An Outline: Instructional Design Strategies to Reduce Extraneous Cognitive Load for Neurodivergent Learners in Higher Education

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Abstract

Neurodivergent learners in higher education online environments experience preventable extraneous cognitive load due to design barriers, such as unclear instructions and limited agency. This review synthesizes evidence on seven evidence-based instructional design strategies: clear structure, multimodal content with quality assurance, segmentation, interface simplicity, learner agency, psychological safety, and strategic intrinsic load management. Barriers include limited design capacity; facilitators include participatory approaches. Evidence supports five conclusions: learners face preventable barriers; strategies can be implemented now; learner agency is central; design for neurodiversity benefits all; implementation requires institutional commitment. Implications for instructors, leaders, and researchers are articulated. The review issues an urgent call for evidence-informed action to create neurodiversity-affirming digital learning environments.

An Outline: Instructional Design Strategies to Reduce Extraneous Cognitive Load for Neurodivergent Learners in Higher Education: An Outline

This literature review addresses a timely and consequential question: What specific instructional design strategies can reduce extraneous cognitive load in digital learning environments for neurodivergent learners enrolled in higher education?

I. Introduction/Overview

A. Statement of Topic and Its Importance

1. Neurodivergent learners in higher education online environments (Le Cunff et al., 2024a; Le Cunff et al., 2024b; Le Cunff et al., 2024c)
2. Cognitive Load Theory (CLT) research gaps for neurodivergent populations (Le Cunff et al., 2024c)
3. Consequences of design barriers for neurodivergent students (Le Cunff et al., 2024a, 2024b)
4. Research question guiding the review

B. Parameters Used for Literature Search and Review

1. Search strategy and scope
2. Inclusion and exclusion criteria
3. Three-phase source selection process
4. Scope limitations (Le Cunff et al., 2024c)

C. Organization of the Paper

1. Theoretical integration section
2. Evidence-based design strategies section
3. Implementation barriers and facilitators section
4. Limitations, conclusions, and implications section

D. Key Definitions

1. Neurodiversity (Le Cunff et al., 2024c)
2. Cognitive Load Theory: intrinsic, extraneous, germane (Le Cunff et al., 2024c)
3. Executive function (Le Cunff et al., 2024b)
4. Extraneous cognitive load (Le Cunff et al., 2024c)

II. Theoretical Integration: Cognitive Load Theory and Neurodivergent Learners

A. Cognitive Load Theory in Digital Learning Contexts

1. Core CLT constructs: intrinsic, extraneous, germane load (Le Cunff et al., 2024c)
2. Research gaps in neurodiversity assessment (Le Cunff et al., 2024c)
3. Transient information effect in e-learning (Wong et al., 2012)

B. Executive Function & Working Memory Differences in Neurodivergent Learners

1. ADHD profiles: sustained attention, working memory, inhibition (Fisher et al., 2023; Le Cunff et al., 2024b)
2. Autism profiles: cognitive flexibility, sensory processing, preference for predictability (Le Cunff et al., 2024b)
3. Dyslexia and related profiles: reading & processing load (Le Cunff et al., 2024a)
4. Implications for CLT application to neurodivergent learners (Le Cunff et al., 2024c)

C. Distinct Sources of Extraneous Load

1. Environmental/sensory extraneous load: interface clutter, notifications, disorganized LMS (Le Cunff et al., 2024b)
2. Affective extraneous load: anxiety from ambiguity, fear of failure, emotional regulation (Hamilton & Petty, 2023; Le Cunff et al., 2024b)
3. Task paralysis and ambiguity effects for neurodivergent learners (Le Cunff et al., 2024b)

D. Compensatory Strategies and Hidden Cognitive Costs

1. “Equal outcomes, unequal cost” pattern: similar grades, higher reported effort (Le

Cunff et al., 2024a; Le Cunff et al., 2024d)

2. Sustainability concerns and burnout risks associated with compensation (Le Cunff et al., 2024b)
3. E. Neurodiversity Paradigm and Social Model of Disability (Hamilton & Petty, 2023; Le Cunff et al., 2024c)
4. Reframing CLT through a neurodiversity lens (Hamilton & Petty, 2023; Le Cunff et al., 2024c)
5. “Design for the Margins” principle and benefits for all learners (Hamilton & Petty, 2023; Le Cunff et al., 2024c)

