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Research Article

Exploring the Structural Logic and Learning Path of Prompt Language in AI-Assisted Interaction Design

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Abstract

With the rapid development of generative artificial intelligence (AI), prompt language has emerged as a crucial interface for human–AI collaboration, reshaping interaction design processes and the practice of design thinking. This study situates itself within an interaction design course, integrating the five-stage model of design thinking (empathize, define, ideate, prototype, test) with project-based learning to systematically explore the structural characteristics and cognitive pathways of prompt language. By analyzing 362 prompts created by 64 students, the study identifies five types of prompt structures—directive, descriptive, narrative, comparative, and hybrid—and reveals their significant impact on the accuracy, stylistic consistency, and creativity of the AI-generated content. Furthermore, the study proposes a "Prompt Interaction Design Model," highlighting that prompt language in AI-assisted design functions not only as a task-oriented tool but also as a medium for expressing design thinking and as a vehicle for learning and reflection. This model provides a practical and operable language training framework for design education, enabling students to develop skills in prompt crafting, critical thinking, and creative experimentation. Ultimately, this research contributes to the pedagogical integration of AI tools in design education, offering insights for educators aiming to enhance AI literacy and foster innovative design practices among students.

Keywords

Generative Artificial Intelligence, Prompt Language, Interaction Design, Design Thinking, Project-Based Learning, Human–AI Collaboration

1. Introduction

In recent years, the rapid development of generative artificial intelligence (Generative AI) has been profoundly reshaping the creative paradigms and thinking models within the field of design. Since the launch of ChatGPT by OpenAI, the transformation of image generation by Midjourney, and Uizard's exploration of interface automation, AI tools have evolved from being mere "assistive tools" to becoming "co-creation partners." This shift not only influences the executional aspects of design but also triggers a fundamental transformation in design education and practice methodologies [1, 2]. Particularly in the field of interaction design, AI has been widely integrated into stages such as user research, prototype generation, and interface optimization—bringing the communication between designers and AI to the forefront of discussion.

Prompt language is gradually becoming a key interface that

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bridges human design intentions and AI generative capabilities. A prompt is not merely an operational command; it has evolved into a "design-driven prompt language" that integrates grammatical rules, interactive semantics, and the expression of design intent. It features a high degree of integration across task description, style control, and contextual setting [3]. The way prompts are constructed not only affects the accuracy and stylistic consistency of AI outputs but also, more subtly, reshapes designers' cognitive pathways, creative logic, and modes of interaction [4].

Current research on prompt language is largely concentrated in the field of computer science under the domain of prompt engineering, with a focus on template construction, few-shot learning paradigms, and in-context learning mechanisms [5, 6]. However, systematic studies on the linguistic structures, pragmatic logic, and collaborative mechanisms of prompts within design contexts remain limited. In the realm of generative design education and practice, prompt language has emerged as a new form of "design grammar." Yet, its structural types, semantic composition, and modes of expressing interactive intent still lack a clear framework and theoretical foundation.

In the workflow of interaction design, how prompt language can be embedded into the various stages of design thinking has become a topic worthy of in-depth exploration. As a human-centered and problem-driven approach to creative problem-solving, design thinking typically consists of five stages: Empathize, Define, Ideate, Prototype, and Test [7]. Recent studies have shown that, with the support of generative AI, designers demonstrate varying degrees of dependence on prompt language, employ different strategies, and engage in distinct interaction patterns across these stages [8].

Prompt language not only serves a technical function for retrieving information and generating task outputs, but also plays a significant design role in the Ideate and Prototype stages—enabling creative expansion and style control. It is gradually evolving into a "co-creative language interface" with semantic structuring and cognitive guiding capabilities.

Do structural differences in prompt language significantly affect the accuracy, creative expression, and stylistic consistency of AI-generated outputs? When designers engage in AI co-creation using prompts, do their linguistic formulations, revision strategies, and cognitive pathways exhibit identifiable behavioral patterns? These questions remain largely underexplored, lacking systematic empirical research and theoretical frameworks. They call for further investigation and modeling from an interdisciplinary perspective that bridges interaction design and cognitive science.

