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Computer-aided Instruction in Ideological and Political Courses Combining the Interactive Influence Distance Learning Model

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Abstract:
To stimulate the innovative thinking of students, the internal relationship between the "Analysis-Synthesis-Evaluation" process model, the "Width-Depth First-Opportunistic" design strategy and the "Divergent-Convergent" thinking pattern are explored from the cognitive perspective: The thinking pattern of students promotes the design practice to follow the design process, and the design strategy is taken as the implementation principle for continuous implementation to establish an interactive influence distance learning model. Cognitive experiments and Linkography data analysis methods are used to verify the effectiveness of the model. Based on the interactive influence distance learning model, according to the thinking characteristics of the design process and the design strategy selection preference principle, the system resources that support the computer-aided innovation design of the ideological and political courses are organized and pushed to establish the computer-aided instruction in ideological and political courses in compliance with the law of interactive influence distance learning and inspiring the students' internal thinking mechanism, laying a theoretical basis for establishing highly efficient computer-aided innovation system for ideological and political courses.

Keywords: *Interactive Influence Distance Learning; Design Cognition; Ideological and Political Course; Computer-aided Innovation; Product Design*

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I. INTRODUCTION

The research on computer-aided innovation (CAI) design for ideological and political courses is a research hotspot in the field of product innovation design. The CAI design system mainly supports innovative design by organizing, configuring, and pushing various resources. The existing studies mainly focus on three aspects as the following [1-2]: ① Provide knowledge bases and information sources related to design to expand problem and solution space, enlarge the incentive categories for innovative design, and increase the success rate of CAI design; ② Provide innovative methods and theories (such as the Theory of Invention Problem Solving, TRIZ), the Quality Function Deployment (QFD), the Failure Modes and Effects Analysis (FAME), which has increased new methods, ways, and means for the use of relevant design resources [3-4]; ③ Provide visual modeling tools such as

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Computer Aided Design (CAD) for ideological and political courses to increase the visibility of design ideas and reduce the cognitive load of design. These skills can help students pay more attention to the innovative design itself to achieve the goal of supporting innovative design [5-6].

The current CAI system has achieved good results and gained extensive recognition. However, there are also problems such as low efficiency and relatively weak targeting for innovative design, etc. [7] One of the leading causes of these problems is that facing all kinds of design resources with explosive growth and information redundancy, the key to CAI system successful assisting design innovation has been transformed from providing abundant design resources to pushing the right resources for the right people at the right time. However, at the current stage, the CAI system is established to ensure design freedom. There are relatively few studies on the accurate, efficient, and systematic design of resource organization and push principles for the purpose of reducing design cognition load [8-9]. Product innovation concept design is a complicated intelligent behavior, which involves the students' thinking patterns as well as the design process, design strategy, interaction between system resources, reasoning, search, etc., in which the students' inherent thinking patterns, design process organization habits, and design strategy choice preferences are the main factors affecting the final innovation of product concept design. Hence, the design and implementation of a new generation of CAI design support tools shall be based on the cognitive rules of design and can inspire the students in their thinking [10].

In this paper, the inherent thinking pattern characteristics and design strategy selection preference rules in the process of product innovation concept design are explored. The product interactive influence distance learning model is established to further concretize the abstract interactive influence distance learning law and guide the structure of the CAI design process based on its design resources organization and pushing principle. The CAI design process is organized and constructed based on the students' thinking characteristics and design strategy selection preferences at various design stages as the principle, which is conducive to enhancing the effectiveness of design strategies and design resources, and improving the students' thinking inspiration efficiency, and providing useful exploration for building a more accurate and effective CAI system that supports conceptual innovation.

2. Study of Interactive Influence Distance Learning

The concept of interactive influence distance learning was first proposed by Law-son. In the interactive influence learning, the fuzzy attribute in the design process is expressed by means of description. Scholars in the design field expect to learn from the innovative relationship of the students' behavior, design process, and design products and explore the thinking components and their structural relationships that generate excellent design, to obtain the inherent thinking law of design. In the process of product design, the research on students' design process, thinking pattern, and design strategy model, as well as their relationship, is an crucial aspect to explore the inherent laws of design, which can provide a theoretical basis for the creation of incentive design innovation in essence and contribute to the CAI design process that conforms to the cognitive law.

