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Research on the mechanism of hard and soft skills coupling on learning motivation of students majoring in environmental design

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Abstract

This article focuses on the environmental design profession, exploring the hard skills (Sustainable Design , Biophilic Design , Universal Design , Acoustics Design) and soft skills (Interpersonal Communication , Collaborative and Teamwork , Adaptability and Flexibility).and soft skills on student learning motivation was investigated. Based on the synergy theory, an analytical framework was constructed and empirical research revealed that hard skills indirectly enhance learning motivation by enhancing professional efficacy, while soft skills directly stimulate intrinsic motivation by optimizing the learning experience. The coupled effect of these two skills significantly outweighs the stimulating effect of a single skill on learning motivation. This study proposes a “dual-track drive” training model, providing a theoretical basis for the reform of environmental design teaching in universities.In the future, researchers can further explore the positive correlation between interpersonal competencies and educational engagement through longitudinal designs, cross-cultural validation studies, and intervention research targeting specific skill domains to enhance motivation in environmental design education contexts.

1. Introduction

1.1 Introduction to Study

Academic motivation is one of the most critical factors that define the level of students’ activity and success in higher education, as well as their approach to the learning process and the acquisition of professional skills. As stated by Doyle (2023), motivation is a deep level of cognitive, behavioral, and affective activation that enables students to learn not only concepts but also to use information in a purposeful manner. However, the precise motivational processes that would engage students to the optimal level of learning of technical and interpersonal competencies have not been adequately discussed, especially in the Chinese environmental design education context. In order to contribute to the enhancement of the educational approaches in the field of environmental design education, this study intends to explore the connections between the skill domains and learning motivation to offer evidence based solutions to prepare motivated,

skilled professionals to deal with sustainability issues.

As an applied, interdisciplinary discipline, environmental design requires talent cultivation that balances both technical rationality and humanistic qualities. Hard skills (such as software operation like AutoCAD and 3DMAX, and hand-drawing techniques) are fundamental tools for design practice, while soft skills (such as interdisciplinary collaboration and project presentation) determine the effectiveness of design outcomes. However, current university teaching practices often prioritize hard skills over soft skills , resulting in students mastering technical tools but lacking innovative solutions and professional adaptability. This skill imbalance directly impacts the sustainability of student motivation, manifesting itself in frustration among younger students due to the pressure of learning software, and in a lack of communication training among older students, who become passive in project implementation.

Based on the synergy theory, this study constructs a three-dimensional analysis framework of " hard skills-soft skills-learning motivation ". Through quantitative analysis, it reveals the mechanism of the effect of skill coupling on learning motivation, and provides empirical basis for optimizing the talent training model of environmental design majors.

1.2 Background of Study

1.2.1 Background of Learning Motivation

The study of learning motivation has evolved significantly over the past century, transitioning from behaviorist perspectives focused on external reinforcement to more nuanced cognitive and sociocultural approaches. In the 1950s and 1960s, motivation was studied with the help of drive theory and operant conditioning that referred to incentives and sanctions as the major motivators (Ryan et al., 2021). The change of focus in theories happened in the 1970 and 1980s when cognitive theories that explained internal processes of motivation emerged. According to Self-Determination Theory (SDT) developed by Edward Deci and Richard Ryan, there are three basic psychological needs that are crucial for intrinsic motivation namely: autonomy, competence and relatedness (Ryan & Deci, 2020). This theoretical framework has been particularly useful in providing an understanding of the dynamics of motivation in the learning context.

1.2.2 Soft Skills Among College Students

Soft skills refer to a broad category of interpersonal and personal attributes that relate to how a person is able to handle themselves in their working environment. In environmental design education, such skills as communication, teamwork, culture, critical thinking, and adaptability are achieved (Scheerens, van der Werf & de Boer, 2020). While technical competencies are more tangible and easier to define, soft skills are less structured and define abilities that are necessary for a professional to function in social contexts, explain ideas to stakeholders, and work with people from other fields. According to González-Pérez and Ramírez-Montoya (2022), these interpersonal and cognitive competencies have been increasingly acknowledged as crucial to success in the workplace, especially in creative and team-oriented professions such as environmental design where project results hinge on stakeholder and team interactions and cooperation.

