An Investigation Of Cultivation Pathways For University Students' Research Abilities: A Survey Based On The "Challenge Cup" Competition In Zhaoqing Institutions

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Abstract:
To investigate the developmental pathways for enhancing the research abilities of university students in China's regional higher education institutions, a questionnaire survey was administered to students in the Zhaoqing area. The "Challenge Cup" competition was utilized as the focal point for this investigation. Grounded in the Theory of Planned Behavior and relevant scholarly literature, a hypothetical model was constructed. In this model, institutional support and personal motivation were conceptualized as exogenous latent variables, with research participation serving as a mediating variable and perceived research ability as the outcome variable. The objective of the research was to examine the influence of institutional and individual-level factors on students' engagement in research activities; furthermore, the mediating effect of research participation in the process of enhancing students' perceived research abilities was also scrutinized. A significant positive influence of institutional support and personal motivation on students' willingness and engagement in research was identified. It was also found that research participation functions as a crucial mediator between the antecedent factors of institutional support and personal motivation, and the outcome of perceived research ability. Based on these findings, specific recommendations were formulated to optimize the cultivation system for university students' research competencies. These recommendations are structured across three distinct levels: the institution, the faculty, and the student body, including proposals for the enhancement of institutional guarantees, increased resource investment, the optimization of mentorship models, and the stimulation of students' intrinsic motivation. It is anticipated that these suggestions will provide valuable theoretical and practical references for the development of innovative talent cultivation models within China's regional higher education institutions.
Keywords: *university students; research ability; Challenge Cup; talent cultivation*

Introduction

Background and Problem Statement

In the contemporary era of globalization and the knowledge economy, innovation has been established as the principal impetus for national development and social advancement. Higher education, positioned as the primary platform for cultivating high-level innovative talent, has seen the pedagogical models for developing the research and innovation abilities of university students receive unprecedented attention (Baumert & Kunter, 2013). In recent years, significant emphasis has been placed on innovation education for university students by the Chinese government. High-level, nationwide competitive platforms, such as the "Challenge Cup" National University Student Extracurricular Academic Science and Technology Works Competition and the "Internet+" University Student Innovation and Entrepreneurship Competition, have been established. The aim of these initiatives is to foster a robust campus research atmosphere by promoting learning and innovation through competition, thereby enhancing students' scholarly literacy and practical skills. The "Challenge Cup" competition, recognized as one of the most influential extracurricular academic activities for university students in the country, is designed to guide and motivate students to revere science, pursue knowledge, and develop their innovative spirit and practical capabilities.

However, significant disparities are observed in how effectively higher education institutions across different regions and tiers organize student participation and translate such engagement into tangible gains in research ability. For regional undergraduate institutions in particular, the question of how to systematically enhance university students' research competencies by effectively leveraging competitions like the "Challenge Cup" under conditions of limited resources presents a critical issue demanding scholarly investigation. This study is

focused on the higher education institutions within the Zhaoqing region of Guangdong Province. Through a survey of university students in this area, an in-depth analysis of the key factors that influence student participation in the "Challenge Cup" and other research-oriented innovation activities is intended to be performed. The cultivation pathways and actual outcomes related to their research abilities are also explored. Specifically, this research attempts to address the following core questions: What is the current state of research participation among university students in Zhaoqing's higher education institutions? What are their perceptions of and attitudes toward competitions such as the "Challenge Cup"? At the individual level (e.g., academic motivation, time and energy, self-efficacy) and the institutional level (e.g., policy support, faculty resources, academic atmosphere), what factors significantly influence the willingness and behavior of university students to participate in research activities? Can participation in the "Challenge Cup" and similar competitions effectively enhance students' research and practical skills, and what are the underlying mechanisms of this effect?

To answer these questions, a quantitative research methodology will be employed in this study. Data will be collected via a questionnaire survey, and Smart-PLS will be utilized to test the complex relationships between the various influencing factors and the research abilities of university students. It is anticipated that this work will provide empirical evidence and optimized pathways for the cultivation of research abilities among students in Zhaoqing and similar regional higher education institutions across China.

