



## Exploration of the Creative Thinking Structure in Chinese Art and Design Undergraduates: A Pilot Study of Jilin Province Undergraduates

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### ABSTRACT

This study investigates the structural dimensions of creative thinking among undergraduates majoring in art and design in Jilin Province and verifies the applicability of measurement tools. A pilot study design was employed, with stratified random sampling used to select undergraduates from universities in Jilin Province offering art and design programs. Data were collected using the University Students Creative Thinking Ability Scale (USCTAS), and statistical analyses including reliability testing, exploratory factor analysis (EFA), and normality testing were conducted using IBM-SPSS 27.0. The results showed that after removing items with low corrected item-total correlation (CITC), the remaining items formed a three-dimensional structure of creative thinking: Ability to Discover, Attention Ability, and Interpretation Ability. The scale demonstrated good internal consistency and suitability for factor analysis. This study clarifies the structural characteristics of creative thinking in this population and provides a reliable measurement tool and empirical basis for fostering creative thinking in art and design education.

### KEYWORDS:

Creative thinking, Exploratory factor analysis, Reliability, Art and Design Education

### 1. INTRODUCTION

Creative thinking is a core competency for art and design undergraduates, as it directly supports innovation in design practice and academic performance. A clear understanding of its structural dimensions is crucial for designing targeted training programs and conducting valid assessments, which in turn enhances the rigor of educational evaluation. However, in current Chinese art and design education, the cultivation of creative thinking often lacks precise structural guidance, relying on general frameworks that may not reflect discipline-specific characteristics like the integration of aesthetic perception and practical expression. Moreover, existing scales such as the University Students Creative Thinking Ability Scale (USCTAS) have not been sufficiently validated for Chinese art and design undergraduates, raising concerns about their applicability. By taking art and design undergraduates in Jilin Province as the research sample and using pilot study data to explore the structural dimensions of creative thinking, this study not only verifies the adaptability

of existing measurement tools in this specific group but also provides empirical support for optimizing localized scales. Furthermore, the findings can inform the design of discipline-specific creative thinking training strategies, contributing to the improvement of art and design education quality.

Existing research on creative thinking, as a multidimensional construct, has seen scholars exploring its structure across disciplines. Contemporary studies generally agree it is a composite of interrelated dimensions, though classifications vary by context. For example, general psychological studies divide it into divergent, convergent, and evaluative thinking, while educational research refines dimensions based on cognitive processes or practical outputs. However, studies targeting art and design undergraduates are limited. This discipline, integrating aesthetic perception, practical operation, and innovative expression, demands unique creative thinking manifestations that existing frameworks (developed for general or non-design populations) often overlook.

In terms of measurement tools, questionnaires are primary due to cost-effectiveness and suitability for large-scale data collection. USCTAS, developed by Xu (2023) with three core dimensions (Ability to Discover, Attention Ability, Interpretation Ability) and 15 items, has shown good reliability and validity in general undergraduates. But its

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structural adaptability in art and design undergraduates remains unvalidated. As scales need context-specific validation to avoid bias, and USCTAS items may not fully capture art and design students' unique creative experiences, its utility in this field is limited.

Existing literature has critical gaps: a lack of empirical studies on creative thinking structure for Chinese art and design undergraduates, unvalidated measurement tools like USCTAS for this group, and a scarcity of localized empirical evidence (given creative thinking is influenced by cultural and educational contexts). A pilot study offers a solution by testing existing scales in the target population, identifying structural inconsistencies, refining tools, and assessing reliability and validity, laying the groundwork for larger-scale research.

Against this backdrop, this study has two primary objectives: first, to clarify the latent structural dimensions of creative thinking among art and design undergraduates in Jilin Province, considering discipline-specific characteristics, and provide a theoretical framework; second, to validate the reliability and validity of USCTAS in this group, including internal consistency and structural validity. To achieve these, it addresses two core research questions: (1) What are the specific dimensional components of creative thinking among these undergraduates? (2) Does USCTAS demonstrate good reliability and structural validity when applied to them?