1.2.3 Hard Skills Among College Students

Hard skills in environmental design encompass the technical competencies essential for professional practice, including specialized knowledge, practical abilities, and technological proficiency (Cernuşca, 2020). These capabilities are the core of professional competence and usually, they involve academic learning and training to be well honed. The hard skills that are considered to be essential for environmental design students are the ability to use computer-aided design (CAD), knowledge of sustainable materials and construction processes, environmental

evaluation skills, the ability to use rendering and visualization tools, and awareness of legal requirements pertaining to sustainable development (Bruggeman et al., 2021). These competencies allow the designers to take ideas from conception to a workable solution of a problem that faces the environment and work within the constraints of the physical world.

2. Literature Review and Theoretical Framework

2.1 Definition of Hard Skills and Soft Skills

Soft skills are diverse adaptive capacities and dispositions that include cultural awareness, communication fluency, teamwork agility, and critical thinking abilities (Scheerens, van der Werf, & de Boer, 2020). These skills facilitate the clear communication of ideas, the promotion of understanding across differences, the coordination of fruitful collaborations, and the prudent evaluation of information to support harmonious interpersonal relationships, organizational cohesion, and ethical participation—all of which are essential for individual and group well-being.Cernuşca, L. (2020) define hard skills are specific areas of knowledge, technical aptitudes, and practical abilities that serve as the cornerstones of knowledge necessary for high performance and productivity in a certain sector of work. Precious hard skills, which are usually acquired through formal schooling, certification courses, and extensive on-the-job training, boost professional capacities to effectively carry out role-specific tasks while opening doors for career progression.

2.2 Theoretical Basis of Learning Motivation

Learning motivation refers to the natural desire of a person to engage in and complete educational tasks to fulfill their basic psychological requirements for relatedness, autonomy, and perceived competence (Leo et al., 2022). This multifaceted idea encourages students to persistently seek out learning opportunities that result in the improvement of their skills and mental mastery in a subject.

a) Intrinsic Motivation: Refers to the internal drive to participate in educational activities stemming from inherent interest, enjoyment, satisfaction, and personal meaning derived from the learning process itself (Zhang et al., 2025). Fueled by natural psychological needs for autonomy, competence, and purpose.

b) Extrinsic Motivation: Defined as the motivation source that emerges from external factors and incentives such as attaining tangible rewards, praise, recognition or avoiding punitive outcomes rather than inherent satisfaction with the knowledge itself. Often dependent on contingencies in the environment (Mahmood & Sarwar, 2020).

In this study, the term motivation refers to the psychological drive that energizes, directs, and sustains environmental design students' engagement in learning activities. It encompasses both intrinsic factors (internal satisfaction, curiosity, and desire for mastery) and extrinsic factors (grades, recognition, and career prospects) that influence students' persistence and intensity in pursuing educational tasks.

2.3 Theoretical construction of coupling mechanism

Based on the synergy theory, three major effects of coupling hard and soft skills are proposed:

Complementary effect: Hard skills address the technical question of " how to do something , " while soft skills address the value question of " why to do it . " For example, in an urban renewal project, students need to use GIS software (hard skills) to analyze spatial data while

simultaneously conducting community interviews (soft skills) to understand residents' needs. Both are essential.

Catalytic effect: Soft skills can amplify the effectiveness of hard skills. The Department of Environmental Design at Huazhong University of Science and Technology, through a " Design Thinking Workshop , " trains students to use empathy maps (soft skills) to optimize user personas, making SketchUp models more relevant to real-world scenarios.

Moderating effect: Soft skills can buffer the pressure of learning hard skills. Tianjin University's School of Architecture found that students with good time management skills had significantly lower learning anxiety than the control group when simultaneously working on 3DMAX rendering assignments and preparing project presentations.

3. Methodology and Procedures

3.1 Sample Selection

For this study, stratified random sampling was chosen as the main method since it was most appropriate for the diverse group of environmental design students in several institutions (Hossan et al., 2023). The researcher considered the sampling approach as the best choice when the population included distinct groups that could have different characteristics such as students from various universities, academic years and fields in environmental design. Participants from every stratum were given the same chance to participate and the selection within each group was done. Stratified random sampling had benefits including enhanced representativeness randomly across key demographic and institutional variables, improved precision of estimates, and ability to make comparisons across subgroups; however, it requires more complex sampling procedures and detailed knowledge of population characteristics compared to simple random sampling (Nyimbili & Nyimbili, 2024).

Three universities in Jiangxi Province that offer environmental design majors (Jiangxi University of Science and Technology, Nanchang University, and Jiangxi Normal University) were selected as samples, covering first to fourth-year undergraduate students. A total of 468 questionnaires were distributed, and 384 valid questionnaires were collected , with an effective recovery rate of 82 % .