At present, many results have been achieved in the research on the respective fields of design process, thinking pattern and design strategy. For example, "Analysis-Synthesis-Evaluation" (ASE) is considered to be the most basic and minimal unit design process model. The ASE process forms the framework of planning and organizational design behavior, which is the flexible unit of the design process. In the conceptual design process, students first pay attention to the

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analysis of the problem, then focus on the synthesis and evaluation of the scheme, while numerous ASE cycles run through the conceptual design process. Innovative thinking includes "divergent-convergent" thinking. Through the divergent thinking, the generation of novelty is implemented. Through convergent thinking, the assessment of novelty is implemented. The transition between processes is the path of divergent thinking, and convergent thinking is related to the process of turning concepts into concrete structures. "Depth first – width first" is a structured design strategy. Opportunistic design strategy is a rapid transfer within and between structured design strategies, and also a design strategy that promotes the sudden occurrence of "epiphany" and other phenomena. The design strategy is the guiding principle to deepen and shift the design focus. Previous literature studies have shown the designer's application of depth first and width first design strategies, as well as the generation and generation of opportunistic strategies. At the same time, domestic and foreign scholars also focus on studying the relationship between the design process and thinking pattern and applying it to CAD. For example, Krys-sanov et al explored the role of "Analysis-Synthesis" mechanism and "Divergent-Convergent" thinking in promoting innovation; Liu et al. discussed the relationship between the design process and thinking pattern at the macro level, established an ideal model and applied it to the construction of CAI design system; Geb-hardt et al. [18] constructed a computer-aided system of ideological and political courses based on the "divergence-convergence" thinking pattern and the "analysis-synthesis" process in the form of multi-model reasoning. Previous studies only considered the internal relationship between the design process and the thinking pattern as well as its application. The interactive influence distance learning law research results thus obtained are too abstract and theoretical. Hence, it is difficult to apply the results directly to guide design practice and CAI design. However, rich design strategies and resources are one of the main characteristics of CAI design. Combining design strategy with internal relationship research of design process and thinking pattern is conducive to the construction of a highly efficient CAI design process. In this paper, the students' thinking pattern characteristics and design strategy selection preference laws at different stages of the design process are explored. Based on the ASE design process as the reference, with the "divergence-convergence" thinking pattern as the driving force, an interactive influence distance learning model is established with the width-depth first design strategy as the implementation criteria. The interactive influence distance learning model is closely related to the design strategy and the organization of resources so that the abstract interactive influence distance learning law can be more concrete and practical, which can be used to guide the structure of the CAI process.

In the past, the definitions of ASE, "divergent-convergent", "width-depth-opportunistic" and other concepts were relatively extensive, the contents were relatively dispersed, and there were relatively few definitions closely related to the product design field. In order to clearly express the interactive influence distance learning model as well as the included elements and their connotations and extensions in the design field, increase the practicability and pertinence of the interactive influence distance learning model, based on the analysis, understanding and further development of previous research results, the definitions of the design process, thinking patterns and design strategies in the field of product design are summarized in this paper.

3. Proposal of Interactive Influence Distance Learning

3.1 Interactive Influence Distance Learning Model Theory

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The interactive influence distance learning model relies on its fault-tolerant characteristics of the computer-aided instruction effectiveness evaluation index of the ideological and political courses. The basic working mechanism of the model is the analysis of the similarity obtained by the error static analysis method and the multi-decision analysis (such as PSNR, MSE, classification accuracy, etc.). Combined the above analysis, the multivariate analysis is carried out in this paper on a variety of different algorithms, and the impact of the difference between this algorithm and other algorithms on the evaluation index of computer-aided instruction effectiveness of ideological and political courses is tested accordingly.

