A Study of a Framework for Assessing Curriculum Creativity Based on Design Thinking

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Abstract: Creativity development has received global attention since the 1990s. Design thinking provides innovative problem solving strategies, and creativity assessment-oriented teaching evaluation innovation is important under teaching reform. This paper proposes the DTCT model to construct a teaching evaluation framework for creativity cultivation, which is based on the design thinking process, combined with real situation teaching, and evaluates creativity from individual, process and product dimensions. The experiment verifies the rationality of the model and develops a course management evaluation system to provide a new way for educational innovation. The DTCT model is an objective and comprehensive assessment of creativity, which has academic value and application prospects for the development of creativity education.

Keywords: Design thinking; Creativity assessment; Course management and evaluation systems; System design

1 Introduction

1.1 Background of the study

Made in China 2025 emphasizes the critical role of enhancing innovation and design capabilities for national manufacturing innovation, and advocates the development of innovation and design education to stimulate social innovation [57].Design thinking, integrating analysis and innovation, is crucial for cultivating innovative and practical talents, and provides educators with methods and tools to solve the challenges of basic education reform. China's basic education multi-curriculum is transforming to cultivate innovative talents, increasing creative design and innovation content and cultivating innovation ability through PBL, STEAM, and creator education. Design thinking simplifies the innovation process and provides strategies, methods and tools [2].

UNESCO pointed out that "the 21st century is the century of innovative education" [42].Teaching evaluation, as an important part of education and teaching, needs to be adapted to the teaching reform of creativity training. The Outline of Basic Education Curriculum Reform (for Trial Implementation) proposes to change the status quo of classroom evaluation that overemphasizes students' academic performance, and to establish an evaluation system that promotes the overall development of students' quality [35]. Teaching evaluation oriented to creativity assessment is an innovative demand for teaching evaluation and an important task for classroom teaching reform in basic education schools.

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1.2 Research objectives and research content

Relying on the project "Curriculum Development of Design Education in Elementary and Middle Schools in Zhejiang Province" of the Department of Education of Zhejiang Province, this study aims to propose a creativity assessment method based on design thinking as a new way of curriculum evaluation, and to develop corresponding informatized teaching aids to improve the efficiency and convenience of teachers' evaluation activities.

This study centers on the following objectives: this study proposes a design thinking-based creativity assessment model (DTCT) through literature analysis, constructs a course evaluation system and determines the application method. Taking Campus Space Design as a case study, faculty, students and experts are invited to use and evaluate the new evaluation method, test its effectiveness through convergent validity, and collect feedback for expert review. Based on the DTCT model, develop the course management and evaluation module on the XTEACH Innovation Academy platform, conduct usability testing and user experience research to verify the system performance.

1.3 Significance and value of the study

At the theoretical level, this study proposes a creativity assessment method for courses based on design thinking, constructs a DTCT model and evaluation system, explores the mapping relationship between design thinking and creativity assessment, enriches the creativity assessment theory, provides new perspectives for the theoretical study of evaluation in basic

4P Model	Definition connotation
Individual	Personality traits, cognition, skills, attitudes, etc
Process	The stage processes of creative activities: discovery, association, problem-solving, etc. Creative cognitive processes: divergent thinking, convergent thinking
Product	Create achievements, such as Ideas, conceptual methods, products, solutions, etc
Environment	Social culture, team organization culture and atmosphere, reward and punishment Settings, etc

Table 1. The definition and connotation of the 4P model of creativity from different perspectives

education, and has academic value and reference significance for the development of domestic innovation education [41]. At the practical level, the development of a creativity assessment system based on design thinking, as an informatization teaching tool, assists the teaching evaluation of creativity cultivation courses, promotes the reform of teaching evaluation, and is of great value to related teaching work.

1.4 Research methodology and research ideas

This study utilizes literature research, experimental research, expert talks, interviews, and observations to provide a comprehensive and in-depth exploration of a model for assessing creativity based on design thinking. The study is divided into seven chapters, firstly introducing the research background, objectives, content and methodology in the introduction, then providing the foundation for the model proposal through literature review and theoretical research. Subsequently, the DTCT model is proposed and the assessment system is constructed, the validity of the model is verified through experiments, and it is applied to system design for testing. Finally, we summarize the research innovations, reflect on the shortcomings, and look forward to the future research direction.

2 Literature Review

2.1 Creativity Studies

2.1.1 The definition of creativity

The research of "Creativity" has a long history, which can be traced back to Golden's "Hereditary Genius" in 1868, at that time, it was believed that creativity was the unique ability of geniuses. 1950, Guilford, an American psychologist, proposed that creativity was the ability of ordinary people to have the characteristics and creative potential, which triggered a research boom. However, due to the complexity and multidimensionality of creativity, there is no unified definition so far.Rhodes and other scholars divided the definition and connotation of creativity into four aspects: creative individual (Person), creative process (Process), creative product (Product), creative environment (Place), i.e., the 4P model of creativity [13].

From the perspective of individual creativity, creativity is influenced by personality traits; Guilford (1950) proposed the concept of "creative personality", emphasized the relevance of non-intellectual factors to creativity, and proposed eight creative personality traits [13]; Sternberg (1986) believed that seven personality factors constitute creative personality [13]; Sternberg (1986) believed that seven personality factors constitute creative personality [13]. personality [13].Csikszentmihalyi (1996) summarized 16 categories of personality traits through empirical research [13]. These studies are important for the development of creative personality of students, which is considered to be an organic whole of the individual, which promotes and ensures creative development and task fulfillment.