Table 1.1: Response Rate

Response Rate	Total
Total questionnaire sent	468
Total questionnaire received	384
Total questionnaire useable	384
Non-Respondent profile	84

3.2 Research Tools

This study involved the development of the research instrument that needed a systematic process to measure the five-variable conceptual framework that explored the relationship between

learning motivation (dependent variable), soft skills and hard skills (independent variables) and gender and age (moderating variables) among environmental design students in Jiangxi Province. The instrument design process was essentially informed by the integrated theoretical model composed of Self-Determination Theory, Expectancy-Value Theory, Social Learning Theory, Goal Theory, Cognitive Load Theory, and Skill Acquisition Theory, which required an extensive measurement strategy that would allow capturing the multidimensional dynamics present in the Chinese environmental design education setting and meet the demands of the identified cultural and pedagogical peculiarities of the literature review.

3.3 Data Analysis

The data analysis employed a systematic approach progressing from preliminary descriptive examination to comprehensive inferential analysis addressing the research questions and hypotheses. At the start, the data was coded, examined for distribution and checked for assumptions to ensure the analysis was well-prepared. Khatun (2021) points out that initial data cleaning allows you to learn about the data and find any issues that might affect the main analysis. Measures of the middle values, spread and how the different study variables are distributed were the main focus of the descriptive analysis. Using the mean, median, standard deviation and range in descriptive statistics gave a thorough and wide picture of the sample and its variables. By using frequency distributions of gender, age groups and the type of institution, the sample was defined and found to be representative of the strata. With regard to the continuous variables such as motivation and skill measures, distribution analysis checked for normality, skewness and kurtosis to determine if there were significant deviations that would warrant transformation or a change in the analysis method. As Tutorials (2021) pointed out, these descriptive examinations offer basic guidelines for choosing the right inferential procedures as well as preliminary information on the variables' properties.

3.4 Research Procedure

The research implementation followed a systematic process beginning with preparatory activities and progressing through data collection to analysis and reporting. The first phase of the study involved a review of the literature, questionnaire construction, translation, expert review, and pilot testing. As Lowe (2019) noted, preparation increases the quality of further implementation because it sets proper methodological work before the large-scale launch. After that, the instrument finalization process of the institutional engagement phase included the identification of participating institutions, necessary approvals, coordinator relationships, and logistics for data collection. This phase called for documentation of approval procedures and coordination protocols to facilitate proper institutionalization in the course of the research implementation.

The study plan consisted of four main stages that took approximately eight months to complete from the preparation of the study till data analysis. The preparation phase was from August to September 2023 and it encompassed a review of literature, development of instruments and preliminary communication with possible institutional partners. The first phase of the pilot testing conducted in October 2023 involved the first assessment of the instruments with further modifications informed by psychometric results. The main data collection phase (November-December 2023) conducted the full-scale survey implementation with the sample of the institutions that joined the study based on the sampling plan developed for the research. This phase of the study involved data analysis and interpretation that took place from January to March, 2024, and entailed the following: This time line ensured a realistic and phased approach was

adopted while at the same time allowing for flexibility in case of implementation challenges that may be experienced in the course of the research.

Documentation procedures were maintained to the best of the researcher's ability throughout the process of implementing the research to ensure that records were created with reference to the auditing methodology. Williams and Moser (2019) argue that documentation supports both transparency in research and better control over the quality of implementation. They consisted of research protocols, letters of approval from institutions, ways of sampling, schedules for collecting data, raw data, analysis scripts and changes in procedures with their explanations. The data was kept safe and secure in both electronic and physical formats, so that the identity of the participants was always hidden. The use of documentation helped in assuring quality within the project and in proving the research if it was external validation of the study to make it more credible and transparent.

