Rethinking Digital Exclusion: Interaction Design Barriers in Adults with Intellectual Disabilities

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Abstract— **Digital exclusion of individuals with Intellectual Disabilities (ID) persists despite improvements in technical accessibility standards. In digital literacy approaches, participation barriers are often attributed to a lack of skills rather than to the interaction patterns embedded in digital systems. However, there has been limited empirical investigation of how such patterns hinder engagement in real-world settings. To address this question, a nine-month exploratory field study was conducted within a semi-structured digital literacy program involving four adults with intellectual disabilities. Participants attended 32 weekly sessions using custom-designed training games. Data were collected through structured field notes, reflective logs, and in-game observations. The study showed recurring interaction breakdowns across participants, clustering into five categories: precision-dependent interactions, structured input and memory reliance, visual discrimination overload, text interaction complexity, and voice interface misalignment. While some adaptation occurred, persistent breakdowns required simplified interaction models. These findings suggest that digital exclusion reflects systemic interaction assumptions rather than solely a literacy deficit, and that some barriers cannot be resolved through training alone.**

Keywords— cognitive accessibility; intellectual disabilities; interaction design; usability barriers; digital literacy; digital inclusion.

I. INTRODUCTION

Digital participation is essential for social inclusion, employment, and independent living; however, individuals with intellectual disabilities remain disproportionately excluded from digital environments. Accessibility research has largely focused on sensory and physical impairments, while cognitive accessibility remains underexplored [1].

Digital literacy training programs often assume that increased familiarity with technology will reduce exclusion. However, such approaches frequently rely on a “deficit model” [2], teaching users to adapt to existing systems rather than questioning whether those systems are inherently accessible. As Bacalja et al. [3] argue, focusing solely on functional competency ignores the embedded design assumptions of technology and risks preparing users to be passive consumers of systems that were not built with their needs in mind. Consequently, learning outcomes remain limited, and acquired skills may not effectively transfer to real-world digital environments where underlying interaction barriers remain unaddressed.

Similarly, established approaches such as Universal Design [4] and Web Accessibility Standards [5] (e.g., Web Content Accessibility Guidelines (WCAG) 2.1) have improved general access, yet they often remain insufficient for addressing the specific cognitive and motor interaction challenges faced by people with intellectual disabilities [6]. While these standards focus on technical compliance, they frequently overlook the cognitive load and temporal precision embedded in standard interface metaphors, which may remain exclusionary regardless of user familiarity.

Prior research has identified interaction challenges such as navigation difficulty, input precision, and information processing [1]; however, these are typically framed as individual deficits rather than systemic design constraints.

Building on prior work introducing a semi-structured digital literacy program at DIGI Lab Siegen [7], longitudinal observations revealed that certain interaction breakdowns persisted despite repeated training and adaptation.

This challenges a core assumption of digital inclusion efforts: that increased exposure and practice are sufficient to overcome barriers.

This study, therefore, addresses the following questions:

1) *How do interaction patterns embedded in digital systems hinder engagement for adults with intellectual disabilities in real-world settings?*
2) *To what extent are persistent interaction barriers a result of systemic design patterns rather than limitations in digital literacy?*

II. METHODOLOGY

A nine-month exploratory field study was conducted with four adults (aged 40–62) with intellectual disabilities participating in a semi-structured digital literacy program. Participants attended 32 weekly sessions combining guided instruction, custom-designed training games, and real-world tasks.

Custom interactive games were developed to isolate specific interaction components (e.g., clicking precision, drag-and-drop, text input), enabling targeted observation of interaction breakdowns.

Data were collected through structured field notes, reflective logs, and in-game observations. Interaction barriers were identified based on repeated failure, assistance requests, or task abandonment. Patterns were analyzed longitudinally to distinguish between temporary learning effects and persistent breakdowns.

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III. RESULTS AND CONSIDERATIONS

Across participants and sessions, five recurring categories of interaction breakdowns were identified:

1) Precision-dependent interactions

Persistent difficulties were observed in tasks requiring temporal accuracy and fine motor control, including double-clicking, drag-and-drop operations, and interaction with small interface elements. Participants frequently demonstrated inconsistent click timing or prolonged button presses, resulting in unsuccessful activation. Modifications replacing double-click interactions with single-click or keyboard-based alternatives led to immediate reductions in error frequency.

2) Structured input and memory reliance

Systematic errors were observed in tasks involving structured text input. These included sequence compression, inconsistent handling of repeated characters, and reduced sensitivity to spatial separation within text. These patterns indicate reliance on working memory and implicit segmentation processes embedded in conventional input design.

3) Visual discrimination overload

Interaction breakdowns were associated with perceptual demands, particularly in cases involving low visual contrast, color similarity, or weak focus indicators. Participants demonstrated difficulty reliably identifying target elements, occasionally selecting adjacent areas rather than intended targets. These effects suggest combined perceptual and motor interaction constraints.

4) Text interaction complexity

Tasks requiring precise cursor placement, such as text selection, resulted in repeated unsuccessful attempts. Additionally, participants showed reduced retention of multi-step instructions, frequently recalling only the final segment. This indicates increased cognitive load associated with both motor precision and sequential information processing.

5) Voice interface misalignment

Speech-based interaction systems demonstrated limited robustness to atypical speech patterns, including delayed onset, pauses, and socially embedded language. In the absence of confirmation mechanisms, misrecognition led to repeated errors and reduced user confidence.

Across categories, several breakdown patterns were observed in three out of four participants and recurred across multiple sessions. While partial improvement was noted, key interaction difficulties—particularly those involving precision and structured input—persisted despite repeated exposure, guided support, and task repetition. In multiple instances, participants were able to complete tasks under guided conditions but were unable to reproduce the same actions independently in subsequent attempts. This suggests that task completion did not necessarily correspond to stable skill acquisition.

Importantly, when interaction structures were modified—such as simplifying input requirements or reducing precision constraints—task success rates increased immediately. These modifications did not alter task outcomes but instead provided alternative pathways to achieve the same result. For example, in a mouse-control activity, one participant repeatedly missed small clickable targets despite understanding the task goal. After the target area was enlarged and the interaction was changed to a single-click action, the participant completed the same task with fewer errors and less assistance. This indicates that many conventional interaction requirements are not intrinsic to task completion but rather reflect established design conventions.

Overall, the observed breakdowns were consistently linked to specific interface patterns rather than to lack of exposure alone. Furthermore, the persistence of these breakdowns despite repeated training, combined with immediate improvement following interaction simplification, indicates that these barriers are primarily rooted in systemic design patterns rather than limitations in digital literacy. However, due to the exploratory design and the small participant group of four adults, the findings should be interpreted as indicative patterns rather than statistically generalizable results.

IV. CONCLUSION

This study demonstrates that digital exclusion cannot be fully explained by limited digital literacy but reflects a mismatch between human cognitive variability and standardized interaction design. The findings suggest that cognitively accessible systems should reduce reliance on motor precision, structured input, and implicit perceptual distinctions. Future work should build on these exploratory observations through controlled usability studies, prioritizing interaction categories that persisted across sessions and improved after simplification. Such studies could compare conventional and simplified interaction models while systematically recording errors, assistance requests, task completion, and independent repetition.

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