This study situates itself within the context of AI-assisted interaction design education, focusing on the structural logic and cognitive mechanisms of prompt language in generative design processes. It aims to systematically explore the linguistic composition, semantic features, and interaction strategies of prompts, and to construct a Prompt-Centered Human–AI Co-Creation Language Model to support future innovations in AI-driven design education and practice. The research seeks to contribute both a new theoretical foundation and practical methodology for generative AI in design education, and to offer a design-oriented academic perspective on the structural and pragmatic logic of prompt language. This study will explore the following core questions:

1) RQ1: What are the structural components and expressive logic of prompt language in the interaction design process?
2) RQ2: How do different prompt language structures influence the accuracy, stylistic consistency, and creativity of AI-generated outputs?
3) RQ3: What patterns emerge in designers' linguistic formulation, revision strategies, and cognitive behaviors when using prompts for AI co-creation?
4) RQ4: How can a Prompt-Centered Human–AI Co-Creation Language Model be constructed to support future AI-driven design practices?

2. Literature Review

The article should be written in English. An article should be between 6 and 25 pages, and exceed 2000 words. For original research articles, it should include the headings Introduction, Materials and Methods, Results, Discussion and Conclusions. Other types of articles can be written with a more flexible structure.

2.1. The Application of Generative Artificial Intelligence in Design

With the rapid advancement of generative artificial intelligence (Generative AI), its capabilities in text, image, interface, and scene generation continue to expand, ushering in a new paradigm of human–AI co-creation in design activities [5]. In the fields of interaction design and user experience, AI is no longer merely a tool for enhancing efficiency; it is increasingly integrated into the entire design thinking process—from needs exploration and concept development to prototyping and feedback testing—becoming deeply embedded in design decision-making [8]. Recent studies have begun to examine the impact of generative AI on the design process. For example, Muehlhaus et al., drawing on the five-stage Design Thinking Model (Empathize, Define, Ideate, Prototype, Test), point out that the modes of interaction between designers and AI vary significantly across different stages. Their findings indicate that prompt language is used most frequently in the Ideate and Prototype stages, where it plays a particularly critical role in facilitating creativity and controlling stylistic outcomes.

2.2. Structural Characteristics and Controllability of Prompt Language

Prompt language, which refers to the “instructions” or

"input phrases" that guide generative AI to produce content, was initially used as an operational interface widely applied in fields such as natural language processing (NLP) and computer vision. With the advancement of multimodal models, the form of prompt language has gradually evolved from simple input commands to a more integrated expression that combines task guidance, stylistic configuration, and contextual understanding [6]. Prompt is now regarded as a linguistic system equipped with syntactic structure, contextual semantics, and interactive logic, offering a high degree of control over generated outcomes (Liu et al., 2023). Current research on prompt engineering primarily focuses on model optimization strategies, such as few-shot learning and chain-of-thought prompting [5, 9]. However, in the context of design, the structural composition, semantic expression, and integration mechanisms of prompt language with design thinking remain in a theoretical exploration stage. As an embedded language interface, the design logic and cognitive mechanisms underlying prompt language have yet to be fully revealed.

2.3. Prompt Language Learning and Cognitive Mechanisms in Design Education

As generative AI continues to play an increasingly important role in design education and collaborative practice, prompt language is gradually being recognized as a key medium for fostering interdisciplinary collaboration and value co-creation. It has become one of the core competencies for design students engaging in AI co-creation. The process of learning prompt language involves not only linguistic construction, but also cognitive modeling, strategic planning, and outcome evaluation across multiple levels. Some scholars have observed that the learning trajectory of prompt language follows a progressive path of imitation – templating – personalization. In the early stages, students often rely on example-based imitation. They then develop structural templates based on task types and stylistic goals, and eventually form personalized prompt models characterized by expressive fluency and strategic control [8].