Creative process refers to the process of creative activity, including cognitive process and stage process.Wallas (1926) proposed that the creative process consists of four stages: preparation, gestation, clarification and verification [40].Stein (1974) proposed three stages: forming a hypothesis, verifying the hypothesis and expressing the results [13]. Scholars consider creativity as the process of creation that may produce creative outcomes but cannot be measured only by products or results. The cognitive process of creativity involves convergent and divergent thinking, divergent thinking is the core component of creative thinking, and convergent thinking also plays an important role in the creative thinking process [19].

Creative product defines creativity from the perspective of outcome, which is the most objective and representative definition.Researchers such as Hennessey [14], Makel [46], Runco [39] believe that creativity is the ability of an individual to generate novel and practical ideas or products.Barron (1955) pointed out that an original idea or a product should satisfy the two conditions of novelty and applicability [36, 47] A product that is novel but useless or useful but not novel is not creative.

Creative environment affects the individual creativity. External environmental factors include dynamic environmental elements and creative atmosphere [30]. All creative potential is realized in a specific environment.

Amabile (1983) believes that creativity is a behavior that is the result of an organic combination of factors such as personality traits, cognitive abilities and external environment [13]. Shi Jiannong (1995) points out that creativity is a form of intellectual activity, is a human being on the basis of knowledge, skills and experience, through the processing of intellectual activity, the formation of concepts or new ideas, and the ability to practice the processing of the collection of new products [13].Sternberg points out that creativity is the intellectual creativity, analytical and practical to balance each

other and the application of the process [13]. According to Lin Chongde (1999), creativity is the intellectual quality or ability to use known information in the process of generating a unique, novel, and valuable product according to a certain purpose [27]. These definitions are the definitions of creativity from a comprehensive perspective that are more agreed upon by researchers.

2.1.2 Creativity assessment

Creativity assessment is an important part of creativity research and practical application, which is of great significance for cultivating creative talents. In this paper, we mainly sort out the assessment tools and methods of adolescent creativity to provide supportive basis for the application of creativity cultivation and teaching evaluation. Currently, the evaluation tools of youth creativity mainly focus on four aspects: creative individuals, creative process, creative products, creative environment, as well as the integrated assessment that integrates several aspects.

Creativity-related personal characteristics are mainly manifested in personality, motivation, interests and attitudes, and behaviors, etc. Hough and Dilchert believe that using self-report as a means of assessing creativity is more effective for assessing some stable personality traits [16]. Classical scales include the MBTI [31], NEO-PI scale [7], KTCPI [15], ACL [15], and KAI. These scales are objectively tested through a series of questions or declarative sentences that require subjects to rate themselves on their own terms. In addition, the level of creativity of creative individuals can also be assessed in terms of the individual's inclination and attitude towards creativity-related interests, such as the Creative Tendencies Scale of Williams' Creativity Test [50]. However, the assessment of creative individuals suffers from low structural validity, and a single personality or motivational indicator is not sufficient to predict creativity [54].

Measures of creative processes are related to the cognitive processes associated with creativity, and predict an individual's creative potential through the performance and completion of activities in creative tasks. Divergent thinking tests are the most commonly used to assess creativity, such as the Torrance Test of Creative Thinking (TTCT) [21], which assesses four indicators of an individual's creativity dimensions fluency, flexibility, uniqueness, and sophistication. Convergent thinking is also an important component of creative thinking, and measures include remote association tests and insight questions [5, 12]. These tests assess participants' ability to aggregate to a single correct solution by switching thinking perspectives, but also do not fully reflect the creative process.

Mckinnon argues that products based on analyzing creativity are the cornerstone of creativity research, identifying creativity by how creative products distinguish themselves from ordinary products [54]. Different scholars have different evaluation indexes for creative products, such as Besemer and O'Quin constructed a decomposition matrix for innovative products and designed a semantic scale for creative products [52].Amabile proposed a synesthesia assessment technique (CAT), which believes that experts in the same field will have a basically consistent view of the same work, i.e., synesthesia, and can be based on synesthesia to conduct a creative product grade evaluation [54]. However, the assessment of creative products may re-face the problem of the definition of creativity in the operation process, and it is impossible to make a comprehensive and objective assessment, and it is difficult to set the scoring criteria, which still needs further development.

The measurement of creative environment is divided into many aspects, such as school environment, learning atmosphere, family environment and other external environmental factors. Measurement of the creativity environment for adolescents mainly focuses on the level of the school environment, such as the Support for Innovation Scale (SSSI) developed by Siegel et al [32]. In addition, Linnerud (2013) pointed out that students in the traditional evaluation model are more inclined to use traditional conventional answers in order to obtain higher test scores, whereas creative answers tend to be unconventional, novel, and have a certain degree of uncertainty and risk [34].Runco's (2014) study suggests that creativity evaluation should be in the context of " game-like" or 'relaxed, mistake-tolerant' environments, where creativity is evaluated without giving a clear score and students are more likely to unleash their creative potential [38].

Researchers and scholars have recognized the narrowness of the current creativity tests and have begun to see a trend toward comprehensive assessments of creativity. Instead of focusing on the size of creativity from a traditional single perspective, integrated assessment of creativity is more reliable and valid than traditional single-indicator assessment by combining different assessment indicators of creativity. For example, Urban et al. developed the Test of Creativity for Drawing and Creativity (TCT-DP) [48], Lubart developed the EPoC (Evaluation of potential for creativity) [3], and our scholars Shen Jiliang, Hu Weiping, and Lin Chongde compiled a scientific creativity measurement tool for adolescents [18]. These tools overcome the shortcomings of some traditional creativity assessments that measure a single process, but the main challenge of integrative assessment is that it requires greater time and effort to measure multiple aspects of creativity.

