; linguistic translation and clarification.	Premature cognitive offloading; unverified reliance on summaries; atrophy of primary interpretive skills.	Algorithmic interrogation, verification, and critical evaluative literacy.

A. Print: Deep Linear Processing and Spatial Mapping

Print literacy relies heavily on the physical stability of the text infrastructure. Cognitive load research demonstrates that the physical manipulation of a text turning pages, tracking spatial locations creates durable cognitive anchors that aid long-term memory consolidation. Because print offers no rapid navigational shortcuts, it forces a sequential, low-velocity interface with the material. The primary affordance here is deep, sustained processing. The trade-off is structural insularity: print lacks the rapid cross-referencing capabilities and expansive information velocity required for large-scale digital research workflows.

B. Pixels: Networked Hypermedia and Navigational Literacy

The transition to screen-based text introduces structural elasticity. Digital documents are searchable, infinitely scalable, and embedded with hyperlinks that transform a linear text into a fluid network node. This modality facilitates hyper-reading an active cognitive strategy marked by keyword filtering, skimming, and associative jumping across documents. But this elasticity compromises the text's boundary conditions. The inclusion of dynamic interfaces and digital notifications frequently induces the split-attention effect, increasing extraneous cognitive load and risking fragmented comprehension. Here, the learner exchanges spatial stability for network range and retrieval velocity.

C. *Prompts: Algorithmic Delegation and Synthetic Processing*

The emergent prompt-mediated stage introduces an architectural shift from automated text-display to autonomous text-interpretation. When a learner interfaces with an LLM to digest course literature, they transition from an absolute reader to an editorial director. The primary affordance of prompting is the immediate optimization of macro-level information triage: the system collapses expansive volumes of text into digestible syntheses, lowering the barrier to entry for highly dense or technical literature. However, the risk is structural and metacognitive. When a learner consumes an algorithmically generated summary, they bypass the primary interpretive friction the sentence-by-sentence labor of evaluating evidence, identifying logical fallacies, and constructing personal meaning. While the learner acquires the informational conclusions of a text, they do not experience the cognitive development required to evaluate how those conclusions were derived.

IV. CRITICAL COUNTER-PERSPECTIVES AND LIMITATIONS OF THE MODEL

1) *The Teleological Reductionism Critique:* Critics may argue that framing the continuum from print to prompts implies a narrative of cognitive decline or progressive deficit, positioning AI-mediated reading as inherently superficial. This paper explicitly rejects technological determinism. Prompting is not a uniform activity; its cognitive value depends entirely on the agentic orientation of the user. A graduate researcher utilizing an LLM to cross-reference methodological parameters across fifty studies is not executing a shallow shortcut; rather, they are exercising advanced cognitive sorting. The model must therefore account for prompting as both a tool for deep inquiry and a mechanism for superficial evasion.
2) *The Hegemony of the Linear Norm:* The implicit prioritization of deep, uninterrupted linear reading as the pedagogical gold standard reflects a specific historical, socio-cultural configuration of literacy. Critical literacy scholars note that sustained, silent engagement with long-form texts requires significant, unevenly distributed capital including undisturbed time, quiet spaces, and advanced linguistic training. By romanticizing print, educational frameworks risk pathologizing the adaptive, non-linear, and algorithmically collaborative strategies utilized by diverse learner populations. The Prompts stage must be evaluated on its own epistemic merits, not merely judged against print-centric parameters.
3) *The Clean Segmentation vs. Recursive Reality Contradiction:* While a three-stage model implies distinct boundaries, empirical student workflows are notoriously non-linear and recursive. Within a single study session, a learner may navigate back and forth across all three modalities: skimming a digital PDF (Pixels), prompting a chatbot to clarify a dense theoretical framework (Prompts), and subsequently printing out a core chapter to annotate by hand (Print). The conceptual utility of the continuum lies not in predicting isolated behaviors, but in providing a clear analytical lexicon to evaluate these fluid transitions.
4) *The Empirical Gap and the Problem of Inference:* A fundamental limitation of current generative AI literacy literature is its highly speculative nature. While the screen inferiority and shallowing hypotheses are grounded in decades of empirical, eye-tracking, and psychometric data, the long-term cognitive impacts of prompt-mediated learning remain largely inferential. It remains unproven whether persistent reliance on AI synthesis genuinely causes primary reading capacities to atrophy, or if it instead fosters highly advanced forms of evaluative critique and prompt-engineering rigor. This model serves as a conceptual scaffolding to guide the empirical testing needed to resolve this uncertainty.