The introduction of generative AI is reshaping the practice of Project-Based Learning (PBL), particularly in courses that integrate design and technology. Zheng et al. [10] through a co-creative study conducted with students, argue that AI functions not merely as a task execution tool in the learning process, but also as a medium for cognitive expansion, expressive articulation, and reflective engagement. In their "AI-PBL Co-Creation Exploration" model, prompt language plays a dual role as knowledge scaffolding and expressive control. The study reveals that students gradually develop personalized strategies for constructing prompts in generative tasks, enhancing their command of the language through cognitive behaviors such as trial-and-error, adjustment, analogy, and imitation. This process not only demonstrates the staged evolution of prompt language along the learning pathway but also highlights its value in supporting the development of design thinking. Prompt, therefore, is not merely a functional input—it serves as a "co-constructed language" in education, facilitating students' ability to build more complex systems of understanding in interdisciplinary creative work.

Kučević et al. [11] proposed the "Prompt-a-thon" model for teaching and practice—a workshop-based approach centered on prompt construction that brings together diverse participants (designers, researchers, developers) to collaboratively explore AI-assisted design problem-solving pathways. This method not only emphasizes the linguistic characteristics and strategic formulation of prompts but also validates their generative guidance, knowledge structuring capabilities, and the teachability and learnability of human–AI interaction logic within co-creative processes. The study suggests that prompt language is not merely an "output trigger" but also a medium that facilitates cognitive negotiation and design co-agency. In generative design contexts, the conception, evolution, and iteration of prompts themselves constitute a vital part of the co-creation mechanism. This highlights the need to construct a methodological framework of "prompt-as-design" from the perspective of linguistic behavior.

Prompt language can also be regarded as a meta-language of design, where structural variations may lead to significant differences in the accuracy, creativity, and stylistic consistency of AI-generated outputs. The linguistic strategies, logical pathways, and cognitive behaviors adopted by designers during the construction and revision of prompts gradually manifest as a stage-based evolutionary pattern of design language behavior [12].

Current studies have begun to focus on how generative AI reshapes the design process and the task performance of prompt language. However, several critical gaps remain: Lack of systematic research on the ontology of prompt language: Analyses of its syntactic structures, semantic composition, and interaction features are still underdeveloped; Neglect of the dynamic characteristics of prompt language in design contexts: Most existing research emphasizes technical implementation, without tracking the functional shifts of prompts across different stages of design thinking; Scarcity of studies on prompt learning paths and cognitive mechanisms: Research on how designers or students formulate, iterate, and evolve prompt strategies is still in its early stages. Therefore, it is necessary to approach prompt language from a design-oriented perspective, integrating methods such as corpus analysis, design experimentation, and cognitive modeling. This study aims to explore the structural logic, generative impact mechanisms, and learning trajectories of prompt language within the interaction design process, and to construct a systematic Human–AI Co-Creation Language Model that can support future AI-assisted co-creative practices and design education.

3. Materials and Methods

This study adopts a combined qualitative and case analysis approach, focusing on the structural logic and learning pathways of prompt language in generative AI–assisted interaction design education. The research was conducted within the context of an interaction design course for third-year undergraduate students majoring in Digital Media Art at a university in China. Two parallel classes were selected as the study sample, totaling 64 students (32 students per class).

The project employed Project-Based Learning (PBL) as the core instructional strategy over an 8-week period. This method emphasizes student-centered, problem-oriented learning, aiming to enhance comprehensive capabilities through a "learning by doing" process [10]. The course theme was "AI + Interaction Design," and students were grouped into 21 project teams, each consisting of 2 to 3 members, tasked with developing creative solutions for real-world interaction design scenarios.

In terms of instructional design, the study integrated three key components: generative AI tools, interaction design processes, and design thinking methods. Students were guided through the five stages of design thinking—Empathize, Define, Ideate, Prototype, and Test—to complete a full project cycle. At each stage, students were required to use generative AI tools (such as ChatGPT, Midjourney, Uizard, etc.) to construct prompts in order to accomplish the following tasks: Problem scenario analysis and persona construction (Empathize & Define); Creative ideation and style exploration (Ideate); Prototype content generation and interface development (Prototype); User testing and feedback refinement (Test).

