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Evidence-based Design of Learning Environments for Information Literacy Development

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Abstract
The research broadens the scope of the Stimulus-Organism-Response (S-O-R) model from environmental psychology to the realm of medical education. It reinterprets elements of evidence-based instructional design, such as authenticity of problems, structural frameworks, and collaborative areas, as environmental triggers for information-seeking actions (organism), thereby enhancing information literacy skills (response). This theoretical shift from tangible to educational settings uncovers the vital role of information-seeking in connecting environmental design with competency results. The model offers theoretical underpinnings for studying environment-behavior in medical training and actionable advice for designing evidence-based practice class.

Keywords: Information literacy; Evidence-based practice; Medical education; S-O-R model

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1.0 Introduction

Research in environment-behavior has confirmed the role of spatial features in molding human actions in various settings. Recent studies demonstrate that retail atmosphere design significantly influences consumer purchasing decisions and store loyalty, urban green spaces and public installations promote community well-being (Oduro & Nisco, 2024). These studies converge on a fundamental understanding: environments act as dynamic facilitators, offering chances, setting limitations, and molding behavioral reactions via the Stimulus-Organism-Response (S-O-R) process (Russell & Mehrabian, 1974).

This study extends environment-behavior research from physical to educational contexts. Teaching methods create structured environments that students must navigate, analogous to consumers in retail spaces or residents in cityscape. In the same way that architects create structures to shape movement habits, teachers craft educational settings to affect mental and behavioral growth. This comparison is theoretically based: the S-O-R model offers a comprehensive structure for comprehending the impact of environmental elements on behavioral results via internal mental activities.

Despite extensive research on physical environmental impacts, educational settings remain under explored within the environment-behavior framework. Traditional pedagogical research has primarily examined teaching effectiveness and learning outcomes, often neglecting the environmental dimensions of educational design. This gap is particularly pronounced in medical education, where

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evidence-based practice (EBP) training demands not only knowledge acquisition but also the development of critical information-seeking behaviors. While we understand how spatial configurations shape consumer behavior in retail environments and social interactions in urban spaces, systematic investigation into how instructional environments function as behavioral stimuli remains limited. This study addresses this critical gap by applying the S-O-R framework to medical education contexts, specifically examining how evidence-based instructional design elements—problem authenticity, scaffolding structures, and collaborative spaces—serve as environmental stimuli that trigger information-seeking behaviors and ultimately cultivate information literacy competencies. By re-framing instructional design as environmental architecture, this research bridges environment-behavior theory with medical pedagogy, offering both theoretical advancement in understanding learning as an environmentally-embedded process and practical implications for designing EBP curricula that systematically foster essential clinical competencies through strategic environmental manipulation.

1.1 Information Literacy Challenges in Medical Education

Modern medical training is confronted with unparalleled challenges in expanding its knowledge base. This rapid increase implies that medical students are unable to grasp the expansion of their knowledge solely through memorization. Rather, they need to cultivate information literacy, which involves recognizing information requirements, tactically finding evidence, thoroughly analyzing sources, and incorporating these insights into clinical decision processes.

However, traditional lecture-based pedagogy proves inadequate for developing these competencies. In passive learning environments, students receive ore-selected information with limited opportunities to practice authentic information-seeking skills (Tachie-Donkor & Ezema, 2023). Evidence-based instructional methods, including Problem-Based Learning (PBL), case-based teaching, and collaborative learning,which attempt to address this gap by creating environments that require active information engagement. Despite their documented effectiveness, the underlying mechanisms through which these strategies enhance information literacy remain insufficiently understood. Current literature lacks comprehensive explanatory frameworks that elucidate the pedagogical processes at work, which constrains both the systematic implementation and broader applicability of these instructional innovations.