2.2 Design Thinking Research

2.2.1 The connotation of design thinking

Design Thinking is an approach to solving problems in a designer's mindset, which was first explored by researchers in the 1960's. Herbert Simon's concept of design as a way of thinking in Artificial Science [44] influenced the basic form of design thinking in the early days, and Peter Rowe's use of the term "design thinking" was the first in 1987 [26], and Richard Buchanan pointed out that its connotation can be applied to various fields [43]. Peter Rowe used the term "design thinking" for the first time in 1987 [26], and Richard Buchanan pointed out that its connotation can be applied

to various fields [43]. Design thinking is divided into three areas: methods of thinking, problem solving and methods of realizing innovation. It emphasizes the balance between image and abstraction, divergence and convergence, analysis and synthesis, logic and intuition, providing innovative skills and tools to facilitate the generation of innovative solutions [37].

2.2.2 Design Thinking Model

- d.school Design Thinking

The design thinking model consists of a series of design processes, activities, and methods that provide ways to solve problems, and Christopher Jones proposed the cyclic model of "analyze-synthesize-evaluate" [20], and Herbert Simon's model has profoundly influenced the formation of today's design thinking models [4]. Herbert Simon's model has also profoundly influenced the formation of today's design thinking models [4].

The design thinking process proposed by Stanford University's d.school consists of five phases: empathy, problem definition, concept generation, prototyping, and testing [33]. Empathy perceives user intent by observing user behavior, attitudes, and experiencing user situations; defining the problem transforms user intent into the essence of the requirement; concept generation gives full play to creativity and imagination; prototype phase expresses the concept quickly; and testing phase adjusts the solution through user feedback.

- HPI D-School Design Thinking

HPI D-School at the University of Potsdam, Germany, proposes a six-phase model based on the d.school model: understanding, observing, defining, conceptualizing, prototyping, and testing [22]. Understanding phase analyzes user needs and proposes design challenges; Observation phase acquires user information; Definition phase refines real needs; Ideation phase finds innovative solutions; Prototyping phase creates a prototype of the solution; and Testing phase obtains feedback through user experience.

- IDEO Design Thinking Models

This paper introduces three design thinking models: (1) IDEO's 3I model, which consists of inspiration, ideation and implementation phases, corresponding to the search for design problems, discovery of solutions, and practical testing to improve the solution; (2) HCD model, which revolves around human-centeredness, and is divided into three phases of listening, creating, and delivering, which are used to collect user information, transform research results into solutions, and quickly realize the solutions, respectively; (3) The Design Thinking Toolkit, developed by IDEO and the Riverdale School in New York, covers five stages of discovery, interpretation, conceptualization, experimentation, and evolutionary development, and is designed to assist educators in meeting their challenges.

- The British Design Council's Double Diamond Model

The Double Diamond Model developed by the British Design Council describes the four stages of Discover-Define-Evolve-Deliver [8]. The discovery phase explores the problem; the definition phase focuses on information and summarizes insights; the development phase conducts ideation, prototyping, testing, and iteration; and the delivery phase defines the final product or service.

The design thinking model has the following characteristics: it provides a solution process for complex problems; it provides visualization tools to communicate ideas concisely and accurately; it is a nonlinear iterative process that requires multiple testing, feedback, and corrections; it requires an interdisciplinary learning model; and it facilitates the development of learners' higher-order thinking skills. As a result, Design Thinking has been widely used in education to promote educational innovation.

2.2.3 Cultivation of design thinking and creativity

Design thinking promotes innovation by enhancing participants' creative thinking skills, involves a problem-solving approach, and is achieved through collaborative and human-centered activities. Design thinking skills can be learned through instruction, including problem-based learning, project-based learning, and inquiry-based learning. Design thinking research scholars have conducted research related to the development of creativity through design thinking instruction to understand how it can be better developed and implemented.Scholars such as Lau, K.W have proposed five categories of skills to develop creative thinking [24]: identifying and mapping attributes, creating possibilities, varying and shifting perspectives, associative and analogical thinking, and exploring the emotional and subconscious mind.Kowaltowski et al. scholars believe that creativity-enhancing methods such as brainstorming and decision making combined with design methods such as prototyping and mapping better stimulate creativity and innovative outcomes [23].Davis believes that incorporating problem-solving methods in the curriculum stimulates students' creativity [10]. The design thinking process guides students step by step through the problem solving process, making them more actively involved in learning activities and promoting their autonomy and motivation to participate in the classroom. Design thinking promotes the participation of students in creative learning activities in the teaching process and teaching methods, supports the training and practice of creative thinking, and has an important role in promoting the creative development of students.

2.3 Research related to teaching evaluation

The theory of developmental curriculum evaluation originated from the Soviet educator Zankov in the mid-1970s, based on the Marxist theory of comprehensive development, constructivist learning theory and multiple intelligences theory [51]. The theory is centered on the promotion of students' general development throughout the whole education process, with the evaluation aim of promoting development, diversified methods and subjects, and focusing on comprehensive

evaluation [17]. It is characterized by developmental, comprehensive and interactive, and the purpose, content, subject and mode of evaluation are shifted to be centered on student development [6]. Information technology promotes changes in curriculum evaluation, and informationized teaching evaluation tools are widely used. E-portfolio with a computer network to collect learning materials, record growth to assist teaching [29]; assessment forms and gauges, the former to help independent learning, the latter quantitative evaluation, support for independent learning and the combination of the objectives [1,55]; example display to provide examples of the results of the results of the clear objectives of the standard [9]; electronic testing system to achieve intelligent automation of the examination, including the questionnaire management, grouping of rolls, exams, scoring analysis , simplifying the process, reducing the burden on teachers, instant feedback personalized guidance for students [56].