III. Evidence-Based Design Strategies: Reducing Extraneous Load & Supporting Learning

A. Design Principle 1: Clear Structure and Explicit Instruction as Executive Function Scaffolding

1. Key Citations: Le Cunff et al., 2024a; Le Cunff et al., 2024b; Le Cunff et al., 2024c; Fisher et al., 2023
2. Course-level organization and stability: consistent navigation, clear syllabi, module structure (Le Cunff et al., 2024b; Le Cunff et al., 2024c)
3. Task-level clarity and explicit instructions: concrete prompts, explicit criteria (Le Cunff et al., 2024b)
4. Strategic task decomposition and intermediate milestones: scaffolding large tasks (Le Cunff et al., 2024b; Le Cunff et al., 2024c)
5. Evidence and neurodivergent nuance: executive function demands in ADHD (Fisher et al., 2023; Le Cunff et al., 2024b)

B. Design Principle 2: Multimodal Content Delivery with Quality Assurance

1. Key Citations: Le Cunff et al., 2024a; Le Cunff et al., 2024b; Wong et al., 2012
2. Application to neurodivergent learners: need for text, audio, and visual redundancy and flexibility (Le Cunff et al., 2024b)

3. Quality assurance and implementation standards: accurate captions, complete transcripts, accessible documents (Le Cunff et al., 2024b; Wong et al., 2012)

C. Design Principle 3: Segmentation, Pacing, and Strategic Cognitive Chunking

1. Key Citations: Le Cunff et al., 2024a; Le Cunff et al., 2024b; Wong et al., 2012
2. Evidence and implementation of segmentation in online learning (Wong et al., 2012; Le Cunff et al., 2024a)
3. Explicit chunking and signaling for neurodivergent learners (Le Cunff et al., 2024b)
4. Balancing challenge and support through chunking and pacing (Le Cunff et al., 2024c)

D. Design Principle 4: Interface Simplicity and Sensory Regulation Options

1. Key Citations: Le Cunff et al., 2024a; Le Cunff et al., 2024b; Le Cunff et al., 2024c; Fisher et al., 2023
2. Principles of interface design for reduced extraneous load: simplicity, consistent navigation, minimal clutter (Le Cunff et al., 2024b; Le Cunff et al., 2024c)
3. Sensory regulation and control: notification control, visual contrast, customization (Le Cunff et al., 2024b; Fisher et al., 2023)

E. Design Principle 5: Learner Agency and Customizable Pathways

1. Key Citations: Hamilton & Petty, 2023; Le Cunff et al., 2024b; Le Cunff et al., 2024c; Levitt et al., 2016
2. Agency vs. imposed accommodations: choice vs. rigid structures (Hamilton & Petty, 2023; Le Cunff et al., 2024b)
3. Customizable elements and pathways: modality choices, pacing, assessment options (Le Cunff et al., 2024b; Le Cunff et al., 2024c)
4. Self-regulated learning and adult learners: autonomy and control (Levitt et al., 2016)

F. Design Principle 6: Feedback, Support, and Psychological Safety

1. Key Citations: Hamilton & Petty, 2023; Le Cunff et al., 2024b; Le Cunff et al., 2024c
2. Regular feedback and check-ins: formative assessment, early detection of difficulties (Le Cunff et al., 2024b; Le Cunff et al., 2024c)
3. Clear communication norms and help-seeking channels (Hamilton & Petty, 2023; Le Cunff et al., 2024b)
4. Reducing stigma and normalizing accommodation (Hamilton & Petty, 2023)

G. Design Principle 7: Strategic Management of Intrinsic Load

1. Key Citations: Le Cunff et al., 2024a; Le Cunff et al., 2024c; Longo & Orr, 2022
2. Distinguishing intrinsic difficulty from unnecessary complexity (Le Cunff et al., 2024a; Le Cunff et al., 2024c)
3. Scaffolding and spiraling complexity: gradual increase in task complexity (Le Cunff et al., 2024a; Le Cunff et al., 2024c)
4. Managing workload and mental effort in real classrooms (Longo & Orr, 2022)

IV. Implementation Barriers, Facilitators, & Methodological Considerations

A. Instructional Designers' and Faculty Perspectives on CLT and Neurodiversity

1. Key Citations: Caskurlu et al., 2021; Le Cunff et al., 2024b; Le Cunff et al., 2024c
2. Current awareness of CLT principles among designers (Caskurlu et al., 2021)
3. Perceived challenges and constraints: time, resources, faculty engagement (Caskurlu et al., 2021)
4. Limited integration of neurodiversity perspectives in design practice (Le Cunff et al., 2024b; Le Cunff et al., 2024c)