Significance

The theoretical significance of this research is threefold. First, the classic Theory of Planned Behavior (Ajzen, 1991) is applied to the analytical framework of university students' research behavior. An exploration is conducted into how attitude, subjective norms (e.g., institutional atmosphere, faculty encouragement), and perceived behavioral control (e.g., knowledge reserves, self-confidence) collectively influence students' intentions and actions regarding research participation. This work thereby extends the application of the Theory of Planned Behavior within the field of higher education research. Second, through the construction of a structural equation model, not only are direct effects analyzed, but the mediating role of "research participation" between multiple influencing factors and the "enhancement of research ability" is also deeply investigated. This approach helps to elucidate the internal logic and operational mechanisms of the "competition-promotes-learning" model, enriching the theoretical framework for innovative talent cultivation. Finally, as empirical research focusing on the "Challenge Cup" as a means to cultivate the research abilities of university students in a specific region (Zhaoqing) has not yet been undertaken, this study provides new material and perspectives for regional higher education research in China.

The practical implications of this study are particularly pronounced. First, through an empirical analysis of the current state and challenges concerning the research abilities of university students in Zhaoqing's higher education institutions, a precise "diagnostic report" can be furnished for the region's educational administrators. This report is intended to help them understand the actual implementation effects of policies and the core needs of students. Second, the conclusions drawn from the research can directly inform specific policy recommendations. For example, if faculty resources and institutional promotion are confirmed by the model to be key driving factors, a heightened focus should be placed by institutions on faculty mentorship development and the targeted dissemination of competition information. Guidance is also provided for students on how to better engage in research activities. By identifying personal barriers to participation (e.g., a lack of confidence, uncertainty about how to begin), students can be guided toward targeted self-improvement, while a basis is concurrently provided for institutions to develop relevant support services, such as offering methodology courses or facilitating the formation of interest groups. Ultimately, an effective pathway for enhancing students' innovative consciousness and research abilities is sought through this research, with the aim of improving the platforms for student research engagement and thereby contributing a greater number of high-quality, innovative talents to society.

Literature Review And Theoretical Framework
Core Connotations of University Students' Research Ability

The research ability of university students is widely conceptualized as a multidimensional and comprehensive construct. It is generally agreed among academic researchers that this ability not only involves the mastery of specialized knowledge but also encompasses the entire process from problem identification to solution implementation. In their social cognitive career theory, Lent et al. (2005) emphasized that research interest and self-efficacy are the key psychological drivers for an individual's engagement in research activities. It has been pointed out by Chinese scholars that the cultivation of research ability should be focused on transforming traditional learning methods, with an emphasis on developing students' capacities for autonomous learning, exploratory inquiry, and lifelong learning; simultaneously, the development of innovative thinking and teamwork skills is underscored (Xiong et al., 2024). Comprehensively, the research ability of university students

can be deconstructed into the following core dimensions:

Information Acquisition and Analytical Skills: The ability to effectively retrieve, screen, and critically evaluate relevant literature and data.

Problem Identification and Definition Capabilities: The possession of academic acuity, enabling the discovery and definition of research-worthy problems from professional studies or social phenomena.

Research Design and Execution Skills: A command of fundamental research methodologies, allowing for the design of research protocols and the collection and processing of data.

Innovative and Critical Thinking: An unwillingness to be satisfied with the acceptance of existing knowledge, coupled with the courage to propose new perspectives and methods, and the capacity for critical reflection on research processes and outcomes.

Academic Expression and Communication Skills: The ability to clearly and normatively compose research reports or academic papers and to conduct effective oral presentations and team collaborations.

Influencing Factors on University Students' Research Ability

The factors that influence the research abilities of university students are multifaceted and complex and can be broadly categorized into several levels, including individual, mentorship, institutional, and social-environmental factors.

At the individual level, a student's intrinsic motivation is positioned as a primary determinant. When students hold a strong interest in research, a greater willingness to invest time and energy is demonstrated (Ryan & Deci, 2000). Furthermore, a student's knowledge reserves, self-confidence, time management skills, and personal initiative are all considered important individual factors that influence their participation in research activities (Wu et al., 2025).

At the institutional and mentorship levels, the overall university environment—which includes the campus academic atmosphere, teaching and research facilities, and relevant incentive policies—constitutes an "institutional ecosystem" that impacts student research engagement. This concept has been systematically summarized from the perspectives of internal and ecological factors in research by Liang and Liu (2024). Within this system, the guidance provided by a mentor is particularly pivotal. A mentor is not merely a transmitter of knowledge but also serves as a guide, supporter, and role model on the student's research path (Jacobi, 1991). The degree to which mentors proactively invite students to form teams and provide meticulous guidance directly affects the depth of student participation and their ultimate achievements.