3 Research on Design Thinking-based Creativity Assessment Modeling

3.1 A proposed model for assessing creativity based on design thinking

3.1.1 Problem Analysis of the Evaluation of Existing Creativity Cultivation Courses

In participating in the design education curriculum development project for primary and secondary schools of the Department of Education of Zhejiang Province, the author's team conducted an empirical study on six schools and found that there are three problems in the evaluation of creativity cultivation courses: the evaluation standard is vague and relies on teachers' subjective judgments; the evaluation content is one-sided and ignores the learning process; and the evaluation method is single and lacks the consideration of students' individual differences.

3.1.2 Application of creativity assessment and teaching evaluation

There are various methods for assessing adolescent creativity, each with its own advantages and disadvantages. In teaching evaluation, creative subject assessment includes student self-assessment, mutual assessment and teacher observation, but self-assessment scales are difficult to measure creativity comprehensively. Creative process assessment includes divergent and convergent thinking, but divergent thinking is not the only component. Creative products and performances are assessed objectively, but are limited by the difficulty of setting scoring criteria and the lack of professional qualitative evaluation. Measurement of the creative environment is mainly at the school level, which has an impact on creativity, but is not applicable to the evaluation of daily teaching and learning, and a relaxed and creative atmosphere is more conducive to the stimulation of students' potential. Comprehensive assessment is comprehensive but difficult to implement. Although existing measurement tools provide new methods, they are difficult to be integrated into teaching evaluation due to the problems of detachment from practice, one-sided content, and long time spent. Different measurement objectives are related to teaching evaluation methods, which require the participation of multiple subjects and the combination of process and result evaluation to create a positive atmosphere.

3.1.3 The advantages of conducting curriculum creativity assessment based on design thinking

Design thinking, as the core of creative activity, has become an effective strategic framework in education. It embodies the continuous thinking and action of designers in solving design problems, and is integrated into learning programs to promote the development of students' higher-order thinking and comprehensive literacy, and to enhance the ability of teachers and students to cope with unstructured problems. The design process includes the personal, process, product and environmental dimensions of creativity assessment, based on which the assessment of creativity in the curriculum has many advantages: firstly, the assessment of real application scenarios makes the concept of creativity concrete and guides the teaching; secondly, it is a comprehensive assessment of the whole process of creativity activities, which is targeted; based on the assessment of the product, the final product or solution of the output of the design activities can be used to objectively and effectively assess the creativity [53].

3.2 Construction of a model for assessing creativity based on design thinking

Referring to the definition of Lin Chongde [27], creativity is the intellectual quality demonstrated by creative individuals in the process of using known information to produce unique, novel, and valuable products for specific goals. Creativity should be assessed by integrating personality traits, processes, and outcomes in three orientations: thinking, results, and values. The Design Thinking Double Diamond Model realizes creative outcomes through four steps and two stages: discovery, definition, development, and delivery. Combined with the definition of creativity, the design thinking-based DTCT model is constructed to expand the Double Diamond model in three dimensions to comprehensively assess creativity.

Design thinking activities produce outcomes through four stages of Discover, Define, Conceptualize, and Deliver, and two Divergent - Aggregative thinking activities assess creative thinking. The design process enables individuals to shift from extrinsic to intrinsic motivation, enhancing knowledge, skills and personality traits, and boosting creative confidence. The creativity assessment model based on design thinking clearly evaluates the process, outcome and subject of creative thinking. Since design is creation and the assessment of creative environment is not the focus of daily teaching, the model does not include "environment" as an assessment element, but draws on the 4P model of creativity and comprehensively assesses the 3P elements to comprehensively and objectively assess creativity. From the viewpoint of 21st century talent cultivation goals and education development principles, creativity cultivation points to the four aspects of students'