## 2. LITERATURE REVIEW

### 2.1 Structural Research on Creative Thinking

Creative thinking, a multidimensional construct, has been explored across disciplines to deconstruct its structure for measurement and intervention. Guilford (1950) laid the foundation by proposing that creative thinking centers on divergent thinking, including fluency, flexibility, originality, and elaboration, which has become a cornerstone (He, 2023). Contemporary studies agree it is a composite of interrelated dimensions, with classifications varying by context.

Torrance (1970) extended this by refining divergent thinking into processes like sensing problems and testing solutions, aligning with the "process view" (He, 2023). The Centre for Real-World Learning proposed a five-dimensional "Creative Habits of Mind" (CHoM): inquisitive, imaginative, persistent, collaborative, and disciplined, integrating cognitive dispositions and behaviors (Lucas, 2016). This model highlights that creative thinking involves not just idea generation but also persistence, collaboration, and refinement—relevant to design.

In art and design, creative thinking is unique due to the integration of aesthetic perception, operation, and expression. Design-based learning research shows it involves problem definition, information collection, solution generation, and prototype iteration (Doppelt, 2009). Fashion and textile design emphasizes "visual thinking" and "idea

documentation" via visual journals, reflecting dimensions like translating abstract concepts into visuals (Bannò, 2020). However, existing frameworks for general populations overlook discipline-specific characteristics. For example, CRL's model includes "disciplined" (Lucas, 2016) but not "material innovation" or "visual synthesis" critical for art and design students, highlighting the need for context-specific exploration.

### 2.2 Current Status of Measurement Tools

Validated measurement tools are key for operationalizing creative thinking. Psychometric scales, divergent thinking tasks, and portfolio assessments are widely used (Jiang et al., 2019). Questionnaires are favored for cost-effectiveness and large-scale data collection (Xu, 2023).

Xu (2023) developed the "University Students Creative Thinking Process Ability Scale" for Chinese undergraduates, with three dimensions:

**Ability to Discover:** Identifying problems and exploring information;

**Attention Ability:** Collecting and synthesizing information;

**Interpretation Ability:** Analyzing plans and selecting solutions.

With 15 items on a 5-point Likert scale, it has good reliability (Cronbach's  $\alpha > 0.8$ ) and validity in general undergraduates (Xu, 2023).

In design, portfolio assessment tracks creative thinking via design process documentation (Doppelt, 2009). In fashion design, visual journals (sketches, material samples) serve as creative tools and assessment media (Bannò, 2020).

Challenges exist in adapting general scales to art and design. Jiang et al. (2019) noted scales need context adjustments as item relevance varies. For example, Xu's (2023) "integrating existing information" should mean "synthesizing visual elements" in design, but no studies verify if the original structure fits art and design students, limiting tool utility.

### 2.3 Research Gaps and the Role of Pilot Studies

A critical gap exists: few empirical studies on creative thinking structure for Chinese art and design undergraduates, with three limitations:

First, most studies focus on general or other disciplines. Lucas (2016)'s model is for K-12, and He (2023)'s review synthesizes general frameworks, lacking art and design-specific dimensions (e.g., visual creativity), leaving educators without guidance.

Second, tools like Xu's (2023) scale, validated generally, lack testing in art and design undergraduates. Without validation, inaccurate evaluations may occur, as design portfolio assessments focus on process, differing from cognitive-oriented general scales.

Third, there is a lack of localized evidence. Creative thinking is influenced by culture and education (Lucas, 2016). Chinese art and design undergraduates, shaped by unique systems and

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values, may have distinct structures not captured by Western or non-design frameworks.

A pilot study can address this by testing scales (e.g., Xu, 2023) in art and design undergraduates to identify inconsistencies and refine tools. It can assess reliability and validity, laying groundwork for larger research (Thabane et al., 2021).

In summary, the lack of context-specific research and validated tools highlights the need for empirical exploration. A pilot study can fill this gap and inform creative thinking assessment in art and design education.