A. *Implications for E-Learning and Instructional Design*

If contemporary literacy exists across a fluid three-stage continuum, the traditional binary architecture of e-learning design which assumes students alternate exclusively between physical books and online screens is obsolete. E-learning instructional designers and curriculum developers must deliberately design for the interactions between all three modalities.

B. *Introducing Stage-Switching as a Meta-Cognitive Competence*

Developing meta-cognitive stage-switching requires training students when not to prompt. For example, introductory information gathering may leverage prompt-mediated reading for rapid domain mapping. However, close textual critique, ideological analysis, and deep conceptual evaluation require the deliberate down-shifting of technology moving the student back to unmediated digital or print environments where cognitive friction is preserved.

V. PEDAGOGICAL STRATEGIES FOR INSTRUCTIONAL DESIGNERS

1) *Scaffolded Algorithmic Interrogation:* Rather than assigning traditional reading summaries, designers should structure tasks that require students to interrogate AI outputs. An illustrative assignment structure involves providing students with an intentionally biased or incomplete AI-generated summary of a text, requiring them to use hyper-reading (Pixels) and close reading (Print) to locate errors, omissions, and hallucinations.

2) *Friction-by-Design in Learning Management Systems (LMS):* Digital course interfaces must counter the shallowing effect by intentionally building pedagogical friction into the asynchronous workspace. This includes embedding mandatory reflective pauses, metacognitive self-assessments regarding the reading strategies used, and diversified delivery formats that require learners to toggle between long-form text analysis and prompt-based synthesis.
3) *Dual-Assessment Frameworks:* Educational evaluations must adapt to assess both the product of learning and the process of algorithmic orchestration. Assessment rubrics should explicitly evaluate a student's prompt literacy grading the rigor, iterative depth, and verification strategies utilized during AI-mediated research sessions alongside their final written arguments.

VI. CONCLUSION

The contemporary debate surrounding generative AI in education has suffered from a profound conceptual bottleneck. By attempting to force prompt-mediated textual engagement into the legacy paradigms of the print-versus-digital divide, educational technology research has overlooked a fundamental shift in learner cognition. This perspective article has introduced the Print–Pixels–Prompts continuum to provide a precise, operationally viable lexicon for this new landscape. Prompt-mediated reading represents a clean break from traditional digital text interaction; it shifts the educational task from human information processing to human-algorithmic orchestration.

As e-learning environments become increasingly saturated with agentic AI systems, the preservation of autonomous learning requires an immediate shift in empirical research priorities.

Crucial questions must now be systematically addressed by the educational technology community:

1) What are the measurable developmental impacts of protracted prompt-mediated reading habits on the baseline long-form reading comprehension capacities of adolescent learners over extended academic cycles?
2) Does explicit instructional training in metacognitive stage-switching yield quantifiable improvements in critical thinking and source verification metrics compared to unguided technology adoption?
3) What do high-competence, rigorous forms of prompt-mediated reading look like in practice, and how can these expert strategies be operationalized into scalable instructional scaffolds within digital course designs?

The answers to these inquiries will determine whether generative AI serves as a mechanism for widespread cognitive offloading, or as a catalyst for a sophisticated new tier of human-machine intellectual partnership. What is certain is that the baseline definition of what it means to "do the reading" has shifted permanently. Educational systems must either intentionally adapt their pedagogical architectures to manage this continuum or leave learners to navigate its structural risks by chance.

