Enhancing Learning Design Workflows with Generative AI using Navigation Support

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Abstract

Learning Analytics (LA) stands as a core pillar in leveraging generative AI for smart learning environments, yet its full potential is notably hindered by critical shortcomings in current AI-assisted Learning Design (LD) tools. While general-purpose AI tools offer interactive flexibility, they neither align with discipline-specific pedagogical frameworks nor embed LA capabilities. To address these gaps, we constructed the research framework around design-aware learning analytics, developing a generative AI-assisted chatbot centered on a specialized navigation bar. For educators who often feel overwhelmed or disoriented when using digital LD tools, the navigation bar provides explicit, structured guidance to enhance their understanding of the platform's workflow. Grounded in the Learning Design Triangle (LDT), the chatbot's navigation bar spans the full LD process, proactively delivering stage-tailored Learning Analytics Questions (LAQs), discipline-adapted cases, and LA solutions via intuitive, step-by-step navigation support. This study provides both theoretical and practical framework support for education, validating the value of human-centered, design-aware generative AI with embedded navigation support.

Keywords

Design-aware learning analytics, Learning Design Triangle, AI-assisted chatbot, Navigation bar

1. Introduction

1.1. Research Background: Learning Analytics Guiding AI-Assisted Learning Design

Generative AI has streamlined educational workflows and bridged design intent with learner outcomes (Gill et al., 2023; Davar et al., 2025), while learning analytics (LA) serves as a key link to validate and optimize learning design (LD) through data feedback (Davar et al., 2025; Raza & Hussain, 2023). However, educators face critical barriers to deep LD-LA integration.

Disconnection between LD and LA: Existing AI tools only generate LD outputs, failing to guide educators in defining multi-level Learning Analytics Questions (LAQs) or linking them to corresponding LA solutions. LA solutions should align with LD stages, Learning Design Triangle (LDT) components, and disciplinary needs, based on LA best practices.

Lack of theoretical grounding: General-purpose AI tools ignore core LD theories (Law et al., 2025), producing outputs that deviate from pedagogical frameworks and disciplinary needs. Notably, LD is a complex, hierarchically nested process spanning course to task levels, and coherence across these levels is critical—an aspect often overlooked (Law & Liang, 2020).

Excessive cognitive load: Curriculum design contributes to educator burnout (Xie & Ding, 2023). Current tools lack structured support for the full LD process, forcing educators to balance discipline adaptability, pedagogical alignment, and LA integration—amplifying workload. LD decisions at all levels require learning sciences-based pedagogical principles, but tools rarely provide explicit guidance for multi-level co-design (Law & Liang, 2020).

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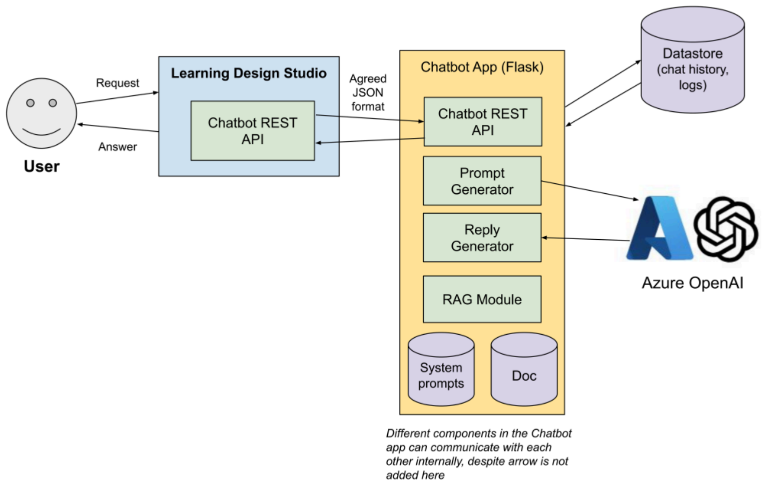

Figure 1: Architecture of AI-assisted Learning Design System.