## 3. RESEARCH OBJECTIVES AND QUESTIONS

### 3.1 Research Objectives

The primary objectives of this study are twofold, both rooted in addressing the identified gaps in existing literature and practice:

First, to clarify the latent structural dimensions of creative thinking among art and design undergraduates in Jilin Province. This objective focuses on empirically identifying the core components that constitute creative thinking in this specific population, considering the discipline-specific characteristics of art and design (e.g., integration of aesthetic perception, practical creation, and innovative expression). By deconstructing the structure, the study aims to provide a clear theoretical framework for understanding how creative thinking manifests in art and design students.

Second, to validate the reliability and validity of the measurement tool (University Students Creative Thinking Ability Scale, USCTAS) in this target group. Specifically, this involves assessing whether the USCTAS, which has been used to measure creative thinking in general undergraduate populations (Xu, 2023), is structurally compatible with the creative thinking characteristics of art and design undergraduates. This validation includes testing internal consistency (reliability) and whether the scale's intended factor structure aligns with the empirical data (structural validity).

### 3.2 Core Research Questions

To achieve the above objectives, this study addresses two core research questions:

(1) What are the specific dimensional components that constitute creative thinking among art and design undergraduates in Jilin Province?

This question aims to explore the latent structure of creative thinking in the target population. It seeks to determine whether creative thinking in this group aligns with existing theoretical frameworks (e.g., the three-dimensional structure of "Ability to Discover, Attention Ability, and Interpretation Ability" proposed by USCTAS) or whether new discipline-specific dimensions emerge. The answer to this question will provide a precise description of how creative thinking operates in art and design contexts.

(2) Does the USCTAS demonstrate good reliability and structural validity when applied to art and design undergraduates in Jilin Province?

This question focuses on the psychometric properties of the measurement tool. It examines: (a) reliability, specifically internal consistency (assessed via Cronbach's Alpha) to ensure that the scale items consistently measure the intended construct; and (b) structural validity, verified through exploratory factor analysis to confirm whether the scale's item-factor relationships match its theoretical design. A positive answer will confirm the USCTAS as a valid tool for assessing creative thinking in this population, while a negative or partial answer will inform necessary adjustments to the scale.

## 4. METHODOLOGY

This study selected 130 valid participants through stratified random sampling from 8 Jilin universities with undergraduate art and design programs (3 first-tier, 4 second-tier, 1 third-tier). The distribution was proportional to the total population of art and design undergraduates in these universities: 32 (24.9%) from first-tier, 67 (51.6%) from second-tier, and 31 (23.5%) from third-tier. The sample size meets the minimum requirement of 100 for robust EFA and includes 30% over-sampling, and participants' demographics (gender, grade, age) are consistent with the target population.

The 15-item USCTAS developed by Xu (2023) was used to measure creative thinking, covering three dimensions: Discovery Ability, Attention Ability, and Interpretation Ability. Data were collected via Questionnaire Star, with 130 questionnaires distributed and all valid after screening. Ethically, relevant permissions were obtained, and participants were informed of details with their information kept anonymous and confidential.

IBM-SPSS 27.0 was used for data analysis, including Reliability Analysis (via Cronbach's  $\alpha$  and CITC), EFA (using PCA and Varimax rotation), Suitability Test for Factor Analysis (via KMO and Bartlett's Test), and other tests (normality and CMV tests with respective criteria).

## 5. RESULTS

### 5.1 Basic Data Feature Tests

Before conducting reliability and factor analysis, the pilot data were subjected to preliminary screening and validation to ensure data quality:

Missing Value Analysis: No missing values were detected in the 130 valid questionnaires, indicating complete data collection.

Outlier Detection: Univariate outliers were examined using box plots, and multivariate outliers were assessed using Mahalanobis distance. No extreme outliers were identified, so all 130 samples were retained.

Normality Test: The skewness values of all items ranged from -0.909 to 0.153, and kurtosis values ranged from -0.946 to

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0.684, both within the acceptable thresholds (skewness < ±1, kurtosis < ±2), confirming that the data conformed to a normal distribution

**Table 1 Normality Test Based on Skewness and Kurtosis(N=130)**

	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Creative Thinking	130	2.8	0.67	0.481	0.212	-0.44	0.422
Ability to discover	130	2.74	0.96	0.208	0.212	-0.86	0.422
Attention ability	130	2.88	0.95	0.394	0.212	-0.932	0.422
Interpretation ability	130	2.79	0.9	0.172	0.212	-0.915	0.422

**Common Method Variance (CMV) Test:** Harman’s single-factor test showed that the first factor explained 27.287% of the total variance (less than 50%), indicating no significant CMV.

