Learner-Centered Design: The (Updated) Challenge for HCI in the 21st Century

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ABSTRACT

This paper revisits the paper entitled "Learner-Centered Design: The Challenge for HCI in the 21st Century", written by Soloway *et al.* in 1994. The introduced notion of learner-centered design, which differentiate from user-centered design, extends beyond ensuring the usability of computer systems: it emphasizes the need to support users in both task completion and knowledge acquisition. This paper examines how these foundational ideas have evolved with technological and educational advances, and how they continue to inform and challenge contemporary HCI research and practices.

CCS CONCEPTS

• **Human-centered computing** → **HCI theory, concepts and models**; **Empirical studies in HCI**.

KEYWORDS

Human-Computer Interaction, Learner-Centered Design, Educational Technologies

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1 ORIGINAL CONTRIBUTION

Since the 1990s, as technology became increasingly accessible, design has shifted from technology-driven to human-centered approaches that prioritize users' needs. The paper "Learner-Centered Design: The Challenge for HCI in the 21st Century" [8] questioned the relevance of this traditional user-centered design (UCD) for educational technologies. The authors argued that while UCD focuses on usability and efficiency, designing for learning purposes requires going beyond to actively support the learning process. Learners, broadly defined as anyone acquiring new knowledge or skills, need systems that foster understanding and growth. The main ambition of the proposed learner-centered design (LCD) is thus to contribute to the broader goal of "making people smarter" [6].

Soloway *et al.* exposed this vision during the early 1990s, when increasing computational power was opening new possibilities for interactive and adaptive educational software. The authors argued that learning technologies should place learners, not just users, at the center of design processes to ensure that digital tools meet pedagogical goals. Accordingly, LCD is build around four core principles:

(1) **Understanding is the goal:** systems should facilitate the understanding of new concepts
(2) **Motivation is the foundation:** systems must help learners stay motivated in their learning process
(3) **Diversity is the norm:** learners differs in their prior knowledge, goals and learning strategies and systems should answer to all of them
(4) **Growth is the challenge:** systems should evolve with the learner, supporting ongoing skill development

To translate these principles into design practice, Soloway *et al.* introduced the Tools–Interfaces–Learners' Needs–Tasks (TILT) Model (See Figure 1), which provides a framework for designing learner-centered softwares that effectively address learners' particular needs. TILT emphasizes that efficient learning environments must balance tool functionality, interface design, and task structure with an understanding of learners' evolving needs. A central concept on which the TILT model relies is **scaffolding**, referring to the adaptive support provided to learners during the learning process, which should gradually fade as learners gain competences and become autonomous. Besides, drawing on the constructivist learning theory [7], authors also emphasized that learning emerges through dialogue, artifact creation, and communication.

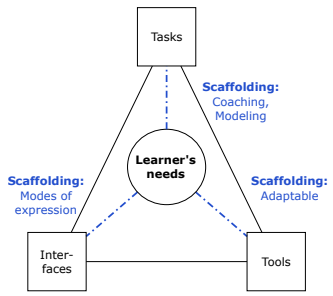

Figure 1: The Tools - Interfaces - Learner's needs - Tasks (TILT) learner-centered model (inspired by the one presented in the original paper [8]).

Through illustrative examples of learning tools (e.g., GoalPlan-Code Editor, MediaText, Emile), Soloway *et al.* illustrated how LCD software can efficiently act not merely as a tool but as a mediator of learning, fostering exploration, reflection, and collaboration. Their

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vision was both practical and aspirational, framing HCI's role in education as a design challenge that brings together technology and educational sciences.

2 RELEVANCE IN TODAY'S CONTEXT

Three decades later, both the educational and technological landscape has transformed dramatically. Digital tools are now ubiquitous, supporting both formal and informal learning across all domains. From online courses and learning management systems to personalized tutors, dashboards, and generative AI assistants, technology is now firmly embedded in today's learning ecosystem [10]. Yet, designing systems that answer specific learners' needs remain strongly relevant, and perhaps even more pressing in our today's digital landscape [1, 9].

The LCD perspective provides a valuable framework for examining both the opportunities and challenges of today's AI-driven learning systems. Modern AI tools have unprecedented capabilities to deliver personalized content, feedback, and guidance, thereby holding great potential to empower learners. However, these same systems also pose risks, as they may affect learners' agency, curiosity, and motivation [3]. This echoes Soloway *et al.*'s idea that "making computers smarter is not incompatible with making people smarter," yet it highlights the need for careful attention to how such systems are designed.

Building on this perspective, the core principles of LCD (understanding, motivation, diversity, and growth) can be examined in greater depth. First, although modern AI systems can provided accurate answers and high-quality outputs, learners may engage passively in the process, showing good performance yet lacking true **understanding** or personal **growth**. Importantly, the widespread adoption of Generative AI tools in educational settings exemplify these challenges [5]. While these tools offer powerful, on-demand and personalized support, they can also undermine learning when providing answers without fostering reflection. In this context, scaffolding, as described by Soloway *et al.*, becomes even more crucial. Current design efforts should therefore focus on scaffolds that guide, question, and adapt dynamically, helping learners progress toward autonomy instead of replacing their cognitive effort.

Second, this shift also reshapes our understanding of **motivation**: with permanent access to on-demand assistance, learners can complete tasks at unprecedented speed. Today's challenge then extends beyond usability to sustaining meaningful engagement throughout the learning process. This calls for new reflections on how motivation can be fostered through design in an age of instant access and automation [2].

Third, the principle of **diversity** is crucial. Differences in digital skills, tools access, and AI literacy [4] raise concerns about equitable support to all learners. Designing fair educational technologies thus requires rethinking design processes to equitably accommodate diverse levels of knowledge, goals, literacies, and learning strategies in an inclusive and equitable manner.

Ultimately, the TILT model remains a powerful framework when designing for learning purposes. Its four components (Tools, Interfaces, Learners' Needs, and Tasks) are still highly relevant to guide the design of systems that balance technological power with pedagogical goals. What has changed is the nature of the tools (now increasingly intelligent and autonomous), the complexity of interfaces and interactions, and the diversity of learners and contexts. In the age of AI, applying TILT remains highly relevant, but it calls for evolving its components to reflect new forms of interaction between learners and AI systems. This evolution should support learner–AI collaboration in ways that leverage the strengths of AI while preserving, and even enhancing, core educational goals.

In sum, Soloway *et al.*'s learner-centered vision continues to resonate in the HCI community more than 30 years after its publication. As educational technologies grow more powerful, the imperative to design for understanding, motivation, diversity, and growth, rather than usability alone, remains central to the HCI agenda.

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