1.2. Theoretical Core: Key Logic and Value of the Learning Design Triangle

To address tool gaps, this study adopts the Learning Design Triangle (LDT) as the core theoretical underpinning (Law & Liang, 2020). Developed from 60 authentic STEM curriculum units, LDT framework is a practical cognitive tool that clarifies interdependencies among three core LD components-Learning Outcomes (LO), Disciplinary Practice (DP) and Pedagogical Approach (PA), as well as scaffolds a seven-step design process for LA-integrated LD.

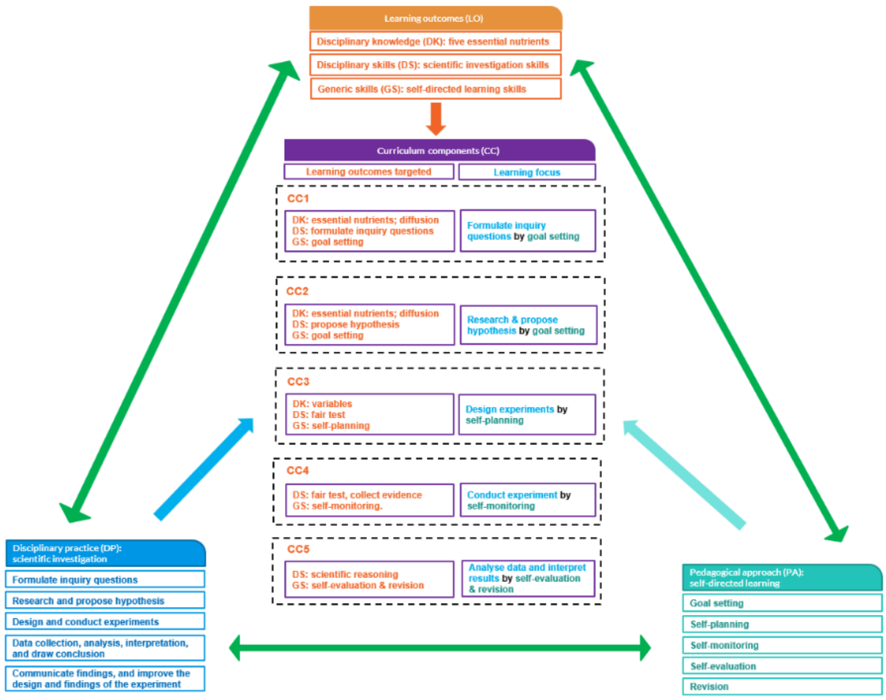

Figure 2: Structure of Learning Design Triangle(Law & Liang, 2020).

LDT's operational framework (Law & Liang, 2020)contains seven steps: (1) Ground LDT (define LO, DP, PA); (2) Sequence curriculum components; (3) Determine pedagogical strategies and task sequences; (4) Design task settings (e.g., social organization, resources); (5) Formulate key LAQs; (6) Select LA solutions (data collection, analytics); (7) Conduct alignment checks. This framework ensures LDT is actionable, addressing LD's multi-level nature and alignment needs. In this structure, LO provides the foundational direction for DP and PA, where DP translates abstract LO into concrete discipline-specific inquiry processes and PA offers high-level instructional frameworks to implement DP effectively, with the effectiveness of all three components validated and optimized through learning analytics to form a coherent closed loop in learning design.

LDT is indispensable for LD-LA integration, but educators' limited familiarity hinders application—highlighting the need for tools that embed LDT into actionable workflows.

2. Navigation Bar for Design-Aware Learning Analytics

2.1. Current Gaps in LD Tools and Needs of Educators

Prior to developing the navigation bar, several comprehensive needs analysis was conducted to identify educators' core pain points in learning design and unmet requirements for AI-assisted tools, reflecting educators' core pain points and unmet requirements.