**Table 2 Common Method Variance Explained Result (Pilot Data)**

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative
1	8.261	22.947	22.947	8.261	22.947	%
						22.947

**5.2 Reliability Analysis Results**

A reliability analysis was performed on the Creative Thinking construct to evaluate the internal consistency of items across its three dimensions: Ability to Discover, Attention Ability,

and Interpretation Ability. The purpose of this analysis was to verify that the items under each dimension are consistent and reliable enough to measure the construct effectively.

**Table 3 Reliability Analysis of Ability to Discover**

Item	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Cronbach's $\alpha$
Ability to Discover1	0.778		0.762
Ability to Discover2	0.634		0.841
Ability to Discover3	0.648		0.836
Ability to Discover4	0.667		0.829
Ability to Discover5	0.132		0.860
			0.781

The Ability to Discover dimension initially had 5 items with a Cronbach's Alpha of 0.781 (acceptable). However, Item 5 had a CITC of 0.132 (below 0.40) and removing it raised the

Cronbach's Alpha to 0.860. Thus, Item 5 was removed, leaving 4 items with a Cronbach's Alpha of 0.860 (good consistency) (Table 3).

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**Table 4 Reliability Analysis of Attention Ability**

Item	Corrected Correlation	Item-Total	Cronbach's Alpha if Item Deleted	Cronbach's $\alpha$
Interpretation Ability1	0.668		0.859	
Interpretation Ability2	0.725		0.850	
Interpretation Ability3	0.675		0.842	0.871
Interpretation Ability4	0.711		0.852	
Interpretation Ability5	0.791		0.845	

The Attention Ability dimension initially had 5 items, with a Cronbach's Alpha of 0.733 (acceptable). Attention Ability1 had a CITC of -0.014 (below 0.40), and removing it raised the

Cronbach's Alpha to 0.846. So, it was removed. The remaining 4 items then had a Cronbach's Alpha of 0.846 (good consistency). Results are in Table 4.

**Table 5 Reliability Analysis of Interpretation Ability**

Item	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Cronbach's $\alpha$
Attention Ability1 -0.014		0.846	
Attention Ability2 0.760		0.596	
Attention Ability3 0.572		0.690	0.733
Attention Ability4 0.841		0.657	
Attention Ability5 0.675		0.707	

The Interpretation Ability dimension had 5 items, with a Cronbach's Alpha of 0.871 (excellent). All items had CITC above 0.50, and their Cronbach's Alpha if Item Deleted was lower than the overall Alpha, meaning they all positively contributed to reliability. Results are in Table 5.

To guarantee the quality and reliability of the measurement tool, items were screened using Corrected Item-Total Correlation (CITC) and the change in Cronbach's  $\alpha$  when an item was deleted. Based on pilot study data, two problematic items were identified and excluded, leaving 13 items. The evaluation of these retained items using Cronbach's  $\alpha$  showed that their overall Cronbach's  $\alpha$  was 0.874 (greater than 0.8), indicating high internal consistency and good overall reliability of the scale. In terms of dimensional reliability, the "Ability to Discover" dimension (4 items) had a Cronbach's  $\alpha$  of 0.860, the "Attention Ability" dimension (4 items) had 0.846, and the

"Interpretation Ability" dimension (5 items) had 0.871. All dimensional Cronbach's  $\alpha$  coefficients exceeded 0.8, meaning each dimension also has good internal consistency and meets the reliability requirements for subsequent analysis.

**5.3 Exploratory Factor Analysis Results**

The suitability of the data for factor analysis was verified through the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's Test of Sphericity. The KMO value was 0.794, which is greater than 0.7, indicating a favorable degree of sampling adequacy. Bartlett's Test of Sphericity was statistically significant ( $\chi^2=900.817$ ,  $p=0.000$ ), confirming the presence of sufficient correlations among items to support factor analysis.