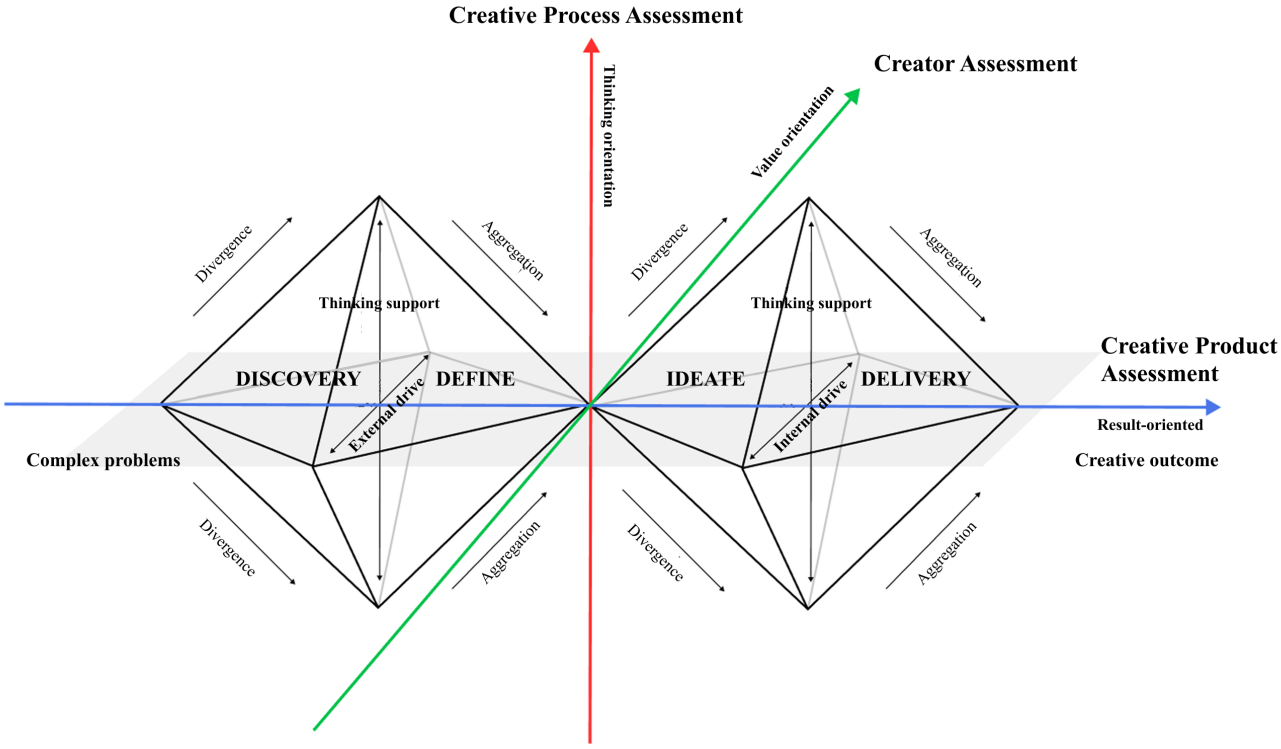

Figure 1. Creativity assessment model based on design thinking.

knowledge construction, ability enhancement, thinking cultivation and value orientation, and the relationship is shown in Fig.1.

3.3 A Curriculum Evaluation System Based on a Creativity Assessment Model for Design Thinking

In the wave of global education reform, creativity development has become a key goal of education. Based on the DTCT model, this paper builds a comprehensive curriculum evaluation system to assess and promote the development of students' creativity,as shown in Fig.2.

It integrates multiple systems such as "P21 Core Skills" and sets the core literacy goals of creativity development curriculum, including four dimensions of knowledge, skills, personality, and meta-learning, and emphasizes the application of information technology in the development of personal social skills [11, 45] [28]. which are mapped to each other with the four dimensions of curriculum core literacy [49].

A comprehensive assessment system is constructed based on the framework of the core qualities of creativity cultivation program, integrating the 3P elements, covering the four dimensions of knowledge, thinking, ability, and values, and comprehensively evaluating the potential of individual creative comprehensive quality. Based on the HPI D-School model and EDIPT design thinking, the evaluation structure is defined as six links, including empathy, and multiple subjects participate in the evaluation during the implementation of the course to realize the process and formative assessment. Each link focuses on different evaluation contents, such as the conceptualization and presentation stage, which emphasizes the power of information communication, and the completion of the course project, which is a comprehensive and objective assessment of creativity. The system comprehensively evaluates creativity cultivation courses, covers the cultivation of core qualities, and provides a powerful tool to support educational practice.

3.4 Related Algorithms and Applied Practical Methods

The traditional teaching evaluation method is static and difficult to process data, with low evaluation frequency and single index. This study proposes a curriculum creativity evaluation method based on design thinking, drawing on the algorithms related to the developmental teaching evaluation technology of Li Lijun [25], combining with the specific research situation, determining the basic algorithm and the realization principle of the application of practical methods.

3.4.1 Related Algorithms

Weighted summation method The weighted summation method is applicable to the observation of the development of students' abilities under multiple evaluation target variables by adding up multiple evaluation data in terms of weights. The specific steps are as follows:

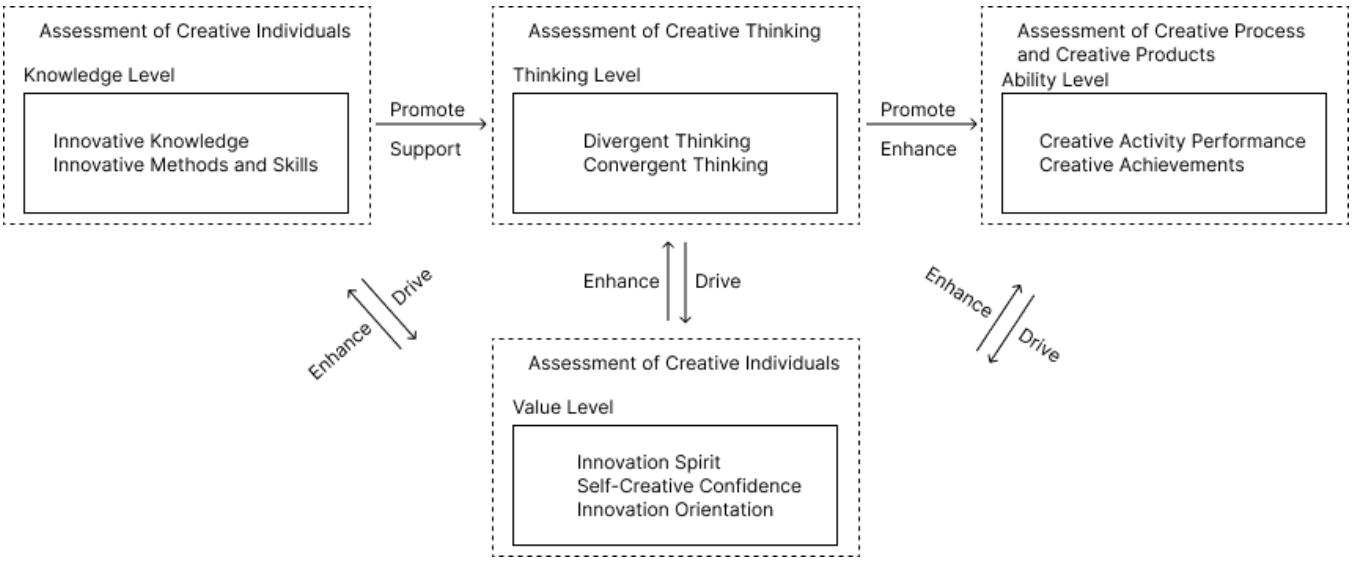

Figure 2. The relationship between elements of creativity cultivation and creativity assessment.

(1) Use a hierarchy chart to identify the relationship between the evaluation objective variables and the evaluable impact factors of the activity at each level, based on the four levels of creativity assessment

A student's creativity is A_i, which consists of four indicators: 'Creative knowledge and skills and methods', 'Creative thinking', 'Performance and achievement of creative activities', It consists of four indicators: 'Creative knowledge and skills and methods', 'Creative thinking', 'Performance and achievement of creative activities', and "Creative tendency", which is expressed as follows.

$$U = (V_1, V_2, V_3, V_4) \tag{1}$$

U refers to creativity assessment,V_1 refers to creative methods and skills,V_2 refers to creative thinking, V_3 refers to performance and achievement in creative activities, and V_4 refers to self confidence in creativity. U refers to the assessment of creativity. It also means that in the teaching evaluation activities based on this assessment method, 'creative knowledge and skills methods' are composed of 'breadth and depth' and 'acquisition channels' in 'innovative knowledge' and 'understanding the connotation' and 'appropriate use' in 'innovative skills and methods'. 'Creative thinking' is composed of the 'fluency', 'flexibility', 'uniqueness' and 'refinement' of 'divergent thinking', as well as the 'closure', 'continuity' and 'pragmatism' in 'convergent thinking'. 'Creative activity performance and achievement' is composed of 'perception ability', 'practical ability', and 'information transmission ability' in 'creative activity performance' and 'suitability' and 'novelty' in 'creative results'. The 'creative tendency' is composed of 'innovative consciousness and innovative spirit', 'creative confidence' and 'innovative tendency'.

Evaluation tasks and evaluation activities according to the design process stage of the specific learning activities, in different stages have different evaluation indicators focus, such as in the design of the pre-design focus on the construction of students' knowledge learning and the creative thinking process of divergent thinking, in the 'design process 01' stage of the assessment of the content of the 'innovative knowledge', 'innovative skills and methods', 'divergent thinking'. For example, if students are concerned about the construction of knowledge and the creative thinking process of divergent thinking in the pre-design stage, the assessment contents in the 'Design Process 01' stage will be 'Creative Knowledge', 'Creative Skills and Methods' and 'Divergent Thinking'. In the final calculation, all the design stages are combined with the same evaluation indicators for multiple evaluation subjects.

(2) Determine the individual weight vectors, noting the weight vector of U

$$\mathbf{R_u} = (r_1, r_2, r_3, r_4) \tag{2}$$

Denote the weight vector of V_1 as $r_1=(r_{11},r_{12})$
Denote the weight vector of V_2 as $r_2=(r_{21},r_{22})$
Denote the weight vector of V_3 as $r_3=(r_{31},r_{32})$
Denote the weight vector of V_4 as $r_4=(r_{41},r_{42},r_{43})$

(3) Calculation of hierarchical results

The student's creativity was calculated to be $A_i = R_u \cdot U^T = (r_1,r_2,r_3,r_4)(V_1,V_2,V_3,V_4)^T$

Fuzzy comprehensive judgement Fuzzy comprehensive judgment with the help of set and fuzzy mathematical theory, the fuzzy quantitative evaluation of numerical quantities, fuzzy processing of raw data to obtain the key features, to facilitate in-depth analysis [25]. The method contains single factor set and multi-layer factor set judgment, used to evaluate the evaluation of the scale evaluation, and finally gives the probability of each grade of the evaluation object, presenting

the results in the evaluation interval, so as to make the evaluation of abstract concepts, such as creativity, more objective and accurate.

(4) Single-Factor Set assessment (SFS)

Let the factor set $U = \{U_1,U_2,\Lambda,U_n\}$, the judgment set $V = \{v_1,v_2,L,v_m\}$, the weights $A = \{a_1,a_2,\Lambda,a_n\}$, $\sum^{n}_{i=1}$, $a_i=1$, the one-factor judgment set $U_i| \rightarrow f(U_i)=(r_{i1},r_{i2},\Lambda,r_{im})$, $0\leq r_{ij}\leq 1$, $0\leq i\leq n$, $0\leq j\leq m$

The one-factor judgment matrix is then:

$$\mathbf{R} = \begin{bmatrix} r_{11} & r_{12} & \Lambda & r_{1m} \\ r_{21} & r_{22} & \Lambda & r_{2m} \\ \Lambda & \Lambda & \Lambda & \Lambda \\ r_{n1} & r_{n1} & \Lambda & r_{nm} \end{bmatrix} \tag{3}$$

A and R are calculated and then synthesized by taking the greater and lesser of the two factors to obtain a single factor judgment.