Novice educators lacked clear guidance on core learning design concepts—such as the distinction between disciplinary knowledge and skills, disciplinary practice, pedagogical approaches like self-directed learning—and frameworks including Bloom's Taxonomy and its digital extension, while non-STEM educators sought discipline-specific templates for intended learning outcomes, curriculum component naming rules, and task sequences instead of generic STEM-focused defaults (Law et al., 2025). Educators also required structured support to formulate learning analytics questions at different levels of design granularity (course, curriculum component, and task levels), match corresponding learning analytics solutions (e.g., mastery grids for quizzes, social network analysis for discussions), and access guidance on data interpretation, alongside needs for operational efficiency such as predefined ILO verbs/phrases, task-elearning tool matching patterns, and clear alignment check criteria (Arista et al., 2023; Mohamed et al., 2024).

This interactive logic grounded on LDT makes it indispensable for LD-LA integration, yet its practical application is hindered by educators' limited familiarity—hence the need for tools that embed LDT into actionable workflows. These findings directly shaped the navigation bar's design priorities, ensuring it addressed real-world educator needs.

2.2. Construction of the AI-assisted Chatbot with Navigation Bar

Drawing on an extended LD-LA integration framework and to remedy the inadequacies, this study develops an AI-assisted learning design chatbot with a specialized navigation bar as a design-aware learning analytics support tool. It not only covers the entire LD process, but also achieves precise matching of "LD stages-LA needs-discipline-adapted resources".

The navigation bar adopts a three-level hierarchical structure, directly mapping the core components of the Learning Design Triangle (LO-DP-PA) and the seven stages of the LD process. This structure makes the logic of the Learning Design Triangle explicit, covers the full range of process needs, and ensures that each stage is associated with corresponding LA support:

Root Level: Core stages of the entire LD process (key links sorted based on educators' core design needs in Learning Design platforms).

Branch Level: Core tasks of each stage (e.g., the "grounding in the Learning Design Triangle" branch includes ILO design, DP definition, PA selection, and Bloom's Taxonomy application), with each branch linked to the corresponding vertex of the Learning Design Triangle.

Task Level: Specific operational modules for LA-related information filling. For example, the "DP design" task includes sub-modules such as discipline-specific DP process templates, DP-LO alignment checks, and LAQs targeting DP effectiveness.

This structure enables educators to clearly perceive the connection logic of "LD stages-Triangle components-core tasks", addressing the rationale gap in tool design while achieving structured coverage of the entire LD process.

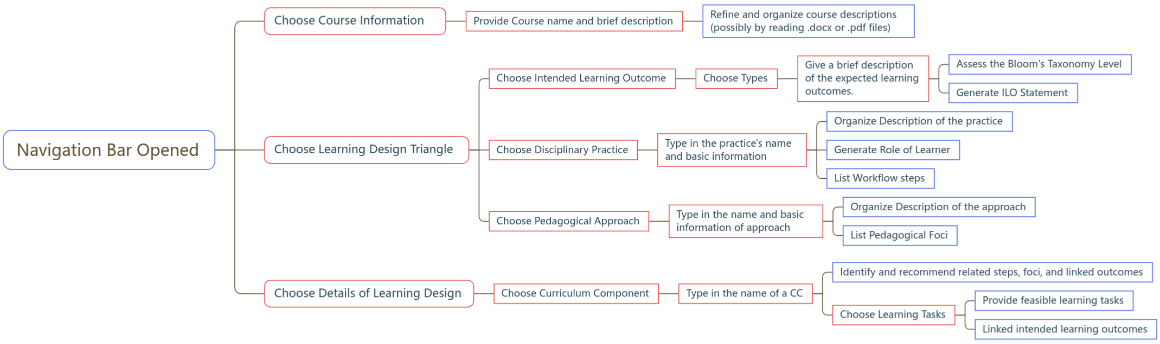

Figure 3: Logical Construction of Navigation Bar Function.