1.2 Research Objectives and Theoretical Framework

This study proposes the S-O-R (Stimulus-Organism-Response) model as a theoretical framework connecting learning environment design to information literacy development. We extend this logic to instructional settings: evidence-based learning environment characteristics (stimulus) trigger information-seeking behaviors (organism), which produce information literacy competencies (response). This framework offers three primary contributions. First, it extends the S-O-R model from physical environments to instructional contexts, demonstrating cross-domain applicability and enriching environmental psychology theory (Hussain et al., 2023). Second, it reveals information-seeking behavior as a developmental mechanism rather than merely an outcome variable, providing process-oriented rather than correlational explanatory perspectives. Third, it integrates social cognitive theory (Bandura, 1986), and information behavior models (Wilson, 1999) within a parsimonious framework, offering unified conceptual tools for medical education.
The remainder of this paper reviews the theoretical foundations (Section 2), presents the integrated S-O-R framework (Section 3), and discusses implications for medical education practice (Section 4).

2.0 Literature Review

Originating from environmental psychology, the S-O-R model was developed to elucidate the impact of physical surroundings on human actions (Russell & Mehrabian, 1974). These environmental factors (stimulus) initiate mental-emotional states (organism), leading to behavioral reactions. This model has demonstrated its strength in various fields. Within retail environments, the ambiance of stores affects shopping feelings, impacting buying decisions. Research in e-commerce indicates that live-streaming elements boost consumer worth and buying decisions via cognitive and emotional processes. The findings validate that intentionally crafted environmental aspects consistently affect behavioral results by molding internal conditions.

2.1 S-O-R Model: Cross-Domain Applications

The S-O-R logic is relevant under three specific circumstances: distinct environmental characteristics that change methodically; quantifiable internal mechanisms that facilitate connections between stimuli and responses; and noticeable behavioral results. Educational settings meet all these prerequisites comprehensively. Teaching methods represent systematically varied environmental stimuli that create distinct learning conditions, while cognitive and affective processes serve as measurable organismic states mediating between pedagogical approaches and learning outcomes (Chen & Liu, 2021). Student behaviors, such as engagement levels, participation patterns, and academic performance, provide observable responses to these structured environments.

The theory of situated cognition further substantiates this framework by suggesting that educational settings shape readily available knowledge and cherished practices. Learning is fundamentally embedded in the physical, social, and cultural contexts in which it occurs, rather than existing as a purely internal cognitive process. Teaching methods, therefore, function as environmental structuring mechanisms that scaffold authentic learning experiences, influence social interactions, and establish cognitive norms. This offers a robust theoretical basis for viewing teaching methods as environmental factors that systematically shape learner cognition and behavior, paralleling how physical environments influence human responses in other behavioral domains.

2.2 Teaching Methods as Environmental Stimuli

Drawing from environmental psychology and medical education literature, we conceptualize evidence-based instructional strategies into three environmental dimensions:

Environmental Dimension	Theoretical Foundation	Design Features	Analogous Physical Environment
Problem Authenticity (Realism)	Situated Learning (Lave &Wenger, 1991)	•Incomplete case info •Real patient data •Clinical uncertainty	Heritage building authenticity (Yi, X., Fu, X., Lin,B., & Sun, J. ,2024)
Scaffolding Intensity (support)	Zone of Proximal Development (Vygotsky,1978)	•Search templates •Expert modeling •Faded guidance	Urban wayfinding systems Public signage (Ma, X, & Yang, Q. ,2025)
Collaborative Engagement (Social)	Communities of Practice (Wenger,1998)	•Group tasks •Peer review •Shared resources	Public art spaces fostering social interaction (Sonke, J. et al. ,2025)

Fig. 1: Learning Environment Dimensions and Operationalization

Problem Authenticity (Environmental Realism) refers to the degree to which learning scenarios resemble authentic professional contexts. Situated learning theory posits that competencies develop through participation in authentic practices. Authentic problems create cognitive disequilibrium, thereby motivating learning. In medical education, authentic clinical cases containing incomplete information and ambiguous diagnoses compel students to identify knowledge gaps and actively seek information. Research demonstrates that authentic environments evoke stronger cognitive engagement and transfer of learning than artificial simulations.