$$\mathbf{B} = A \cdot R = (b_1, b_2, \Lambda, b_m) \tag{4}$$

Included among these, $b_j = \sum^{n}_{i=1}$, $j = 1,2,\Lambda,m$

Normalizing B in Eq.(2), if the set of judgments is expressed quantitatively,i.e., $V = (k_1,k_2,\Lambda,k_m)^T$, then the total number of judgments for individual factors is $(b_1,b_2,\Lambda,b_m)(k_1,k_2,\Lambda,k_m)^T$

(5) Multi-Level Factor Set Synthesis Judgment Method

The factor set is first divided into various levels of factor sets, and then from the highest level of the factor set, the individual factor set evaluation method is used to evaluate each level, and finally the comprehensive evaluation is obtained by evaluating the first level of the factor set. By normalization, if the set of factors is expressed quantitatively, the total score of the multilevel set of factors can be obtained.

3.4.2 Application realization process

(1) Establishment of an assessment coding system

In order to effectively analyze the relationship between the four levels of creativity assessment in teaching and learning assessment, the assessment tools and methods are coded to find the mapping relationship according to the four levels of elements to form the evaluation framework table. Coding rules: the first letter table level, knowledge (K), thinking (T), ability (A), values (V); the second digit table level of important components, the lower level of subdivided with '-' with the number; the third for the underscore '_'; the fourth digit table Design process; 5th digit table assessment content serial number. The four-level framework table was completed first, and the second-level items were deconstructed according to the assessment elements to obtain the assessment level coding comparison table.

First complete the comparison of the four-level framework table for creativity assessment. Deconstruct the second-level assessment items according to the assessment elements of each level, and the assessment level coding comparison table is shown in Table.2 below. (1) Determine the individual weight vectors, noting the weight vector of U.

Level of assessment	Assessment item	Code
Knowledge	Innovation knowledge	K1
	Innovation skills and methods	K2
Thinking	Divergent thinking	T1
	Convergent thinking	T2
Competencies	Process performance	A1
	Outcome performance	A2
Values	Creative Dispositions	V1

Table 2. Assessment Hierarchy Coding Comparison Table

Creativity assessments cover multiple levels, each of which is critical to the final outcome. Academics have not yet harmonized which level has the greatest impact on creativity, and it is difficult to determine the weight of each level in a comprehensive assessment. Evaluation items at different levels are intertwined in creativity activities, and the assignment of their weights also lacks reliable criteria. Therefore, this study distributes the weights of the factors equally to obtain comprehensive assessment results.

In this study, coding units were set according to the design process assessment stage, and teaching evaluation was conducted according to the process nodes. "01 empathy" stage, fill in the blanks to evaluate the concept of design tools, coding A1_11, A1 refers to the behavioral layer of innovative skills approach, the number after underlining the table process stage evaluation serial number. The coding system helps statistical evaluation activities, distinguishes the content of the same stage, identifies the assessment activities, structured multi-subject multi-modal evaluation, and facilitates the calculation and analysis. For example, information communication power is composed of four different stage activities such as A1 - 3_31, synthesizing comprehensive evaluation results.

3.4.3 Data entry and processing

When a student or a teacher sends a request for evaluation data processing at a certain point in time, the system performs a comprehensive fuzzy evaluation process using the Gauge Analysis Tool and obtains the following statistical data about the student's design work:

(1) One-Way judgment:

Categorize the work into five levels of judgment, i.e., excellent, good, fair, poor, and poor. Establishment of a set of judgmental differences.

$$\mathbf{V} = \{V_1, V_2, V_3, V_4, V_5\} \tag{5}$$

Where V_1 is excellent, V_2 is good, V_3 is fair, V_4 is poor, and V_5 is poor.

Divide the factor set U = {U_1,U_2,U_3,L,U_5} into two levels as follows:

The first level factor sets:

$$A = \{K, T, A, V\}$$

The corresponding weights are:

$$a = \{0.25, 0.25, 0.25, 0.25\}$$

The second level factor sets:

$$K = \{k_1, k_2\}$$
$$T = \{t_1, t_2\}$$
$$A = \{a_1, a_2, a_3, a_4, a_5, a_6\}$$
$$V = \{v_1, v_2, v_3\};$$

The corresponding weights are:

$$\mathbf{a}_k = \{0.5, 0.5\},$$
$$\mathbf{a}_t = \{0.5, 0.5\},$$
$$\mathbf{a}_a = \left\{\tfrac{1}{6}, \tfrac{1}{6}, \tfrac{1}{6}, \tfrac{1}{6}, \tfrac{1}{6}, \tfrac{1}{6}\right\},$$
$$\mathbf{a}_v = \left\{\tfrac{1}{3}, \tfrac{1}{3}, \tfrac{1}{3}\right\}.$$

Suppose first that a synthesis judgment is made on the set of content factors K first:

The one-factor judgment matrix is:

$$\mathbf{K_{21}} = \begin{bmatrix} 0.67 & 0.33 & 0 & 0 & 0 \\ 0 & 0.5 & 0.5 & 0 & 0 \end{bmatrix}$$

Make a synthesis judgment by multiplying and adding to get

$$\mathbf{B_{21}} = a_k \cdot K_{21} = \begin{bmatrix} 0.5 & 0.5 \end{bmatrix} \cdot \begin{bmatrix} 0.67 & 0.33 & 0 & 0 & 0 \\ 0 & 0.5 & 0.5 & 0 & 0 \end{bmatrix} = \begin{bmatrix} 0.34 & 0.42 & 0.25 & 0 & 0 \end{bmatrix}$$