As Figure 2 shows, the navigation bar is developed with a focus on structured interaction, usability, and compatibility with a 3-level hierarchical structure covering eleven tasks settled in an educator-end learning design platform, Learning Design Studio (LDS), building on generic chat input methods with key enhancements:

1. Structured Template Design: The core front-end interactive interface covers the full process stages and discipline-specific needs, capturing LD and LA-related parameters (especially LO-DP-PA alignment information) and adapting to educators' operational habits. Each task is paired with a domain-specific template containing 3 to 6 core parameters.
2. User-Centric Interaction Optimization: Replace mainstream AIs' single-line with to support multi-line template display, facilitating clear parameter separation and reducing cursor navigation effort; also set auto-selection of the first placeholder after template loading, enabling direct content input without manual cursor positioning.
3. Natural Language Interaction Module: Supporting natural language generation and interaction based on generative AI technology, ensuring that outputs comply with educational pedagogical frameworks, disciplinary DP-PA characteristics, and LA matching logic, and guaranteeing interactive fluency and professionalism.

The navigation bar is embedded within the chatbot interface of LDS, achieving seamless ecosystem compatibility. The integration workflow is as follows: (1) Educators access the navigation bar within the LDS chatbot; (2) By selecting a stage/branch from the navigation bar, a predefined template is automatically populated in the chat input area (as shown in Figure 4); (3) Educators fill in the template with context-specific information; (4) The filled template is sent to the chatbot as structured prompt context; (5) The chatbot generates outputs aligned with LDT, discipline needs, and LA logic.

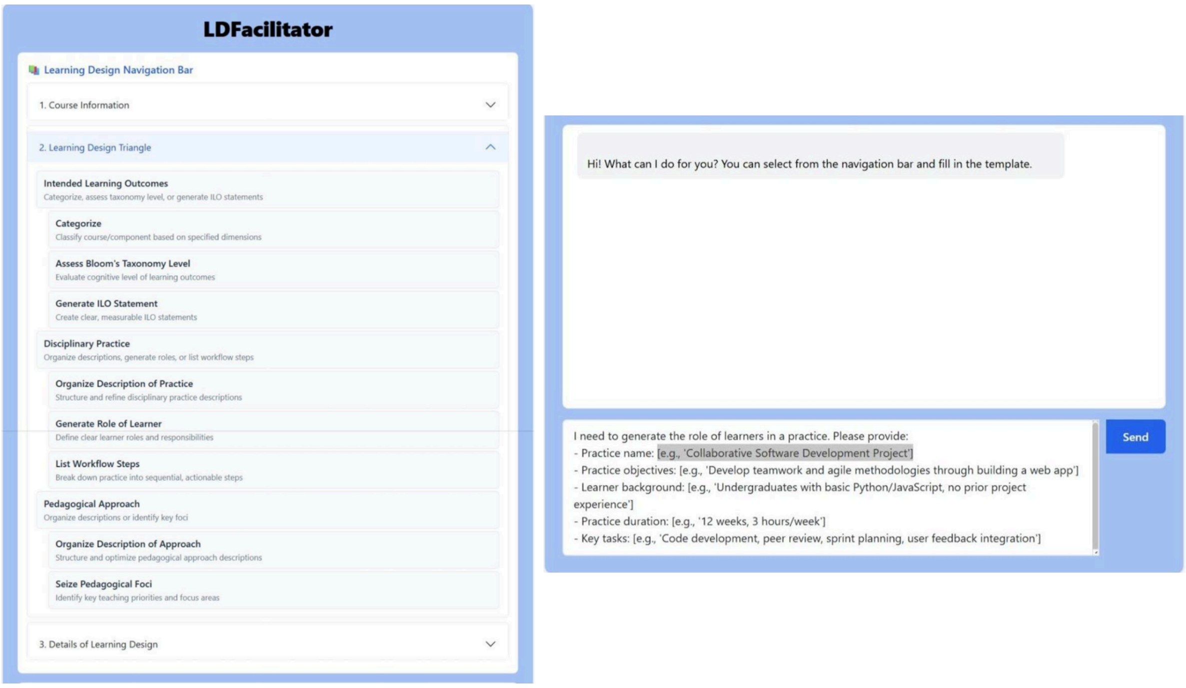

Figure 4: User Interface of Chatbot with Navigation Bar and Templates.