The term "Multivariate" as defined herein stands for the ratio between the resource saved and the output error value under similar operations, as shown in the following.

$$Xbility @ \frac{E_{savings}}{Q_{loss}} \quad (1)$$

In the above equation, the metric value to be solved shall be determined according to the actual problem. For example, in the process of image processing, the signal-to-noise ratio (PSNR) of the peak value of the image is generally used as a metric according to a similar order. The content of this paper is mainly about the time consumed in the classification phase. Based on the computing system level and time-consuming factors, the time of the classification phase can divided into the following:

$$E = E_{SMS} + E_{SMA} + E_{MMA} + E_{MCP} \quad (2)$$

In the above equation, it represents the use time of computer-aided teaching effectiveness evaluation of ideological and political courses. In this paper, it mainly refers to the time used to save the computer-aided teaching effectiveness evaluation of ideological and political courses to DRAM; represents the time of computer-aided teaching effectiveness evaluation of ideological and political courses.

3.2 Interactive Influence Distance Learning Model Relationship Unit

The basic relationship between the ASE process model, the "width first – depth first - opportunistic" design strategy, and the "diverge-convergence" mindset are shown in Figure 1.

In the analysis process, under the control of divergent thinking, the width first design strategy is first used to inspire as many concepts as possible. When students evaluate the feasibility of high-level concepts that are not sensitive, the width first strategy may be accompanied by depth first strategy (that is, an opportunistic strategy) where a particular width option is logically analyzed in order to develop one or more design concepts into relatively detailed design concepts, so as to determine the feasibility of the concept.

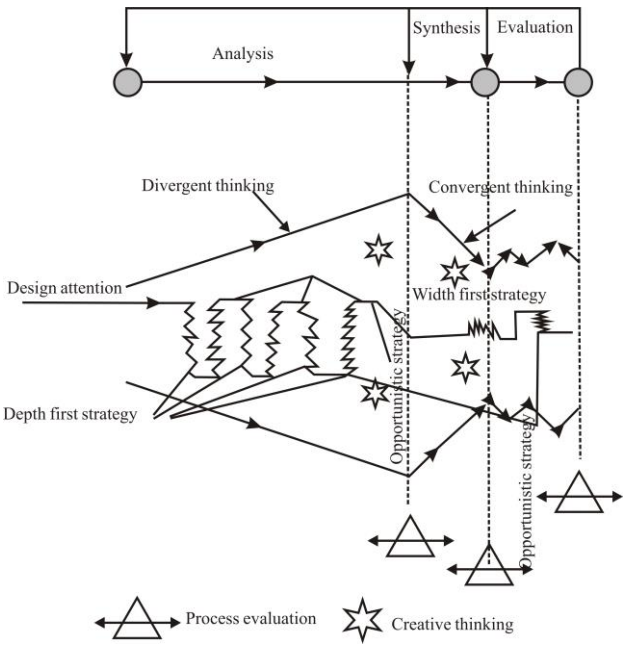

Figure. 1 Process model - design strategy - thinking pattern relationship unit

In the synthesis process, the depth first design strategy is adopted under the control of convergence thinking. The purpose is to integrate multiple design focus (multiple concepts) into one or several schemes. The process is most likely to have other innovative thinking patterns, such as the role

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of inspiration and innovative thinking, which inspires the sudden generation of concepts.

The relationship between the quantity and quality of the concept is an S-curve [22]. Hence, there is always an evaluation process within the minimum design unit, so that the relationship between quantity and quality is in a proper state. The evaluation process adopts the "fast shift opportunism between the width and depth first (referred to as opportunistic) design strategy. The design attention will quickly change between the "depth-width" design strategies, presenting the opportunistic design activities, while the dominance law is also a combination of "diverging and convergent" effect to evaluate the feasibility of alternative concepts.

The hexagonal star symbol as shown in Figure 1 is used to indicate the evaluation strategy of the external design management and intervention model. Through the evaluation process, whether the number of schemes is sufficient and whether it should be advanced to a deeper level are analyzed. Then, the timing of the design process changing at each stage of the ASE is further determined.

3.3 Interactive Influence Distance Learning Process

The complete interactive influence distance learning process is as shown in Figure 2.