Scaffolding Intensity (Environmental Support) represents the degree of structured guidance embedded within learning environments. Building on Vygotsky's Zone of Proximal Development, contemporary research demonstrates that optimal learning occurs through activities that exceed independent capabilities yet remain achievable with appropriate support (Vygotsky, 1978). In medical education, scaffolding manifests through search templates, evaluation checklists, worked examples, and expert demonstrations. Effective scaffolding is dynamic, it provides substantial support initially, then gradually fades as learners develop competence, progressively transferring responsibility to students.

Collaborative Engagement (Social Interaction Features) describes the extent to which learning environments facilitate peer interaction and collective knowledge construction. In medical education, collaborative structures, including small group discussions, peer teaching, problem-based learning, and collective problem-solving, create interactive spaces where knowledge is co-constructed through dialogue and diverse perspectives are integrated. These collaborative approaches enhance not only knowledge retention but also clinical reasoning skills and diagnostic accuracy. Such environments mirror professional medical practice, where clinical reasoning typically involves consultation and team-based decision-making. The contemporary shift toward inter-professional team-based care models in healthcare makes collaborative competencies increasingly essential, suggesting that educational environments fostering peer interaction better prepare learners for authentic professional contexts.

2.3 Information-Seeking Behavior as Mediating Mechanism

Information-Seeking Behavior as Mediating Mechanism. Information-seeking behavior occupies the "organism" position in the S-O-R framework, serving as the critical mediating mechanism between environmental characteristics and literacy outcomes. Unlike moderators that specify "when" or "for whom" effects occur, mediators explain the psychological and behavioral processes through which effects are transmitted. We conceptualize information-seeking behavior across three interconnected dimensions: information need recognition, the meta cognitive capacity to identify knowledge gaps and formulate answerable clinical questions; strategic information seeking, the employment of goal-directed search strategies that evolve from scaffold, deliberate practice toward automatized competence; and reflective evaluation, the critical assessment of source credibility, evidence quality, and synthesis of diverse perspectives through collaborative discourse.

These three dimensions represent a progressive developmental trajectory wherein environmental affordances shape learner behaviors, which subsequently generate literacy outcomes. Through sustained engagement with supportive learning environments, these initially externalized, socially mediated practices gradually become internalized as individual cognitive capabilities. This internalization process constitutes the fundamental mechanism through which specific environmental features, including scaffolding intensity, resource accessibility, and collaborative structures translate into durable professional competencies in information literacy. By positioning information-seeking behavior as the mediating variable, our model explicates not merely whether environmental features influence outcomes, but precisely how this influence operates through learners' active, strategic engagement with information resources and practices. This mechanistic understanding enables more targeted interventions: rather than assuming direct environmental effects, educators can deliberately design experiences that cultivate specific information-seeking behaviors known to enhance literacy development.

Information Literacy as Progressive Response. The response component represents hierarchical literacy development: functional literacy (database access, query formulation), critical literacy (evaluating evidence quality and research methodology), integrative literacy (synthesizing contradictory sources), and transformative literacy (generating new knowledge and research questions) (Chen et al., 2023). Each level builds cumulatively upon predecessors, reflecting the staged development of professional expertise.

3.0 Methodology

This conceptual research employs theoretical synthesis methodology to construct a novel framework integrating insights from environmental psychology, medical education, and information science. Unlike traditional literature reviews that summarize existing knowledge, theoretical synthesis actively builds new theoretical structures by identifying cross-domain patterns and mechanisms. We systematically analyzed three literature streams: S-O-R model applications across diverse contexts (retail, digital environments, urban design) to extract generalizable environment-behavior principles; evidence-based instructional strategies in medical education, particularly Problem-Based Learning and collaborative pedagogies (Shi et al., 2022); and information literacy frameworks examining competency development processes (Zhou, 2024). By synthesizing these disparate literatures, we develop an integrated S-O-R framework that explicates how learning environment characteristics shape information literacy through behavioral mediation.