The research process adopted a multi-phase data collection approach, which primarily included the following components: Prompt corpus collection: Prompts written by each student group at different stages were collected, resulting in a total of 362 initial entries. These prompts were categorized and organized for structural analysis and word frequency statistics; Interviews and observation records: Semi-structured interviews were conducted with 16 representative students to understand their prompt construction logic, revision strategies, and reflections on language behavior; Learning journals and analysis of generated outcomes: Students submitted weekly learning journals along with their AI-generated outputs—including images, text, and interface designs—which were analyzed to examine the relationship between prompt strategies and generation results; In addition, the course incorporated a tool called the Prompt Mapping Canvas to guide students in clarifying their prompt objectives, syntactic structures, and contextual strategies at each stage. This supported the gradual development of their prompt control skills and cognitive logic. Through a systematic analysis of prompt construction behaviors, language evolution pathways, and cognitive feedback mechanisms, this study aims to explore the structural logic and learning patterns of prompt language in AI-assisted design education, thereby providing theoretical support for the future development of instructional methods and tools in generative design education.

4. Data Analysis

This study focuses on the structural logic and learning pathways of prompt language in generative AI–assisted interaction design education. It conducts a systematic analysis by integrating prompt text analysis, student interviews, learning journals, and generated outcomes. Through cross-stage and cross-group comparisons and synthesis, the following preliminary research findings have been identified.

Based on an analysis of 362 prompt samples, five distinct types of prompt structures were identified. Task-oriented prompts (29%) explicitly specify a generative objective, such as "design an interface for children." Style-controlled prompts (23%) focus on visual language, emphasizing elements like style, texture, and mood—for example, "generate an app interface in a minimalist style." Format-driven prompts (17%) center on the structure and formatting of output, such as "generate a three-part copy with a specific tone." Context-guided prompts (15%) guide AI generation by setting user scenarios or problem contexts to ensure relevance. Lastly, iteratively refined prompts (16%) emerge from multi-round prompt adjustments, aiming for greater precision in details and output control, see Figure 1. These structural types reflect diverse strategies students employed to communicate intent, shape style, and control outcomes in AI-assisted design tasks.

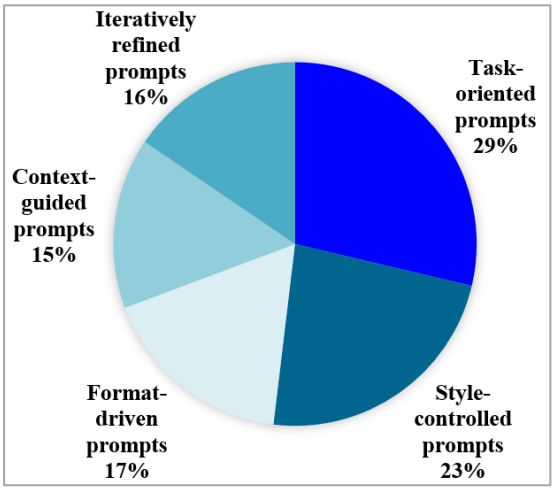

Figure 1. *Prompt Language Structure Types.*

4.1. Correspondence Between Prompt Structure and Generated Content

Through an analysis of the relationship between prompt language and AI-generated outputs (including images, text,

and interface designs), the study found that prompts with clear structure and precise semantics are more likely to produce stylistically consistent and information-rich results. This is particularly evident in visual design tasks, where prompts that include elements such as color, composition, and scene description tend to perform better. Style-controlled prompts produce content with stronger visual expressiveness, though they often exhibit lower creative divergence. In contrast, context-guided prompts show higher contextual relevance, especially in generating interactive text and user scripts. Iteratively refined prompts can significantly improve output quality, but require students to possess stronger cognitive feedback abilities and prompt control skills. For example, in the ideation phase, one student group used the prompt: "design a futuristic smart home interface for elderly users with large fonts and voice assistance." The initial results were relatively generic. After multiple rounds of refinement, adding more contextual and stylistic parameters—such as: "a minimalist voice-based smart home UI in black-and-white theme with oversized icons for elderly with mild dementia"—the generated outputs showed marked improvements in both interface structure and stylistic control.