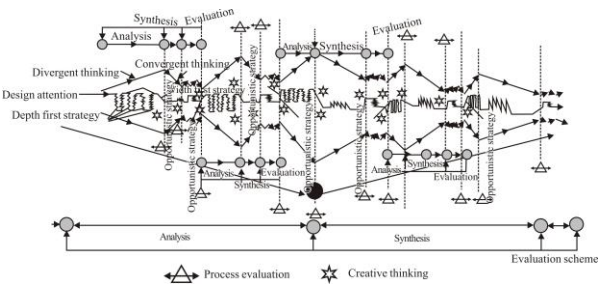

Figure. 2 Interactive influence distance learning process

The interactive influence distance learning model can be divided into three stages in general: ① The analysis stage with design task analysis, design target determination and concept generation as the main task; ② The synthesis stage with concept refinement and multi-concept convergence as the main task; ③ The scheme evaluation stage with the final evaluation and selection of the scheme evaluation phase as the main task in a controlled number of schemes. The scheme is obtained by gathering numerous concepts, the process of concept generation is dominated by divergent thinking, and the process of scheme generation convergent thinking is the primary thinking pattern.

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3.4 Experimental Verification of Computer-aided Instruction in Ideological and Political Courses

The cognitive experiment is performed. The oral analysis is used as the data acquisition method, and Linkography data analysis method is applied to encode the oral analysis records, observe the design behavior, and analyze the degree of fit between the experimental phenomena and the theoretical model. Linkography is a method for studying the design cognition and analyzing the colloquial record data of research design cognition and design reasoning which has gained a lot attention in the design cognition field. In this method, by determining and analyzing the design operation steps (Move, M), the relationship links between the steps, and forming more relational links, key steps, and other means, the graphical representation is used to track the relationship between each design transformation and the path formed by the concept and achieve the purpose of studying the path of research design and design concept and exploring the purpose of interactively affecting the nature of distance learning. The design task and oral language used in the experimental analysis record come from the previous research results of our research group. Among the 6 subjects, a woman with the highest comprehensive score and 7 years of design experience is selected as the typical analysis sample. The design theme, thinking pattern, and design strategy in the middle section of the design process are relatively complete, which is suitable for

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model validation analysis and selection. The middle section of the record is analyzed in detail: 09:28~28:00, length 18 min 32s (total duration 40:54), consisting of 3 units (units 12~14), 124 steps (move 99~ move 222). Before data analysis is carried out, the oral experiment record has been transcribed. According to the design theme division unit, step M and the key step CM are determined, coding is performed according to the following coding scheme, and the details are not discussed. Part of the step M distribution for the section based on the Linkography method is shown in Figure 3.

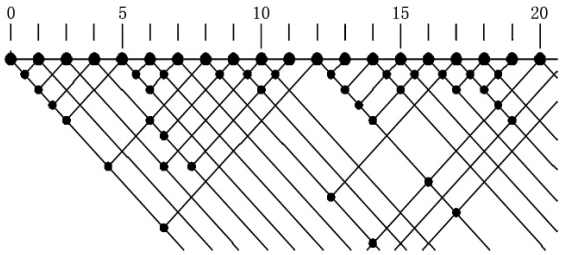

Figure. 3 Experimental data: Step M distribution diagram of the Linkography (partial)

(1) Coding scheme and data analysis scheme

According to the research purpose, the following coding scheme is generated based on the analysis of related research [9, 27-28]. The design behavior encoding scheme 1 based on the design process is shown in Table 1.

Table 1 Encoding scheme based on the design process

Design process	Design activity
Analysis	Classification of problem function or performance analysis in the function/performance aspects
	Function or performance justification
	Determination of the design purpose, design reasons / proposed processing functions or performance
Synthesis	Generation and convergence of schemes
	Determination of the operability of the solution, whether it meets design constraints and standards
Evaluation	Evaluation of the functions or performance

The encoding scheme 2 of the design behavior based on the thinking pattern is shown in Table 2.

Table 2 Encoding scheme based on the thinking pattern

Type of thinking	Design behavior	Design activity / result
Convergent thinking	Learning	General knowledge
	Remembering	Domain knowledge
	Problem identification	Focusing on expertise
	Target setting	Application of cognitive elements
Divergent thinking	Generating association	Combination of cognitive elements
	Producing a structure that can be further developed	Novel structure
Divergent thinking + convergence thinking	Checking the validity and association of novel structures	Displaying the relevance and effectiveness of the scenario
	Feedback effect	Description validity
	Determining the relevance and validity of related structures	Product evaluation and effectiveness judgment

The encoding scheme 3 of the design behavior based on the design strategy is shown in Table 3.