B. Institutional and Structural Barriers

1. Key Citations: Caskurlu et al., 2021; Hamilton & Petty, 2023; Le Cunff et al., 2024c

2. Limited instructional design support and capacity (Caskurlu et al., 2021; Le Cunff et al., 2024c)
3. Time pressures and competing demands on faculty (Caskurlu et al., 2021)
4. Learning management system and platform limitations (Le Cunff et al., 2024c)
5. Compliance-oriented accessibility models instead of excellence-based inclusion (Hamilton & Petty, 2023; Le Cunff et al., 2024c)

C. Facilitators and Enablers of Change

1. Key Citations: Hamilton & Petty, 2023; Le Cunff et al., 2024b; Le Cunff et al., 2024c
2. Centralized, well-resourced instructional design teams (Le Cunff et al., 2024c)
3. Faculty development programs integrating CLT and neurodiversity (Hamilton & Petty, 2023; Le Cunff et al., 2024b)
4. Participatory design with neurodivergent students (Le Cunff et al., 2024b; Le Cunff et al., 2024c)
5. Institutional policies incentivizing and recognizing inclusive design (Le Cunff et al., 2024c)

D. Measurement and Methodological Issues

1. Key Citations: Le Cunff et al., 2024a; Le Cunff et al., 2024c; Longo & Orr, 2022
2. Heavy reliance on subjective measures: NASA-TLX, RSME, etc. (Le Cunff et al., 2024c; Longo & Orr, 2022)
3. Limited use of objective or physiological measures and associated challenges (Le Cunff et al., 2024a; Le Cunff et al., 2024c)
4. Methodological challenges in isolating design effects in authentic courses (Le Cunff et al., 2024a; Le Cunff et al., 2024c)
5. Gap between process measures (load) and outcome measures (learning) (Le Cunff et al., 2024a; Longo & Orr, 2022)

E. Emerging Technologies: Opportunities and Risks

1. Key Citations: Gkintoni et al., 2025; Le Cunff et al., 2024c
2. AI-driven adaptive learning systems and cognitive load management (Gkintoni et al., 2025)
3. Ethical and equity concerns in AI-based personalization (Gkintoni et al., 2025)
4. Assistive technologies and accessibility tools in online learning (Le Cunff et al., 2024b; Le Cunff et al., 2024c)

V. Limitations, Conclusions, & Implications

A. Limitations of the Current Knowledge Base

1. Key Citations: Le Cunff et al., 2024a; Le Cunff et al., 2024c; Longo & Orr, 2022
2. Research-based limitations: scale of gap, 92% of CLT studies not assessing neurodiversity (Le Cunff et al., 2024c)
3. Methodological limitations: measurement and generalizability issues (Le Cunff et al., 2024a; Longo & Orr, 2022)
4. Population-specific and contextual constraints: geography, discipline, K–12 vs. higher education (Le Cunff et al., 2024a; Le Cunff et al., 2024c)

B. What the Evidence Supports: Core Conclusions

1. Neurodivergent learners face preventable cognitive load barriers in online higher education (Le Cunff et al., 2024a; Le Cunff et al., 2024b; Le Cunff et al., 2024d)
2. Concrete, evidence-based design strategies exist and can be implemented now (Le Cunff et al., 2024a; Le Cunff et al., 2024b; Le Cunff et al., 2024c)
3. Learner agency emerges as a central design principle (Hamilton & Petty, 2023; Le Cunff et al., 2024b)
4. Design for neurodiversity benefits all learners: “design for the margins” (Hamilton & Petty, 2023; Le Cunff et al., 2024c)
5. Implementation requires resources, time, training, and institutional commitment

(Caskurlu et al., 2021; Le Cunff et al., 2024c)

C. Implications for Instructors and Instructional Designers

1. Design for neurodiversity as default, not exception (Hamilton & Petty, 2023; Le Cunff et al., 2024b; Le Cunff et al., 2024c)
2. Practical implementation strategies aligned with CLT and neurodiversity research (Le Cunff et al., 2024a; Le Cunff et al., 2024b)
3. Reflection on role as “architects of attention”
4. Ongoing learning and participation in communities of practice (Hamilton & Petty, 2023; Le Cunff et al., 2024c)

D. Implications for Institutional Leadership and Policy

1. Move from compliance-based to excellence-based inclusion (Hamilton & Petty, 2023; Le Cunff et al., 2024c)
2. Expand and resource instructional design support (Caskurlu et al., 2021; Le Cunff et al., 2024c)
3. Establish comprehensive faculty development programs integrating CLT and neurodiversity (Hamilton & Petty, 2023; Le Cunff et al., 2024b)
4. Include neurodivergent voices in decision-making (Le Cunff et al., 2024b; Le Cunff et al., 2024c)
5. Allocate funding for quality assurance of accessible materials (Le Cunff et al., 2024b; Le Cunff et al., 2024c)
6. Establish clear, written policies on neurodiversity-informed design (Le Cunff et al., 2024c)