The synthesis comprised four iterative steps: identifying generalizable environment-behavior mechanisms across domains; mapping evidence-based instructional strategies onto environmental design dimensions; constructing theoretical linkages among environmental characteristics, information-seeking behaviors, and literacy outcomes based on established mechanisms; and deriving practical implications for medical education. This approach transcends traditional literature summarization by establishing novel theoretical connections that explain the systematic pathways through which learning environments shape information literacy development.

4.0 Findings

The conceptual model proposes that evidence-based learning environment design (stimulus) activates information-seeking behaviors (organism), ultimately developing information literacy competencies (response).we proposed a research model that identifes the relationships between learn environment design, information-seeking behaviors, and information literacy development (see Fig. 2).

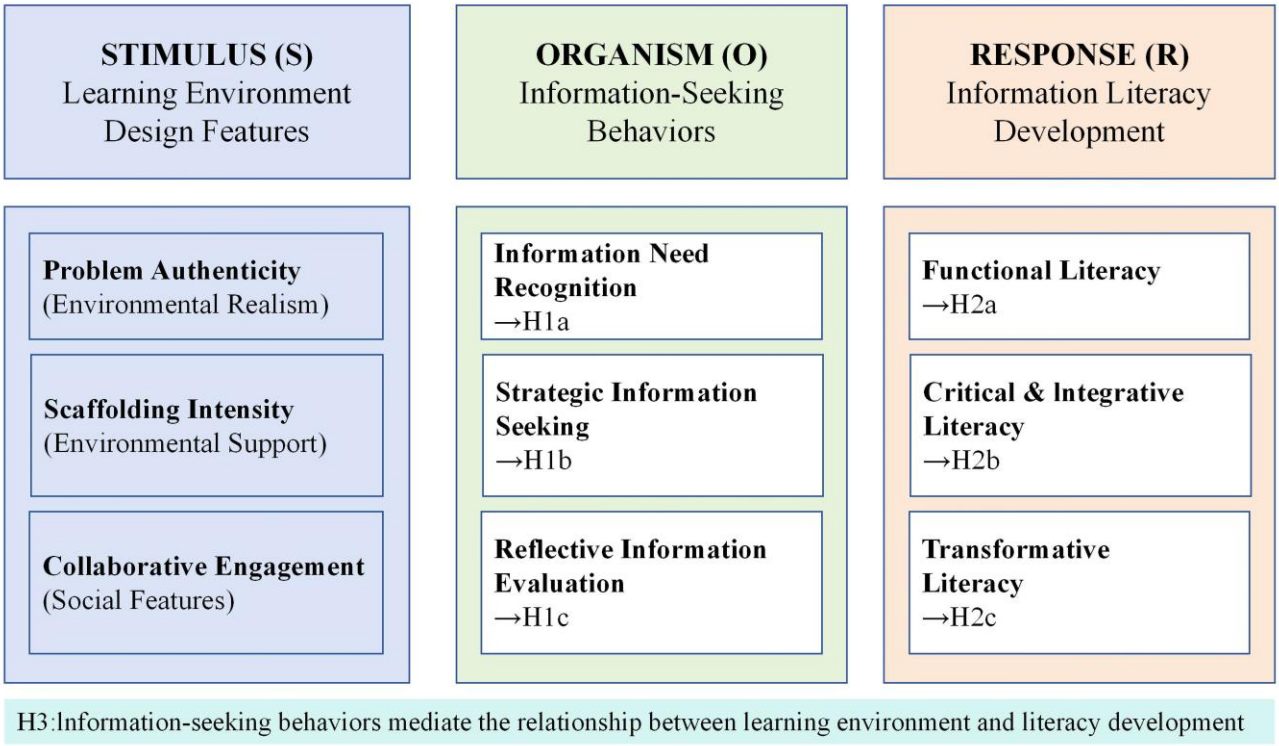

Fig. 2: The S-0-R Framework for Learning Environment Design and information Literacy Development

4.1 Environmental Stimuli → Behavioral Activation (S→O)

The challenge of authenticity affects the identification of information requirements via cognitive imbalance processes. Genuine clinical instances with partial information lead to a conflict between existing knowledge and situational needs (Nachtigall et al., 2022). Instances of patients exhibiting vague symptoms lacking essential diagnostic details necessitate extra information, prompting students to understand the need for further information. This recognition arises from the intrinsic reasoning of the task, not from outside influences, making motivation inherent.