Table 3 Encoding scheme based on the design strategy (description hierarchy)

Description level	Design activity
System layer	Entire design entity and / or its environment
Subsystem layer	Part of the designed entity and/or its environment
Detail	Appearance and environment

In the encoding scheme, when a design theme basically falls in the same level (1 or 2 or 3), the design strategy that can determine the time is a width first strategy. In a given unit, the design theme belongs to different levels. However, there is a logically related (logically nested) hierarchy, which can be judged to adopt a depth-first strategy. In a certain period of time, if there are frequent transitions at each level, it is determined that the opportunistic strategy is adopted in this period.

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(2) Experimental results

For the analysis material time period selected, statistics is performed on the encoding results of each M in the closed region composed of different thresholds CM. If M satisfies the condition: M or CM between [CM>, <CM] of the same threshold falls in the analysis stage. The width first is taken as the main design strategy, and the divergent thinking is taken as the main dominant thinking mode. The M or CM between the same threshold [<CM, CM>] falls in the synthesis stage, and the depth design is the main design strategy with the convergent thinking as the main dominant thinking pattern. The CM at the endpoint falls in the evaluation stage, with the transformation of "width-depth" or "depth-width" (opportunistic) as the main design strategy, and the main dominance mode is the "divergent + convergence" thinking pattern. Those meeting the above conditions are recorded as "+", and otherwise as "-". The encoding schemes 1, 2 and 3 meet the conditional statistics, and analysis results in each interval are shown in Table 4 to Table 6: Hyp+ stands for the number of the conditional M, Hyp- stands for the number of Ms that do not meet the condition, the total number (Total) stands for the total number of Ms participating in the verification, Perc+ stands for the percentage of M that meets the condition, and the percentage of M that is measured, and Perc- stands for the percentage of M that does not meet the condition in the total number of M being measured. The number 1, 2 and 3 after each characterization symbol represents analytical statistics for encoding schemes 1, 2 and 3, respectively.

Table 4 Statistical results of analysis scheme 1

	Hyp1+	Hyp1-	Total	Perc1+/%	Perc1-/%
[CM3>,<CM3]	22	8	30	73.3	26.7
[<CM3,CM3>]	22	17	39	56.4	43.6
[CM5>,<CM5]	25	17	42	59.5	40.5
[<CM5,CM5>]	21	19	40	52.5	47.5
[CM7>,<CM7]	46	24	80	57.5	42.5
<CM	33	17	50	66.0	34.0
CM>	24	18	42	57.1	42.9

Table 5 Statistical results of analysis scheme 2

	Hyp2+	Hyp2-	Total	Perc2+/%	Perc2-/%
[CM3>,<CM3]	19	11	30	63.3	46.7
[<CM3,CM3>]	23	16	39	59.0	41.0
[CM5>,<CM5]	24	18	42	57.1	42.9
[<CM5 CM5>	23	17	40	57.5	42.5
[CM7>,<CM7]	45	35	80	56.3	43.7
<CM	36	14	50	72.0	28.0
CM>	25	17	42	59.5	40.5

Table 6 Statistical results of analysis scheme 3

	Hyp3+	Hyp3-	Total	Perc3+/%	Perc3-/%
[CM3>,<CM3]	20	10	30	66.6	33.4
[<CM3,CM3>]	27	12	39	69.2	30.8
[CM5>,<CM5]	31	11	42	73.8	26.2
[<CM5,CM5>]	25	15	40	62.5	37.5
[CM7>,<CM7]	62	18	80	77.5	22.5
<CM	34	16	50	68.0	32.0
CM>	28	14	42	66.7	33.3

According to Table 4 of the corresponding encoding scheme 1: 73.3%, 59.5%, 57.5% of M between the [CM> and <CM] of the same threshold are in the analysis stage; 56.4% and 52.5% of M between [<CM, CM>] of the same threshold are in the synthesis stage; 66.0% of the <CM is in the evaluation stage, and 57.1% of the CM> is in the synthesis stage.

According to Table 5 of the corresponding coding scheme 2: 63.3%, 57.1%, and 56.25% of M between the [CM> and <CM] of the same threshold are divergent thinking; [<CM, CM>] of the same threshold 59% and 57.5% of M fall in the convergent thinking classification; 72.0% of the <CM falls in the "divergent + convergence" thinking, and 59.5% of the CM> falls in the convergent thinking.