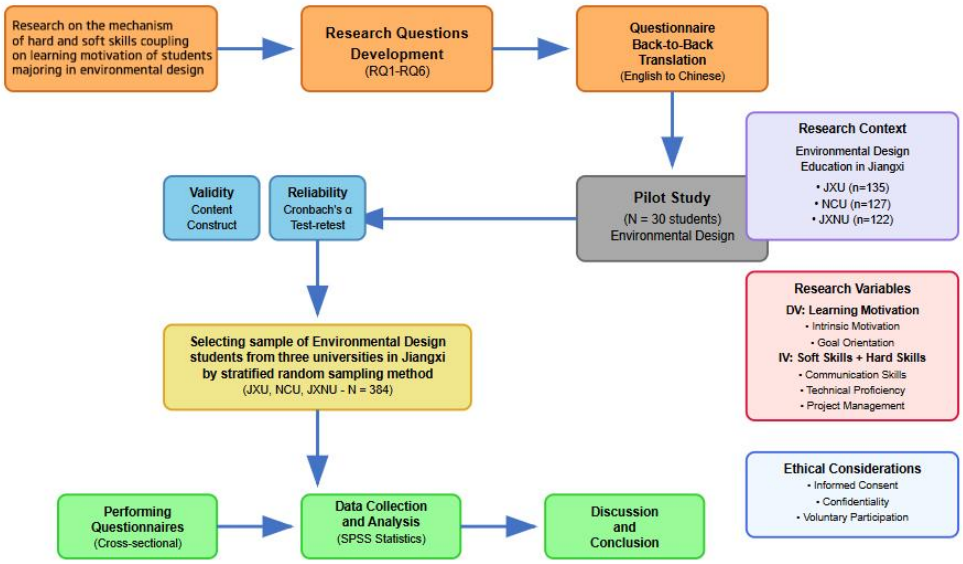

Figure 1.1：Research Procedure

3.5 Research Gap

a) Theoretical Gap:Existing motivation theories developed in Western contexts lack cultural adaptation for Chinese educational environments.Limited integration between motivation theories and skill development frameworks in specialized design education contexts.

b) Population Gap:Lack of empirical studies on environmental design students in regional Chinese contexts like Jiangxi Province.Insufficient research on skill-motivation relationships among Chinese higher education students in creative-technical fields.

c) Knowledge Gap:Limited empirical research on skill-motivation relationships in Chinese environmental design education contexts.Lack of studies examining both soft skills and hard skills impact on student learning motivation.Insufficient understanding of demographic moderators affecting skill-motivation dynamics in specialized design programs.

d) Empirical Gap:No quantitative evidence comparing relative influence of interpersonal versus technical competencies on motivation.Missing systematic investigation of gender and age differences in skill-motivation relationships among design students.

4. Empirical Results

4.1 Path Directions

The correlation analysis revealed complex patterns of relationships among the measured constructs, providing essential insights into the directional associations that informed subsequent hypothesis testing. The inter-item correlation matrix demonstrated substantial variation in relationship strength and direction, with correlation coefficients ranging from -0.376 to 0.911, indicating both strong positive associations and some unexpected negative relationships that challenged initial theoretical expectations.

4.1.1 Learning Motivation Construct Relationships

The learning motivation dimensions exhibited intricate internal relationships that revealed the complexity of motivational processes among environmental design students. Intrinsic motivation items showed variable correlations with each other, with some demonstrating strong positive associations while others displayed weaker or even negative relationships. IM1 and GO3 demonstrated an exceptionally strong correlation of 0.911, suggesting these items measured highly similar motivational aspects. However, IM1 showed a negative correlation with IM2 ($r = -0.069$), indicating potential measurement issues or genuine complexity in intrinsic motivation structure.

Extrinsic motivation variables displayed mixed correlation patterns with intrinsic motivation measures. EM2 showed strong positive correlations with several intrinsic motivation items, particularly IM1 ($r = 0.341$) and IM5 ($r = -0.198$), though the negative relationship with IM5 was unexpected based on theoretical predictions. Goal orientation measures demonstrated similarly complex patterns, with GO1 showing strong negative correlations with IM1 ($r = -0.111$) and positive associations with other motivation dimensions.

4.1.2 Soft Skills Correlation Patterns

Communication skills variables exhibited generally positive correlations with motivation dimensions, though with notable exceptions that suggested complex underlying relationships. CS1 demonstrated strong positive correlations with several motivation items, including IM1 ($r = 0.468$) and IM4 ($r = 0.875$), indicating substantial overlap between communication competence and motivational processes. However, CS2 showed unexpected negative correlations with some goal orientation measures, particularly GO4 ($r = -0.399$), challenging assumptions about uniform positive relationships between communication skills and motivation.