The "competition-promotes-learning" model, in which research training is integrated into competitive events, serves as an effective pathway for stimulating student potential. For instance, "Scientific Research Methods" courses are commonly offered in American universities, and "Project-Based Learning" is adopted in the United Kingdom (Wu et al., 2022). Competitions in China, such as the "Challenge Cup," provide a platform for students to apply theoretical knowledge to practice. Through the establishment of clear objectives and reward mechanisms, students' enthusiasm for participation is greatly stimulated, and their skills in teamwork, project management, and complex problem-solving are honed through practical application (Lu, 2024).

Theoretical Framework and Research Hypotheses

This study is primarily informed by the Theory of Planned Behavior (TPB) as its core theoretical framework (Ajzen, 1991). According to TPB, an individual's behavioral intention is the most direct predictor of their behavior, and this intention is, in turn, influenced by three main factors. The first is Attitude Toward the Behavior, which refers to the positive or negative evaluations an individual holds about performing a particular behavior. In the context of this study, this corresponds to the student's belief that "participating in research competitions is beneficial and valuable." The second factor is Subjective Norms, defined as the perceived social pressure from significant others or groups regarding whether one should or should not perform the behavior. This is reflected in this research by the perceived importance placed on competitions by the university, the campus academic atmosphere, and the influence of teachers and peers. The third factor, Perceived Behavioral Control, relates to an individual's perception of the ease or difficulty of performing the behavior, reflecting their judgment of their own capabilities and external resources. This corresponds to the students' belief about whether they possess sufficient time, knowledge, and confidence to participate in a competition.

By integrating the TPB with the aforementioned literature and the variables from this study's questionnaire, the following research framework and hypotheses were developed. "Institutional factors" from the questionnaire are conceptualized as manifestations of subjective norms and partial perceived behavioral control (e.g., facility support), and are collectively termed Institutional Support. "Personal reasons" are regarded as manifestations of behavioral attitudes and perceived behavioral control and are collectively termed Personal Motivation. In light of the literature reviewed, the following hypotheses are proposed for this study:

H1: Institutional Support will have a significant positive effect on university students' research participation.
H2: Personal Motivation will have a significant positive effect on university students' research participation.

H3: Research Participation will have a significant positive effect on students' perceived research ability.
H4: Institutional Support will have a positive indirect effect on perceived research ability through the mediating role of research participation.
H5: Personal Motivation will have a positive indirect effect on perceived research ability through the mediating role of research participation.

Methodology

Based on the theoretical framework and hypotheses established, the present study was structured around four core latent variables: school support, personal motivation, research participation, and perceived research ability. A five-point Likert scale was utilized for the questionnaire design, with options ranging from "1 = strongly disagree" to "5 = strongly agree."

The survey instrument comprised 21 questions, distributed across two sections: a demographic information section and the main body of the questionnaire. Focused on innovative competitions, such as the "Challenge Cup," the main section was designed to measure students' perceptions, willingness to participate, and the influencing factors thereof. The questionnaire items were mapped to the latent variables posited in the hypotheses. The latent variable of school support was measured by data from questions concerning the university's emphasis on the "Challenge Cup," the influence of the campus's academic atmosphere, the impact of faculty strength, and the availability of teaching and research facilities. The latent variable of personal motivation was primarily gauged through questions related to having ample time and energy, possessing sufficient knowledge and confidence, demonstrating a high degree of initiative, and understanding the competition process and methods. The research participation latent variable was used to reflect students' willingness and actual behavior, measured by items such as "Have you participated in the 'Challenge Cup'?" and "Have you participated in other research projects?" The perceived research ability latent variable was used to reflect the students' belief in the effectiveness of research activities for their skill enhancement. This variable was measured by questions assessing the degree to which participation in competitions improved research abilities, practical skills, and was beneficial for graduate school applications. In addition to these core variables, demographic information (gender, grade level, major, etc.) was used as control variables for other analyses within the study.

Data Analysis

Data were collected through both offline and online channels. Offline distribution was conducted by the researchers who personally delivered the questionnaires to students in their classrooms. For online data collection, the Wenjuanxing platform was used to distribute the survey to class groups via social media platforms such as QQ and WeChat. To ensure the accuracy and scientific validity of the collected data, measures were implemented to limit each device to a single submission and to automatically delete surveys completed in under 100 seconds. A total of 900 questionnaires were collected, of which 872 were deemed valid.