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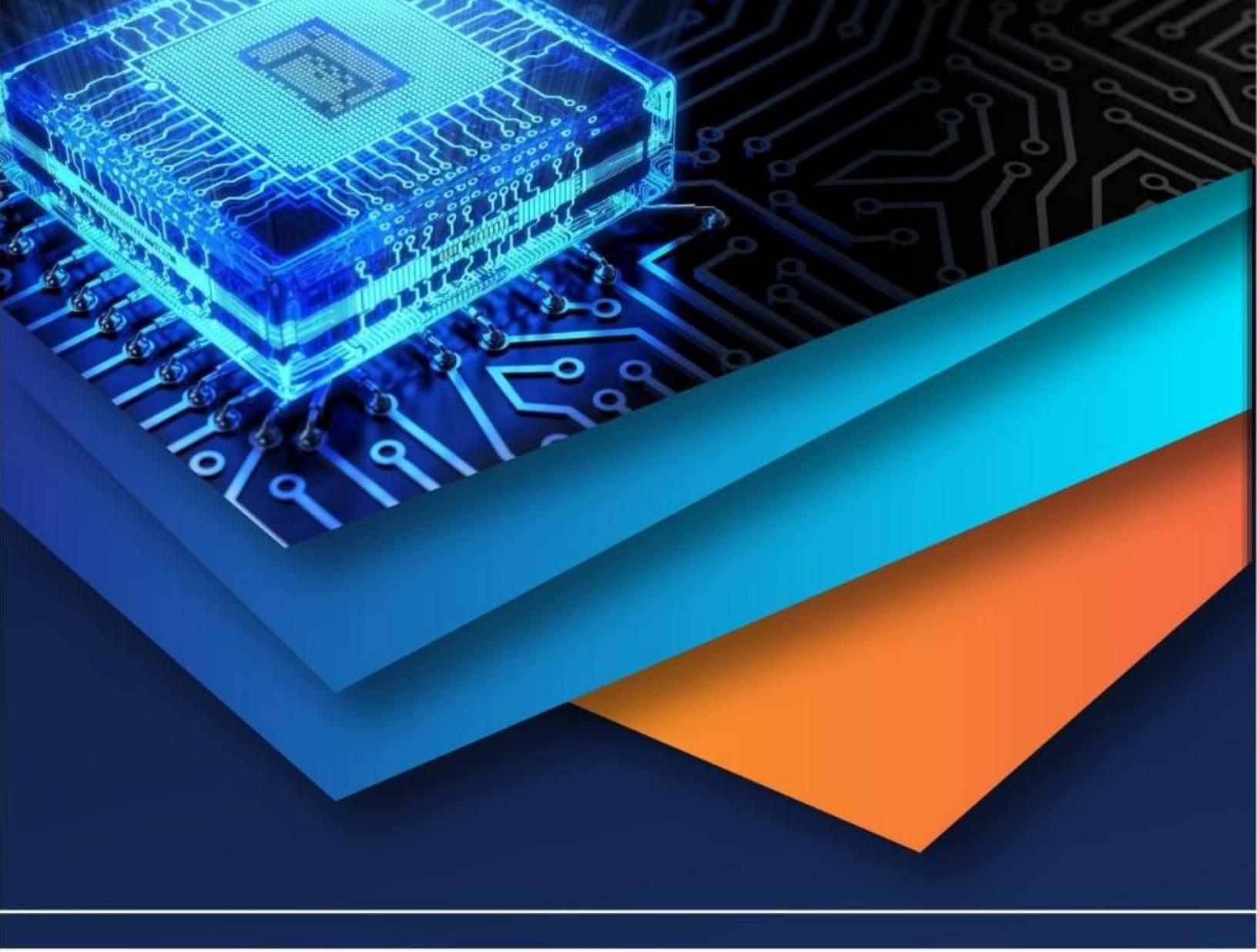

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