Table 6 KMO and Bartlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.0.794		
Bartlett's Test of Sphericity	Approx. Square	Chi-900.817
	df	78
	Sig.	0

Regarding the factor structure, Principal Component Analysis (PCA) with Varimax rotation extracted 3 factors based on the criterion of eigenvalue >1. These three factors collectively explained 69.449% of the total variance, which exceeds the 50% threshold, indicating that they effectively capture the

main information of the measured variables. The extracted factor structure was consistent with the theoretical dimensions of creative thinking (Ability to Discover, Attention Ability, and Interpretation Ability).

Table 7 Total Variance Explained for creative thinking ability

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.662	35.862	35.862	4.662	35.862	35.862	3.362	25.864	25.864
2	2.496	19.198	55.061	2.496	19.198	55.061	2.891	22.238	48.102
3	1.871	14.389	69.449	1.871	14.389	69.449	2.775	21.347	69.449

Extraction Method: Principal Component Analysis

As shown in Figure 1, the scree plot for the creative thinking ability variable sorted the 13 items into three components.

Following the third factor, a break was discovered on the scree plot for creative thinking ability.

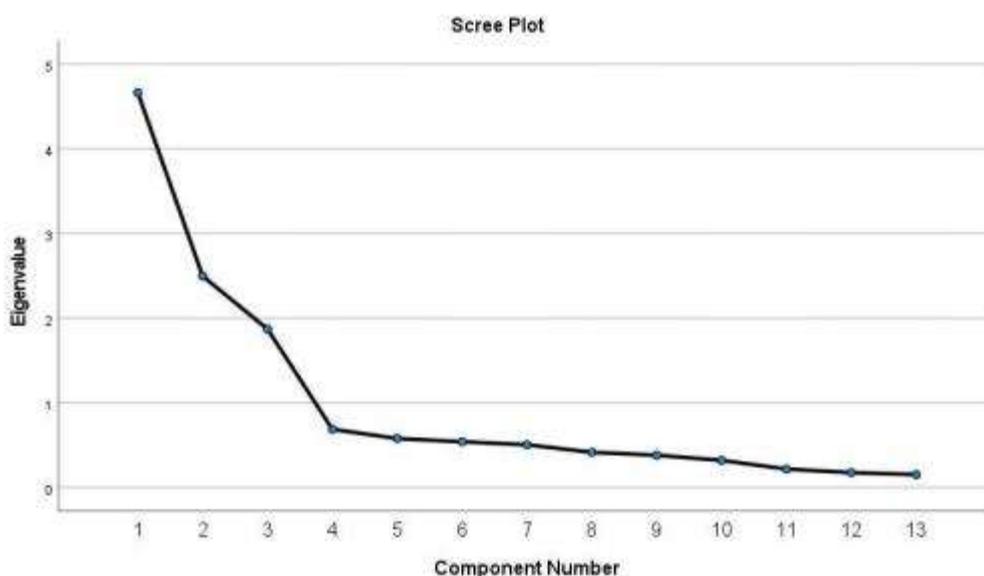


Figure 1 Scree Plot of creative thinking ability

As shown in Table 8, the eigenvalues of the actual data for the three components were higher than those of the simulative data, while the eigenvalues of the simulative data from the fourth component onwards were higher than those of the real data.

Thus, according to the scree plot and parallel analysis results, the creative thinking variable has a three-factor structure that should be retained, which is consistent with the existing literature on creative thinking.

Table 8 Parallel Analysis of Creative Thinking

Component Number	Actual Eigenvalue from PCA	Criterion Value from Parallel Analysis	Decision
1	5.231	1.8523	Accept
2	2.517	1.6345	Accept
3	1.189	1.3267	Accept
4	0.956	1.2154	Reject

6. DISCUSSION

6.1 Validation of Creative Thinking Structure

The results of this study confirm that the creative thinking of art and design undergraduates presents a three-dimensional structure, consisting of Ability to Discover, Attention Ability, and Interpretation Ability. This structure is consistent with the theoretical design of the USCTAS (Xu, 2023), which conceptualizes creative thinking as a process involving problem exploration, information organization, and solution optimization.