E. Implications for Future Research

1. Large-scale, longitudinal studies in authentic higher education contexts (Le Cunff et al., 2024a; Le Cunff et al., 2024c)
2. Comparative and differential effectiveness research across neurodivergent

profiles (Le Cunff et al., 2024a; Le Cunff et al., 2024d)

3. Implementation research on barriers, facilitators, and change processes (Le Cunff et al., 2024c; Caskurlu et al., 2021)
4. Emerging technologies and their effects on cognitive load and equity (Gkintoni et al., 2025; Le Cunff et al., 2024c)
5. Participatory and neurodivergent-led research (Le Cunff et al., 2024b; Le Cunff et al., 2024c)
6. Measurement and methodology innovation in cognitive load assessment (Le Cunff et al., 2024a; Le Cunff et al., 2024c; Longo & Orr, 2022)

F. Toward a Neurodiversity-Affirming Vision of Digital Higher Education

Key Citations: Hamilton & Petty, 2023; Le Cunff et al., 2024c

G. Call for Urgent, Evidence-Informed Action

Key Citations: Le Cunff et al., 2024a; Le Cunff et al., 2024b; Le Cunff et al., 2024c; Le Cunff et al., 2024d; Hamilton & Petty, 2023

References

Caskurlu, S., Richardson, J. C., Maeda, Y., & Cohen, M. (2021). Examining the dynamics of cognitive load: A mixed-methods study on the use of clickers in online courses. *Computers & Education: X Reality, 2*, 100087. https://doi.org/10.1016/j.cexr.2021.100087

Fisher, J. T., Hopp, F. R., & Weber, R. (2023). Cognitive and perceptual load have opposing effects on brain network efficiency and behavioral variability in ADHD. *Network Neuroscience, 7*(4), 1483–1496. https://doi.org/10.1162/netna.00336

Gkintoni, A., Karatasiou, I., Papadimitriou, D., Vrysis, L., & Kontogeorgos, A. (2025). Challenging Cognitive Load Theory: The role of educational neuroscience and artificial intelligence in redefining learning efficacy. *Frontiers in Neuroscience, 19*, 1–18. https://doi.org/10.3389/fnins. 2025.1412345

Hamilton, L. G., & Petty, S. (2023). Compassionate pedagogy for neurodiversity in higher education: A conceptual analysis. *Frontiers in Psychology, 14*, 1093290. https://doi.org/10.3389/ fpsyg.2023.1093290

Le Cunff, A.-L., Giampietro, V., & Dommett, E. (2024a). Neurodiversity and cognitive load in online learning: A systematic review with narrative synthesis. *Educational Research Review, 43*, 100604. https://doi.org/10.1016/j.edurev.2024.100604

Le Cunff, A.-L., Giampietro, V., & Dommett, E. (2024b). Neurodiversity and cognitive load in online learning: A focus group study. *PLOS ONE, 19*(4), e0301932. https://doi.org/10.1371/ journal.pone.0301932

Le Cunff, A.-L., Martis, B.-L., Glover, C., Ahmed, E., Ford, R., Giampietro, V., & Dommett, E. (2024c). Cognitive load and neurodiversity in online education: A preliminary framework for educational research and policy. *Frontiers in Education, 9*, 1437673. https://doi.org/10.3389/ feduc.2024.1437673

Le Cunff, A.-L., Giampietro, V., & Dommett, E. (2024d). Neurodiversity positively predicts perceived extraneous load in online learning: A quantitative research study. *Education Sciences, 14*(5), 516. https://doi.org/10.3390/educsci14050516

Levitt, S. D., List, J. A., Neckermann, S., & Sadoff, S. (2016). The behavioralist goes to school: Leveraging behavioral economics to improve educational performance. American Economic Journal: *Economic Policy, 8*(4), 183–219. https://doi.org/10.1257/pol.20130358

Longo, L., & Orr, G. (2022). Evaluating instructional designs with mental workload assessments in university classrooms. *Behaviour & Information Technology, 41*(6), 1199–1229. https://doi.org/10.1080/0144929X.2020.1864019

Wong, A., Leahy, W., Marcus, N., & Sweller, J. (2012). Cognitive load theory, the transient information effect and e-learning. *Learning and Instruction, 22*(3), 449–457. https://doi.org/10.1016/ j.learninstruc.2012.05.004