Transitioning from Scaffolding Intensity to Strategic Information Seeking. The intensity of scaffolding influences the pursuit of strategic information via cognitive apprenticeship methods. The emergence of expert search techniques via demonstrations, verbalized thoughts, or organized templates leads to students developing procedural frameworks via observational learning. Offering frameworks for search strategies ("identify key concepts," "select appropriate databases," "use Boolean operators") clarifies unspoken expertise . With the evolution of competence, scaffolding slowly diminishes, promoting autonomy (Fan, 2025).

The shift from Collaborative Engagement to Reflective Evaluation enhances reflective assessment via dialogic methods. Students rationalize their information selections to peers, questioning the credibility of the source and identifying the study's constraints, leading

to social negotiation. This process evolves into internal self-inquiry, evolving into autonomous evaluative abilities. Such collective evaluation introduces students to varied viewpoints, confronting confirmation bias and enriching critical thinking (Yang et al., 2024).

4.2 Behavioral Mechanisms → Literacy Development (O→R)

Through intentional practice, continuous recognition of information needs fosters functional literacy. Every instance of searching strengthens procedural understanding, encompassing database access, query creation, and result filtering. As these processes continue, they evolve from deliberate to automated proficiency, liberating mental capacities for complex tasks.

The quest for Strategic Information leads to the development of Critical and Integrative Literacy. This process fosters critical and integrative literacy by enhancing metacognitive awareness. Students, when faced with diverse types of information, ranging from peer-reviewed studies to online resources, formulate evaluative heuristics. They acquire skills in identifying methodological shortcomings, evaluating the robustness of evidence, and integrating contradictory results, necessitating a profound grasp of research methodology and the evaluation of evidence.

This process fosters transformative literacy by rigorously scrutinizing presuppositions. Students who challenge the validity of knowledge premises, such as "What constitutes valid evidence?" or "Whose viewpoints are omitted?", cultivate an understanding of knowledge. Such a comprehensive comprehension empowers them to scrutinize knowledge assertions critically, pinpoint areas lacking evidence, and aid in the generation of knowledge.

4.3 Theoretical Propositions

Based on the integrated S-O-R framework (Figure 2), we propose testable relationships at three levels. Direct effects specify how environmental features activate behaviors: problem authenticity influences information need recognition (H1a), scaffolding intensity shapes strategic information-seeking (H1b), and collaborative engagement facilitates reflective evaluation (H1c). Developmental effects articulate how behaviors cultivate competencies: information need recognition develops functional literacy (H2a), strategic seeking enables critical/integrative literacy (H2b), and reflective evaluation cultivates transformative literacy (H2c). Mediation effects establish that information-seeking behaviors mediate environment-literacy relationships (H3), representing the process through which environmental affordances become internalized competencies. These propositions enable systematic empirical validation through quantitative, qualitative, or mixed-methods approaches.

4.4 Boundary Conditions

The framework's effectiveness may be moderated by three contextual factors that warrant consideration in implementation. Prior domain knowledge influences how learners respond to problem authenticity: novices may experience cognitive overload when confronted with highly authentic cases, whereas experts require authentic complexity to maintain engagement and avoid perceiving scenarios as artificially simplified (Setyadi et al., 2025). This suggests that authenticity should be calibrated progressively to match learner expertise levels. Digital literacy shapes scaffolding effectiveness, as students with strong technological proficiency benefit from minimal guidance that preserves autonomy, while those with limited digital skills require more structured support to prevent frustration and disengagement (Martí nez-Bravo et al., 2022). Cultural orientations toward learning may influence collaborative engagement pathways: students from collectivist cultural backgrounds often naturally embrace collaborative structures, whereas those from individualist contexts may initially resist group-based learning, requiring explicit facilitation to recognize its value. These moderating factors highlight the necessity for adaptive instructional design that personalizes environmental characteristics to individual learner profiles rather than applying uniform approaches.