Specifically, the “Ability to Discover” reflects the initial stage of creative practice in art and design—identifying potential topics or problems through active exploration, which aligns with the discipline’s emphasis on “observational sensitivity.” The “Attention Ability” corresponds to the information processing stage, focusing on screening and integrating visual, material, or user-related information, a core skill for translating abstract ideas into design concepts. The “Interpretation Ability” emphasizes evaluating and refining solutions, such as adjusting visual expressions or optimizing material applications, which directly matches the “from concept to implementation” logic of art and design creation.

Compared with existing studies, this three-dimensional structure fills the gap in discipline-specific research on creative thinking. Previous studies on general populations or non-design fields often highlight “abstract thinking” or “logical reasoning” (Creswell, 2018; Gagnon & Barber, 2018), but rarely address the practical orientation of creative thinking in art and design. For example, the “Interpretation Ability” identified in this study emphasizes “scheme implementation and optimization,” which distinguishes it from the theoretical “evaluative thinking” in other fields. This refinement not only verifies the applicability of the USCTAS in art and design contexts but also provides a more targeted framework for understanding how creative thinking operates in creative practice.

6.2 Appropriateness of the Scale

The optimized 13-item version of the USCTAS demonstrates strong applicability for measuring creative thinking among Chinese art and design undergraduates. In terms of reliability, the overall Cronbach’s  $\alpha$  coefficient of the scale is above 0.8, and the coefficients for each of the three dimensions (Ability to Discover, Attention Ability, and Interpretation Ability) also exceed 0.8, indicating high internal consistency. In terms of

validity, the exploratory factor analysis (EFA) results show a clear three-factor structure that matches the theoretical dimensions, with cumulative variance explanation rate reaching 69.449% and all item loadings above 0.6. These psychometric properties confirm that the optimized scale can effectively capture the characteristics of creative thinking in this population.

The two items removed during the optimization process (AD5 and AA1) provide insights into adjusting the scale for art and design disciplines. AD5, which measures “persisting in exploration when goals are uncertain,” and AA1, which focuses on “generating new ideas through intuition,” may have weak relevance to the discipline’s emphasis on “practical verification.” Art and design creation typically requires combining intuitive inspiration with practical testing, so items that overly emphasize “uncertain exploration” or “pure intuition” may not align with students’ actual creative experiences. Future applications of the scale in art and design contexts could refine the wording of such items to better reflect the discipline’s integration of intuition and practice, further enhancing the scale’s contextual appropriateness.

6.3 Research Value and Limitations

This study clarifies that art and design undergraduates’ creative thinking has three operational dimensions (Ability to Discover, Attention Ability, Interpretation Ability), bridging the gap between theory and educational practice and providing guidance for “dimension-specific cultivation” in teaching—for example, designing project-based learning to enhance Interpretation Ability or organizing information tasks to strengthen Attention Ability, thus improving creative education effectiveness. However, it has limitations: the sample was only from Jilin Province, and the three-dimensional structure may not generalize to other regions, so future research should expand samples; additionally, it did not explore differences across grades or specialized directions, limiting a nuanced understanding.

7. CONCLUSION

Based on the pilot study data of art and design undergraduates from 8 universities in Jilin Province, this research confirms that the creative thinking of this group is composed of three distinct dimensions: Ability to Discover (information exploration and

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problem identification), Attention Ability (information screening and integration), and Interpretation Ability (scheme optimization and practice). These dimensions form a logical creative thinking process that aligns with the “observation-implementation” characteristics of art and design disciplines. Additionally, the optimized University Students Creative Thinking Ability Scale (USCTAS) with 13 items (after removing 2 items with low relevance) demonstrates good reliability (overall Cronbach’s  $\alpha = 0.874$ ) and structural validity (three-factor structure explained 69.449% of total variance). This confirms that the adjusted scale is an effective tool for measuring creative thinking among Chinese art and design undergraduates in Jilin Province.

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