(2) Multifactorial evaluation:

The same calculation gives

$$\mathbf{B_{22}} = \begin{bmatrix} 0.25 & 0.5 & 0.25 & 0 & 0 \end{bmatrix}$$
$$\mathbf{B_{23}} = \begin{bmatrix} 0.17 & 0.46 & 0.38 & 0 & 0 \end{bmatrix}$$
$$\mathbf{B_{24}} = \begin{bmatrix} 0.5 & 0.17 & 0.33 & 0 & 0 \end{bmatrix}$$

The following level 2 composite judgment is made:

$$B = a \cdot R = \left[\tfrac{1}{4}, \tfrac{1}{4}, \tfrac{1}{4}, \tfrac{1}{4}\right] \cdot \begin{bmatrix} B_{21} \\ B_{22} \\ B_{23} \\ B_{24} \end{bmatrix} = \begin{bmatrix} 0.32 & 0.39 & 0.3 & 0 & 0 \end{bmatrix}$$

If the set of judgments is quantitatively represented as y = $[5,4,3,2,1]^T$

Then the student's total composite assessment score is:

$$\hat{B} = B \cdot y = \begin{bmatrix} 0.32 & 0.39 & 0.3 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 5, 4, 3, 2, 1 \end{bmatrix}^T = 4.06$$

3.4.4 Creativity curve

Since the results of a comprehensive evaluation can be labeled as a function of time-dependent.

$$U = f(t) \tag{6}$$

Through the implementation of different curriculum projects, a model of students' creativity over time can be constructed to understand the path of their creativity changes. Cultivating creativity is a gradual process, and the learning effect should be viewed from a process-oriented developmental perspective. Students' individual differences are large and their abilities are different, so the generation of creativity curves is of great value and significance to teaching activities.

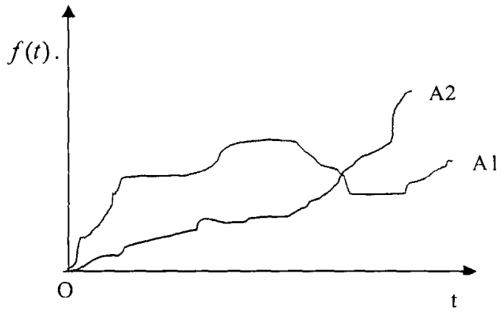

Figure 3. Creativity Curve.

The evaluation data are obtained from multiple stages, levels and subjects, and the weighted value and fuzzy comprehensive judgment method can be used to objectively and comprehensively evaluate the objects. This chapter analyzes the problem of creativity assessment method, proposes the assessment method based on design thinking, analyzes the relationship between it and creativity, and proposes the DTCT model; then refines the core qualities of creativity cultivation, and builds the curriculum evaluation system according to the DTCT model, which provides a framework basis for the practice of the curriculum cases in the following article [25].

4 Research Outlook

4.1 Shortcomings and improvements

This study uses design thinking as the foundation and support for the assessment of creativity in basic education, but there are still some incompleteness or inadequacies in this study:

(1) At the level of theoretical research, due to professional constraints, we are not well educated in cognitive science, psychology, education and other fields, and the creativity assessment model based on design thinking needs further research and revision. There is a lack of research on the assessment of individual creativity in student teamwork, which needs to be supplemented in later studies.

(2) At the level of evaluation system design, the evaluation methods and indicators used in this study are more complicated, and there are more evaluation links and

contents. Compared with the traditional course evaluation methods, teachers have to make more evaluations, which increases their workload, and further adjustments and improvements are needed in the evaluation framework and the application of operation in large-class teaching.

(3) At the level of system design, the functional design is not perfect enough, and students do not have a strong sense of creativity assessment, so they are not interested in using the system, and more functions that attract students' motivation are needed. In addition, creativity assessment is part of the construction of teaching management.
In addition, the creativity assessment is part of the teaching management construction, and the design of the assessment platform is independent of the teaching management system, which may increase the learning and operation costs of teachers.

(4) At the level of experimental design, the scope of the experimental study was small, the sample size was small, and the experimental samples were teachers and students from the project "Curriculum Development of Design Education in Primary and Secondary Schools in Zhejiang Province" of the Department of Education of Zhejiang Province, which is one of the leading regions in education research and pays more attention to the assessment of creativity in the curriculum. However, the education level and conditions of schools in other stages of basic education in China are different, so the popularization and application of the model is a key concern for future research.

4.2 Future and Prospects

In addition, the creativity assessment is part of the teaching management construction, and the design of the assessment platform is independent of the teaching management system, which may increase the learning and operation costs of teachers. As creativity cultivation is at an initial stage in China, the assessment of creativity in the curriculum should go hand in hand with the educational reform of creativity cultivation. Based on the construction of knowledge and skills, we should pay attention to the cultivation of students' creative ability, creative thinking and values, and we need to further study and improve the assessment system and methods, so as to realize the core concept and advantages of creativity education and cultivate new-age talents with creativity ability and literacy.

In the era of rapid development of information technology, informationized teaching aids provide more convenience and possibilities for the reform of teaching evaluation, change the traditional examination, scale evaluation and other fixed and single evaluation methods, pay attention to the learning process and individual differences of students, realize the diversification of evaluation indexes and evaluation methods, and build a more scientific and intelligent evaluation system. Evaluation of informatized teaching is an emerging product of informatized teaching and an important form of effective combination of modern information and education, which requires more researchers in related fields to carry out relevant research and practice, and is of great significance to the promotion of informatized education.

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