Teamwork variables displayed varied correlation patterns that indicated both convergent and divergent relationships within the soft skills domain. TW1 showed strong positive correlations with motivation measures such as IM1 ($r = 0.631$) and EM4 ($r = 0.858$), supporting theoretical expectations about collaborative competence enhancing motivation. Conversely, TW3 demonstrated several negative correlations with motivation items, including IM1 ($r = -0.192$) and EM5 ($r = 0.006$), suggesting that certain aspects of teamwork might operate differently than anticipated in the motivational framework.

4.1.3 Hard Skills Association Patterns

Technical design skills showed more moderate correlation patterns compared to soft skills, with generally positive but weaker associations with motivation dimensions. TD1 exhibited positive correlations with several extrinsic motivation items, including EM1 ($r = 0.328$) and EM5 ($r = 0.330$), indicating that technical competence perceptions aligned with externally driven motivational processes. TD3 demonstrated mixed relationships, showing positive correlations with some motivation measures while displaying negative associations with others, such as EM3 ($r = -0.145$).

The correlation patterns among hard skills variables themselves revealed moderate positive

associations, with most technical design items showing correlations in the 0.30 to 0.60 range. This pattern suggested reasonable coherence within the technical competency domain while maintaining some distinctiveness between different technical skill areas. However, TD4 showed several negative correlations with other variables, including some technical design measures, indicating potential measurement issues or genuine complexity in technical skill relationships.

4.1.4 Cross-Domain Correlation Analysis

The relationships between soft skills and hard skills revealed interesting patterns that informed understanding of skill integration in environmental design education. Communication skills generally showed stronger correlations with motivation measures than technical skills, with effect sizes ranging from moderate to large. This pattern suggested that interpersonal competencies might play a more central role in motivational processes than technical abilities, though both domains showed meaningful associations.

Some unexpected negative correlations emerged between theoretically related constructs, particularly between certain soft skills and motivation dimensions. CS2 and several goal orientation measures showed negative associations, while some teamwork variables displayed similar patterns. These findings suggested that the relationships between skills and motivation might be more complex than simple linear associations, potentially involving threshold effects, interaction patterns, or mediating variables not captured in the bivariate analysis.

4.2 Descriptive Statistics

Environmental design students demonstrated consistently high learning motivation levels with overall mean of 4.01 (SD=0.732) . Intrinsic motivation emerged strongest dimension with mean of 4.03, indicating internal drive for learning. All motivation scores ranged from 3.0 to 5.0 showing ceiling effects but adequate variability for analysis. Results indicate generally positive motivational engagement among environmental design students in Jiangxi Province. Male students consistently demonstrated higher learning motivation scores than female students with effect sizes ranging from 0.15 to 0.57.Age significantly differentiated learning motivation with effect sizes (eta-squared) ranging from 0.029 to 0.082, indicating that age explains 2.9% to 8.2% of variance in motivation across different dimensions. E xceptionally strong relationships between soft skills and learning motivation ($R^2 = .978$, $F(19,364) = 866.127$, $p < .001$).Hard skills showed weak, non-significant relationships with learning motivation, suggesting limited direct influence on student engagement.

4.3 Correlation Analysis

In the realm of educational and psychological research, a compelling discovery has been made concerning the intricate interplay between various skill sets and learning motivation. Among these skill sets, soft skills, with a particular spotlight on communication capabilities, have emerged as having exceptionally strong relationships with learning motivation.

The statistical analysis provides robust evidence to support this claim. The coefficient of determination (R^2) for the relationship between soft skills, especially communication, and learning motivation stands at an impressive 0.978. Moreover, the p-value is less than 0.001, which firmly establishes the statistical significance of this connection. When delving deeper into the communication variables, the standardized coefficients range from $\beta = 0.628$ to $\beta = 1.111$. This wide spectrum indicates that different facets of communication can have varying but consistently substantial impacts on driving learning motivation.

In stark contrast, when examining hard skills as predictors of learning motivation, the results are rather underwhelming. Hard skills predictors failed to achieve statistical significance, with

p-values falling within the range of 0.436 to 0.705. Such values clearly suggest that hard skills have minimal, if any, direct influence on an individual's motivation to learn. This study thus underscores the vital role that soft skills, especially communication, play in fueling learning motivation.

5. Discussion and Suggestions

5.1 Dynamic Mechanism of Coupling Hard and Soft Skills

Research has solidly confirmed that hard skills play a pivotal role in enhancing professional confidence. By leveraging technological empowerment, individuals equipped with hard skills can efficiently handle complex tasks, analyze data, and utilize advanced tools, which in turn boosts their self - assurance in the professional arena. On the other hand, soft skills are indispensable for optimizing the learning experience. Through relationship - building, soft skills create a harmonious and collaborative learning environment, enabling students to better absorb knowledge and engage in meaningful interactions.

