

Development and Empirical Validation of a Cognitive-Load-Aware Digital Safety Feature for Children and Adolescents

[Masters]

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Children and adolescents are navigating an increasingly complex digital landscape, making them vulnerable to a wide range of online risks, including phishing, misinformation, and social engineering. While digital safety interventions like warnings and nudges exist, their effectiveness is often inconsistent. A critical, yet underexplored, factor influencing a young user's ability to process safety information and make safe decisions is cognitive load—the mental effort required to process information and perform a task. High cognitive load, stemming from task complexity, information density, or time pressure, can overwhelm a user's limited cognitive capacity. For young users, whose cognitive capacities are still developing, this can severely impair their ability to recognize threats, understand warnings, and make safe choices.

The problem is that current digital safety interventions are often designed without considering the user's momentary cognitive state. They tend to be static, offering the same warning regardless of whether the user is calm or already mentally overloaded. A static warning, like a small pop-up, might be effective for a user with spare cognitive capacity, but it is likely to be ignored or misinterpreted by a user who is distracted or under pressure. There is a significant research gap in understanding the specific relationship between cognitive load and digital safety performance in children and adolescents. Without this understanding, we cannot design truly effective, adaptive safety features that support users when they need it most.

Research Objectives:

To achieve this, the thesis will focus on the following key objectives:

1. Review and synthesis of existing research/knowledge: Conduct a concise systematic/scoping review covering: (i) cognitive load and cognitive capacity in children and adolescents; (ii) recognition of online risks and safe decision-making; (iii) established methods for measuring cognitive load and decision quality; and (iv) adaptive warnings, nudges, and human-centred digital-safety interventions. The review will identify relevant constructs, measurement instruments, experimental paradigms, and research gaps.

2. Identification and operationalization of indicators: Based on the review, identify a practical set of indicators for assessing cognitive load and digital-safety performance. Cognitive-load indicators may include task complexity, information density, time pressure, task-switching, response time, error rate, perceived workload, hesitation, and repeated actions. Digital-safety indicators may include threat-recognition accuracy, safe/unsafe decision accuracy, inappropriate selections, response time, confidence, recognition of warning signs, and decision justification. Relevant control variables, such as age, digital experience, and digital-safety knowledge, will also be defined.

3. Development of experimental methodology and scenarios: Develop the research protocol for testing the two hypotheses. Define the experimental design, participant requirements, procedures, cognitive-load conditions, outcome measures, and ethical requirements. Develop realistic digital-risk scenarios (we can consider phishing, suspicious messages, unsafe links, requests for personal information, misleading content, and social-engineering situations). Scenarios will be designed to represent low-, medium-, and high-cognitive-load conditions.

4. Small-scale experimental validation/testing: Conduct a small-scale experiment with children/adolescents - if possible - subject to appropriate ethical approval and parental consent. Participants will complete a limited number of simulated digital-risk scenarios under different cognitive-load conditions using a within-subject or mixed experimental design. The study will focus on short sessions and non-sensitive simulated tasks to remain feasible within the project's budget and timeline.

5. Elicitation of product requirements and intervention strategies: Translate the experimental findings into requirements for the new feature. Identify how the system should detect or estimate periods of increased cognitive load and determine what type of intervention should be provided. Define adaptive intervention strategies, including potential changes to the timing, complexity, prominence, and wording of safety warnings.

6. Development of a prototype: Develop a visual prototype demonstrating how the proposed feature could be implemented.