4.2. Students' Prompt Construction and Cognitive Strategy Patterns

Based on interviews and observation records from 16 students, the research team identified a three-stage cognitive evolution model in students' prompt-writing processes. In the initial stage, students tended to imitate examples or apply templates directly, relying heavily on teacher guidance or system suggestions—characterized by template dependency and format replication. In the development stage, they began experimenting with contextual expression and task refinement, paying more attention to the feedback from AI-generated outputs. This stage involved strategies such as scenario setting, keyword optimization, and trial-and-error adjustments. By the mastery stage, students were able to construct more complex sentences independently, integrating task goals, stylistic preferences, and structural logic to form personalized strategy systems—demonstrated through custom prompt structures, detail control, and multi-round interactions. Many students reflected, "At first, I just tried to describe what I wanted. Later, I realized that the tone, order, and choice of words in the prompt directly affected how the AI drew the image or wrote the content." This illustrates that prompt language is not merely a technical input, but a learnable and trainable linguistic skill with distinct cognitive and strategic developmental patterns.

4.3. Prompt-Driven Interaction Design Model

This model positions prompt language behavior as the core driving force, embedded within the five stages of the design thinking process (Empathize, Define, Ideate, Prototype, Test). It emphasizes that prompts are not merely operational interfaces for tools, but serve as a cognitive language interface that facilitates the co-interaction among the human, the AI, and the problem context, see Table 1.

Table 1. *Prompt Template for Interaction Design.*

Design Thinking Stage	Design Goal	Prompt Statement
Empathize	user personas and analyze usage scenarios	*Describe a typical user scenario for a visually impaired person using a smart home interface.*
Define	Identify design pain points and key user needs	*Summarize the main pain points faced by elderly users when interacting with mobile interfaces.*
Ideate	Stimulate creativity and define stylistic direction	*Generate 5 different UI design directions for a meditation app in minimalist style.*
Prototype	Generate interface content or prototype elements	*Design a mobile login interface for a financial app with a dark theme, including logo, input fields, and CTA buttons.*
Test	Simulate user dialogues or testing scenarios	*Write a sample user dialogue testing the chatbot's ability to recommend restaurants based on dietary preferences.*

4.4. Case Study: AI-Assisted Cultural Puzzle App Design Based on Ningbo Traditional Architectural Woodcraft

This case presents a project from the course that exemplifies the structured application of prompt language in a full-cycle interaction design process. The project focuses on designing an educational and cultural puzzle application inspired by traditional wooden construction techniques found in Ningbo's heritage architecture, such as mortise-and-tenon joints, bracket sets, and carved beam patterns.

The design follows the five-stage design thinking model, with prompt language used strategically at each stage to guide ideation, visual direction, content generation, and user testing.

See Table 2.

Table 2. Prompt for AI-Assisted Cultural Puzzle App Design Based on Ningbo Traditional Architectural Woodcraft

DesignThinking Stage	Design Goal	Prompt Statement
Empathize	Construct user personas and analyze scenarios	*Describe a typical user persona of a primary school student who visits a heritage museum in Ningbo and is interested in interactive wooden architecture exhibits.*
Define	Identify user needs and pain points	*List the main challenges children face when trying to understand complex wooden structure systems in ancient buildings.*
Ideate	Generate creative ideas and stylistic direction	*Generate five UI concept directions for a mobile puzzle app teaching Ningbo wood joinery techniques using traditional Chinese visual styles (e.g., ink wash, woodblock).*
Prototype	Develop interface layout and content elements	*Design a puzzle-solving interface where users drag and fit different mortise-tenon parts to reconstruct historical wooden joints. Include UI elements such as animated hints and culturally styled icons.*
Test	Simulate user interaction and feedback loop	*Write a sample dialogue of a child testing the app, expressing confusion and excitement while solving a puzzle on reconstructing a beam-bracket system.*

5. Results

This study centers on prompt language within the context of generative AI–assisted interaction design education and conducts a systematic empirical analysis and theoretical discussion addressing the four research questions (RQ1–RQ4). The specific findings are as follows:

RQ1: What are the structural components and expressive logic of prompt language in the interaction design process?

The study finds that students' prompts written at different stages exhibit clear structural compositions, which can be categorized into five main types: task-oriented, style-controlled, format-driven, context-guided, and iteratively refined. These structural types demonstrate a stage-specific distribution throughout the design process: early stages focus on task and style, mid-stages emphasize scenario construction and output formatting, while later stages tend to involve fine-tuning and detailed adjustments. This indicates that prompt language has evolved from simple commands into a "structured generative language" with layered semantics and task-oriented logic.