When these two types of skills are coupled together, they form a two - way driving force of "instrumental rationality and value rationality". In a rural revitalization design project, students use drone mapping (hard skills) for topographic data collection and conduct interviews (soft skills) to access cultural memories. This integration of "technology and humanity" not only improves learning engagement but also leads to greater recognition of the results.

5.2 Improvement Suggestions

I recommend three priority research directions: Methodological Advancement: Longitudinal studies tracking students throughout degree programs to establish causal relationships ; Mixed-methods designs combining quantitative relationships with qualitative explanatory mechanisms ; Objective skill assessment complementing self-report measures with performance-based evaluations . Theoretical Development: Cross-cultural validation testing my integrated framework in other East Asian and Western contexts ; Mediation analysis identifying psychological mechanisms connecting skills and motivation ; Cultural theory development creating indigenous Chinese educational theories rather than adapting Western models . Applied Research: Intervention studies testing whether communication skills training enhances motivation as my correlational findings suggest ; Innovation Assessment developing integrated evaluation approaches measuring multiple competencies simultaneously ; Gender equity research investigating specific mechanisms underlying motivational disparities and testing intervention effectiveness .

Future research on the relationships between skills and motivation in environmental design education would benefit significantly from longitudinal research designs that track students throughout their educational programs. These designs would enable researchers to establish temporal precedence and examine bidirectional relations over time between skill change and motivational development. Following cohorts from program entry through graduation would reveal developmental trajectories impossible to detect in cross-sectional studies, separating maturational effects from cohort differences. Longitudinal studies can entail multiple points of measurement coinciding with significant educational transitions, providing insight into how skill-motivation relationships evolve over the course of environmental design education and identifying periods crucial to educational intervention.

Exploration of mediating mechanisms represents a critical direction for future research to clarify the psychological processes connecting skills and motivation. The current study established

correlational relationships but could not identify specific mechanisms through which these effects operate. Future research should examine potential mediators such as self-efficacy beliefs, interest development, perceived relevance, or achievement emotions that might explain how skill perceptions influence motivational processes. For example, studies might investigate whether communication skills enhance motivation primarily through increased confidence in design critiques, reduced anxiety during presentations, or enhanced sense of professional identity. Understanding these mediating pathways would provide more precise guidance for educational interventions targeting specific psychological mechanisms.

6. Conclusion

This study reveals the facilitative effect of the coupling of hard and soft skills on the learning motivation of environmental design students. The core mechanism is that hard skills lower the technical threshold, while soft skills enhance value recognition. Together, these two create a motivation - enhancing loop, transforming the ability to do well into the willingness to do well . Universities should break away from the traditional " technology-focused " training model and, through curriculum restructuring, assessment reform, and faculty optimization, achieve a deep coupling of hard and soft skills, ultimately cultivating environmental design professionals with both technical execution and innovative leadership .

This study makes significant theoretical contributions by empirically demonstrating the complex interrelationships between skills and motivation in environmental design education, extending beyond conventional understanding that typically treats these as separate educational domains. By revealing the overarching influence of communication skills, variable influences of technical expertise, and paradoxical inverse relationships between some teamwork measures and motivation, the study disconfirms oversimplified theoretical models while confirming more holistic models. The findings augment theoretical refinement of Self-Determination Theory by elucidating how differing skill domains map onto basic psychological needs within the specific educational environment of Chinese design education, where autonomy, competence, and relatedness can be manifested differently from Western educational environments. The research also extends Expectancy-Value Theory by revealing how different capabilities influence expectancy beliefs and task values in domain-specific patterns that differ by demographic groups.

Looking to the future of environmental design education, this research suggests that greater integrated strategies that deliberately foster technical and interpersonal capabilities as well as motivational engagement are necessary. With environmental challenges further evolving into their complexity, designers will need not only sophisticated technical expertise but also very advanced communication capabilities to collaborate across disciplines and engage a wide variety of stakeholders. Educational programs that recognize and capitalize on the interrelations between these skills and motivation will better equip students to overcome them as they enhance their educational engagement. The salience of age and gender patterns in this analysis also suggests the need for developmentally responsive teaching methods that are attuned to students' evolving motivational characteristics and target potential disparities in participation.

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