According to Table 6 of the corresponding coding scheme 3: 66.6%, 73.8%, and 77.5% of the M between the [CM> and <CM] of the same threshold adopt the depth first strategy; between the same threshold [<CM, CM>], 69.2% and 62.5% of M adopt the width first strategy; 68.0% of <CM and 66.7% of CMs at the endpoints adopt an opportunistic strategy.

From Tables 4 to 6, the average percentages of the corresponding encoding schemes 1, 2 and 3 and the endpoint CM

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satisfying the conditions in each interval are 59.84%, 58.57%, 69.92% and 61.55%, 65.50%, and 67.35%, respectively. All the results have exceeded the threshold of 50%. The results mean that students have preference: in the analysis stage, the students use divergent thinking as the main mode of thinking and prefer to select the width-first design strategy; in the synthesis stage, the students adopt convergent thinking as the main dominating mode of thinking and prefer the depth first design strategy; in the evaluation phase, the students focus on frequent movements between divergent and convergent thinking and prefer opportunistic strategy for the design strategy choice (fast transitions between the depth and width first design strategies). Based on the relationship between the "process-strategy-thinking pattern" of students and the construction of the design thought model fitting and the results of cognitive experiment data analysis, it is verified that the established interactive influence distance learning model has a certain objective rationality.

4. THEORETICAL FRAMEWORK OF COMPUTER-AIDED INSTRUCTION IN IDEOLOGICAL AND POLITICAL COURSES

According to the discussion of the interactive influence distance learning theory model described above, the design activity distribution of the students in the design practice process follows the interactive influence distance learning model to a certain extent. Combined with the design practice thinking flow and information flow, according to the thinking characteristics and design strategy selection preference law of the students at different design stages, the "strategy-process-thinking" structural framework is proposed under the CAI design flow, as shown in Figure 4.

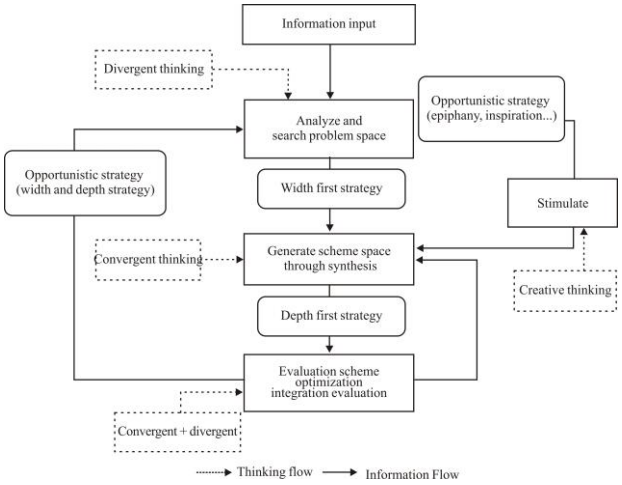

Figure. 4 Structured framework of the interactive influence distance learning model

The product concept design stage can be divided into three design processes: analysis, synthesis and evaluation. After the design information enters, the analysis stage searches for the problem space, with divergent thinking as the main dominating thinking, and the width first as the execution strategy. The design tasks can be divided into subtasks and decisions. The function and structure of the tasks are determined, and the corresponding preliminary concepts are generated. At the synthesis stage, the scheme space is generated. With the convergence thinking as the main dominating thinking, the depth first strategy is adopted to deepen and refine the preliminary concept, generate the sub-functions and structures, and converge them into a holistic scheme, which is characterized by generating as many schemes as possible and uniting sub-schemes in new ways. At the same time, at some point or time in the analysis and synthesis stages, upon external stimuli strongly stimulate students' subconscious thinking process, innovative thinking has become the dominant pattern of thinking. Based on the opportunistic strategies (epiphany, inspiration), the routine analysis and synthesis process are skipped to realize the sudden generation of the scheme directly.