5.0 Discussion

5.1 Theoretical Contributions

The framework he developed propels medical education studies forward by integrating three distinct theoretical elements. Initially, it broadens the scope of the S-O-R model from tangible settings to educational environments, illustrating how educational design molds learning results via processes similar to the impact of environmental design on behaviors in retail, urban planning, and digital areas (Zhao et al., 2021). This approach shows that effective teaching doesn't directly convey literacy but rather fosters an environment conducive to the development of literacy skills. Thirdly, the framework amalgamates various theoretical approaches—situated learning theory, social cognitive theory, and information behavior models, within a concise S-O-R framework, highlighting their conceptual synergy and providing comprehensive analytical instruments for the development of competencies.

5.2 Evidence-Based Design Principles

The framework translates into three environmental design principles that systematically develop information literacy through carefully architected learning contexts. First, engineer authentic problem environments centered on clinical scenarios with intentional information gaps. Use de-identified patient cases with genuine diagnostic ambiguity, deliberately omit critical information to create epistemic necessity, and embed ethical or cultural complexities requiring diverse evidence sources (Scott et al., 2023). Foundation environments provide explicit search templates and expert demonstrations; development environments offer partially completed frameworks and peer teaching opportunities; autonomy environments present open-ended problems with minimal prompts and self-assessment tools. This graduated complexity ensures optimal challenge while building independent capability. Third, establish collaborative accountability

structures where information literacy develops through structured social interaction (Ward et al., 2025). Assign complementary roles within groups (source locator, methodology critic, evidence synthesizer), implement peer review protocols requiring students to justify source selections, and create shared knowledge artifacts—annotated bibliographies, evidence matrices—that document collective reasoning processes and externalize evaluative thinking.

These three principles function synergistically to create comprehensive learning ecosystems: authentic problems provide clinical necessity (why seek information), scaffolded environments supply procedural capability (how to seek effectively), and collaborative structures offer social learning mechanisms (learning to evaluate critically). Together, they constitute evidence-based environmental design that develops information literacy not through didactic instruction but through sustained participation in carefully designed learning contexts that mirror and prepare students for professional clinical practice.

6.0 Conclusion and Recommendations

The research formulated a comprehensive S-O-R model, elucidating the role of evidence-based learning environments in enhancing information literacy in medical education via information-seeking behaviors. Viewing teaching methods as deliberate environmental triggers, this model uncovers structured mechanisms where real-world problem settings, flexible support systems, and joint accountability setups influence the evolution of information literacy. It propels medical education research forward by incorporating situated learning theory, social cognitive theory, and information behavior models into a streamlined framework.

Upcoming studies ought to explore various avenues to confirm and broaden this model. Empirical research ought to examine the suggested links between environmental aspects and behavioral reactions and literacy results in a range of medical education settings, from preclinical to clinical education, across different specialties, and in diverse institutional environments. Prolonged studies monitoring students' information literacy paths over time could shed light on developmental trends and key transitional stages. Comparative research into how diverse environmental traits lead to different literacy results could enhance design methodologies and pinpoint ideal setups. Moreover, studies investigating the framework's relevance in other health professions education settings would evaluate its applicability and theoretical solidity. This model offers both theoretical underpinnings for comprehending competency development processes and practical design guidelines for developing educational settings that consistently develop information literacy among medical students, crucial for evidence-based medical practice.

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Paper Contribution to Related Field of Study

This study contributes to environment-behavior research by extending the S-O-R framework from physical to instructional environments, demonstrating the model's applicability across environmental domains. It advances medical education research by providing mechanistic explanations for evidence-based pedagogy effectiveness and offers practical guidance for digital learning environment design in medical institutions. The framework bridges environmental psychology, educational theory, and information science, creating interdisciplinary connections that enrich all three fields while providing actionable insights for educational practitioners and policymakers.

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