This integration enables the LDS chatbot not only to generate learning design outputs but also to deliver context-aware LA solutions anchored in the Learning Design Triangle, thereby significantly enhancing the practical value and usability of LD intelligent support capabilities.

3. Method: Pilot Trial

3.1. Pilot Trial Design

As an experimental function, We recruited a group of human-AI interaction education researchers (ranging from educational backgrounds to technical backgrounds) to participate in the pilot trial and collect feedback to comprehensively evaluate the navigation bar. The trial adopted a mixed-methods design, combining semi-structured interviews (30-minute individual sessions), task performance surveys (5-point Likert scale), and interaction log analysis:

1. Which functions of the navigation bar do you find most helpful for your learning design ?
2. When you encounter uncertainties about educational frameworks during learning design tasks, does the navigation bar-aided chatbot provide accurate guidance?
3. What functional needs specific to your discipline do you hope the navigation bar can add or optimize?
4. How would you compare the efficiency of completing learning design tasks with the navigation bar-aided chatbot vs general-purpose AI tools?
5. Are there any aspects of the navigation bar's interaction experience that need improvement? Please give specific suggestions.

3.2. Trial Feedback

The pilot trial focused on identifying functional limitations, interaction barriers, and discipline-specific needs of the tool. Results were analyzed through thematic analysis (for interview responses, coding and categorizing feedback into core themes) and descriptive statistics (for survey data, calculating mean scores and standard deviations). Key findings from the feedback were synthesized into core existing problems and targeted improvement suggestions, as summarized in the table below.

Table 1
Existing Problems of the Navigation Bar-Aided Chatbot and Corresponding Improvement Suggestions

Existing Problems	Improvement Suggestions
At present the tool is limited in individual-use scenarios, which constrains its utility in contexts requiring multi-educator coordination.	For courses delivered through team teaching models, the integration of collaborative functionalities—such as a shared repository of learning design templates and real-time synchronization of design elements would enhance the tool's applicability to collaborative learning design workflows.
Ambiguity in the navigation bar's placeholder text presented usability barriers for users.	Embed exemplar content directly in placeholder fields to establish explicit reference frameworks for educators, mitigate input formulation uncertainty, and strengthen alignment between user inputs and the chatbot's predefined output criteria.
Current navigation bar templates are overly generic, lacking discipline-specific information input guidance.	Design differentiated templates for courses across different disciplines to provide a discipline-specific information input framework for the chatbot.

These findings not only validate the tool's initial value in streamlining individual LD tasks but also provide clear, actionable directions for iterative optimization. Addressing the identified problems will enable the navigation bar-aided chatbot to better meet the diverse needs of educators across disciplines and collaboration modes.

4. Future Directions

The future optimization of the navigation bar aims to further deepen the interaction between Chatbot and users, strengthen LDT framework popularization, and expand team collaboration capabilities—moving beyond the traditional question-and-answer format to a 'collaborative intelligence' model.

1. Discipline-Specific Interface Templates: Three preset navigation templates will be provided for STEM, Humanities, and Vocational Education. For example, the STEM template will highlight "Lab Resource Matching" under the "Disciplinary Practice" branch, while the Humanities template will emphasize "Reading List Alignment" in ILO generation, supporting one-click switching based on course type.
2. Collaborative Workflow Enhancement: Introduce role-based access control and real-time collaborative editing features to support multi-educator teamwork. Team leaders can assign roles with customized permissions, while all members can view and edit real-time updates. The chatbot will automatically track version history, generate change logs, and facilitate comment-based feedback exchanges to enable coordination in team teaching scenarios.

These optimizing directions will further strengthen the human-centered nature of the AI tool, not only promoting its deeper integration with diverse educational scenarios but also delivering more refined, collaborative-focused support for educators' learning design work. By facilitating seamless multi-educator coordination, role-based collaboration, and shared data-driven optimization, the tool will better align with the project's core direction of supporting team use, empowering educators to co-construct high-quality LDs in smart learning environments.

Declaration on Generative AI

During the preparation of this work, the authors used ChatGPT-4o and Doubao in order to: Grammar and spelling check. After using these tools, the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

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