According to the structural framework of the interactive influence distance learning model, the CAI design process framework is

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established. Based on the existing research on the characteristics of innovative methods, the characteristics of the distance learning characteristics are matched based on the characteristics of the innovative techniques and the interaction of different processes of students (for example, in the analysis stage, students adopt divergent thinking as the dominant mode of thinking. The CAI system provides morphological analysis with divergence as the method feature, and innovative methods such as mind mapping as the main auxiliary method). In the synthesis stage, the students use convergent thinking as the dominant mode of thinking. The CAI system provides a family-oriented Abstraction Specification and Translation (FAST) tree, with TRIZ as the main auxiliary method, which has provided the students with appropriate innovative techniques and resources at the right time to stimulate and meet the purpose of interaction and distance learning needs, as shown in Figure 5.

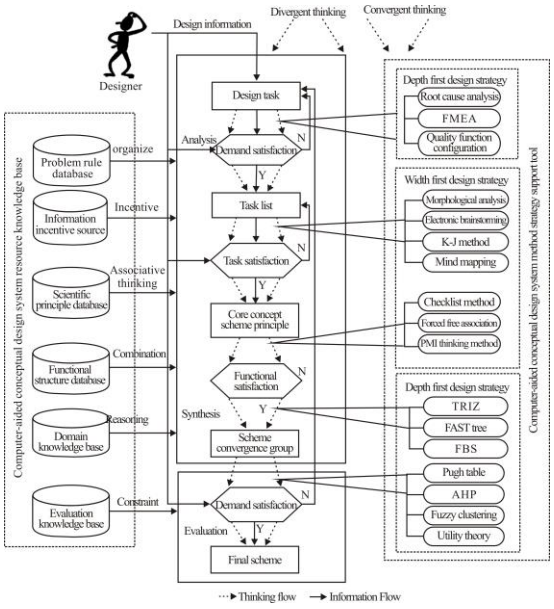

Figure. 5 Flow chart of computer-aided instruction in ideological and political courses

In this process, the interactive influence distance learning model is used as the system architecture guiding ideology to organize and provide abundant computer resources and methods to support students' innovative design activities reasonably. In addition, it effectively supports the design subjects to create, generate, decompose, converge, evaluate, and select innovative design concepts in the analysis, synthesis and evaluation design process, providing the resources and methodological support for thinking characteristics at different design stages.

According to the interactive influence distance learning model, the students use divergent thinking as the main dominant thinking form in the analysis process and adopt the width first as the main design strategy. Hence, in the task determination stage, deep-priority strategies such as root cause analysis, FMEA, and quality function configuration are provided to students for their choice to stimulate their divergent thinking from multiple perspectives and consider the design tasks in an all-round manner. The design tasks are organized and modeled with the problem rule database. The analyzed design task list is compared with the original design tasks to evaluate the task satisfaction and naturally stimulate the students' convergent thinking and determine whether the design task list is reasonable. If the design task list meets the requirements, a list of task lists is provided; otherwise it returns to the design task entry for analysis again.

The generation of core concepts and scheme principles is the primary design goal of the analysis process. At this stage, the intuitive concept generation methods are provides based on the support of the information-stimulus knowledge sources and scientific principles knowledge bases consisting of sketches, three views, models, etc. Width analysis, KJ method, mindset map, and electronic brainstorming are the priority design strategies for students to choose. They stimulate the divergent thinking subconscious process of the students from two aspects: knowledge type, information relevance and method, so that the students' attention is concentrated on the shift between design themes or in multiple

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aspects of the design theme, maintains a certain macroscopic feature, stimulates divergent thinking to generate, search, create, organize as many core concepts and scheme principles as possible, and ensures that no valuable concepts are missed.

5. CONCLUSIONS

In this paper, the thinking characteristics and design strategy selection preference rules of students at different stages of the design process are studied to establish a design thinking pattern. With this model as the principles for organizing and pushing computer resources, CAI design process that complies with the characteristics of design patterns and design strategies is put forward. From cognitive science, the students' internal thinking rules are studied, and the corresponding model is established to concretize the abstract design rules. The interactive influence distance learning model is taken as the resource organization and push criteria. By providing various types of resources that are inspiring for each design stage accurately, a CAI design process is established to provide an operable way to establish a computer-aided system for ideological and political courses that meets the law of interactive influence distance learning and improve its pertinence and auxiliary efficiency.

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