RQ2: How do different prompt language structures influence the accuracy, stylistic consistency, and creativity of generated outcomes?

Through a one-to-one analysis of prompt samples and their corresponding AI-generated content, the study reveals that prompts with clearer structure and more specific semantics tend to produce more accurate and stylistically consistent results. Prompts that embed usage contexts or adopt a user-centered perspective are more likely to stimulate creative output. Notably, style-controlled prompts demonstrate strong visual expressiveness in image and interface generation, while context-guided prompts show higher contextual relevance in interactive text and user script generation. Overall, the structure type of a prompt directly impacts the quality of the generated outcomes.

RQ3: What patterns emerge in designers' linguistic formulation, revision strategies, and cognitive behaviors when using prompts for AI co-creation?

Through interviews and classroom observations, this study identifies a three-stage cognitive evolution model in students' prompt construction process: the template imitation stage (reliance on examples with simple structures), the contextual debugging stage (keyword optimization and repeated trial-and-error), and the strategic mastery stage (complex constructions that integrate task objectives, stylistic cues, and grammatical structure). This progression demonstrates that prompt language is not merely a functional input, but a lan-

guage skill characterized by cognitive strategies and behavioral patterns.

RQ4: How can a Prompt-Centered Human–AI Co-Creation Language Model be constructed to support future AI-generated design practices?

Based on the analysis of prompt language structure types, usage strategies, and learning pathways, this study proposes a preliminary prototype of a Prompt Co-Creation Language Model. The model consists of four core components: Intent Definition, Semantic Framing, AI Feedback, and Strategic Iteration. It emphasizes the dynamic adaptability and interaction-guiding role of prompt language within the design thinking process. At the tool level, the integration of the Prompt Mapping Canvas in instructional practice further validates the model's feasibility, providing a theoretical foundation for the future development of educational systems and AI co-creation platforms.

This study systematically reveals the structural logic, generative mechanisms, and cognitive pathways of prompt language in AI-assisted interaction design, and proposes a preliminary model for human–AI co-creation language. The findings not only enrich the perspective of design language research but also offer practical teaching strategies and tool design references for generative design education.

6. Discussion

In this section, authors are advised to provide a thorough analysis of the results and make comparisons with relevant literature, not a short summary or conclusion. Any future research directions could also be stated in the discussion.

7. Conclusions

This study systematically explores the structural logic, generative mechanisms, and cognitive pathways of prompt language within the context of AI-assisted interaction design education. Through multi-modal data collection—including prompt corpus analysis, student interviews, learning journals, and generative outcomes—the research identifies five distinct prompt structure types and proposes a three-stage cognitive evolution model in student prompt construction behavior.

The findings reveal that prompt language has evolved from a simple input instruction into a structured, task-oriented design language with layered semantics and adaptive interactivity. Different prompt structures significantly influence the accuracy, creativity, and stylistic consistency of AI-generated outputs. Moreover, students' ability to formulate, refine, and strategically control prompts progresses through imitation, contextual experimentation, and personalized mastery—demonstrating that prompt writing is not only a technical skill but also a learnable and trainable cognitive practice.

Building upon these insights, the study introduces the Prompt-Driven Interaction Design Model (PDIDM), which integrates prompt behavior into the five stages of design thinking. This model conceptualizes prompts as cognitive language interfaces that mediate the co-creation process between humans, AI, and problem contexts. The use of tools such as the Prompt Mapping Canvas further supports the operationalization of this model in design education.

Overall, this research offers new theoretical perspectives and practical tools for generative design education. It contributes to a deeper understanding of prompt language as a meta-language of design and provides a foundation for future instructional models and AI co-creation systems that emphasize language-driven design thinking.

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Author Contributions

Xin Kang: Conceptualization, Methodology, Formal Analysis, Writing – original draft, Project administration, Funding acquisition

Xin-Zhu Li: Data curation, Investigation, Writing – review & editing, Resources

Xiao Xia Bai: Supervision, Validation

Yi Zhang: Writing – review & editing

Shiyi Chen: Data curation

Keying Wang: Visualization

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Conflicts of Interest

The authors declare no conflicts of interest.

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