Descriptive Statistics

The demographic characteristics of the sample were as follows: 411 respondents were male, accounting for 47.1% of the total sample, while 461 were female, comprising 52.9%, indicating a balanced gender ratio within the sample. Regarding academic level, vocational students constituted 39.0% (340 individuals), while undergraduate students accounted for 61.0% (532 individuals), a distribution consistent with the general student population in local universities. The grade distribution was as follows: first-year students comprised 31.4% (274 individuals), second-year students made up 49.9% (435 individuals), and third-year and above students accounted for 18.7% (163 individuals). The sample encompassed the primary stages of university education, with a majority of participants being second-year students. By major, liberal arts students comprised 34.2% (298 individuals), science and engineering students accounted for 61.8% (539 individuals), and medical students made up 4.0% (35 individuals), with science and engineering students having the highest representation. For residency type, 39.9% (348 individuals) had urban residency, while 60.1% (524 individuals) were from rural areas.

To understand the specifics of students' research participation, a statistical analysis of the relevant core questions was performed. Regarding participation experience, for the questions "Have you participated in the 'Challenge Cup'?" (Q6) and "Have you participated in other innovation competitions or a teacher's research project?" (Q7), only 11.9% (104 students) had participated in the "Challenge Cup," and 29.6% (258 students) had participated in other innovation competitions or research projects. This indicates that despite the widespread influence of these competitions, the actual student participation rate, particularly for high-level events like the "Challenge Cup," remains at a low level. A stark contrast to the low participation rate was observed in students' willingness to participate. When asked, "Are you willing to participate in the 'Challenge Cup' or other innovation competitions?" (Q16), a combined 85.8% of students selected "somewhat willing" or "very willing."

This finding suggests that a vast majority of students hold a positive attitude toward participating in research and innovation activities. There exists a significant gap between this substantial potential enthusiasm and the low actual participation rate. Regarding research perception, a general recognition of the value of research competitions was observed among university students. The proportions of students who selected "somewhat agree" or "fully agree" for the statements that competition participation "improves students' research abilities" (Q13), "improves practical skills" (Q14), and "is helpful for graduate school applications" (Q15) were as high as 88.8%, 90.3%, and 79.2%, respectively. This data demonstrates a clear and high level of student recognition of the value inherent in research activities.

Analysis of Factors Influencing Research Ability

Analysis of personal factors influencing participation: In response to the question, "What are the personal reasons that influence students to participate in the 'Challenge Cup' or other innovation competitions?" (Q18), the top four barriers cited were: "limited knowledge, lack of confidence," mentioned 713 times by 81.8% of respondents; "lack of understanding, not knowing how to start," cited 630 times by 72.3%; "too busy with life, not enough time," cited 565 times by 64.8%; and "lack of initiative," cited 442 times by 50.7%. The results suggest that insufficient self-efficacy and a lack of information and methodological knowledge are the most critical personal barriers preventing students from taking the first step.

Analysis of school factors influencing participation: When asked about the school-related factors that influence participation in the "Challenge Cup" or other innovation competitions (Q19), students identified the following as the four most important: "campus academic atmosphere," mentioned 724 times, accounting for 83.0% of responses; "faculty strength," mentioned 690 times, representing 79.1%; "school's level of emphasis," mentioned 687 times, comprising 78.8%; and "teaching and research facilities," mentioned 543 times, or 62.3%. This indicates that students perceive a strong academic environment fostered by both faculty and peers, along with high-quality mentor guidance, as the most crucial external conditions for encouraging their research participation.

Reliability and Validity Testing

To validate the hypotheses proposed by this study, the collected questionnaire data were subjected to reliability and validity analyses. Reliability analysis is employed to ascertain the accuracy and consistency of a survey instrument. In the present study, three key metrics were used for this purpose: Cronbach's alpha (α), composite reliability (CR), and convergent validity. Generally, a Cronbach's α value greater than 0.6 is considered acceptable for scale reliability; values between 0.7 and 0.8 are indicative of good reliability, and values exceeding 0.9 suggest very high reliability. Similarly, a CR value greater than 0.7 is considered to indicate high questionnaire reliability.

Utilizing SmartPLS 3.0 for the reliability analysis, the Cronbach's α values for the four latent variables—school support, personal motivation, research participation, and perceived research ability—were found to be 0.815, 0.824, 0.801, and 0.911, respectively. All values exceeded the recommended threshold of 0.6, indicating strong internal consistency within the scales. As presented in Table 1, the Cronbach's α values for all four variables were greater than 0.8, and their composite reliability (CR) values also surpassed 0.8. These two indicators collectively affirm the excellent reliability and trustworthiness of the questionnaire.

Table 1. Reliability Analysis Results

Variable	Cronbach's α	Composite Reliability
School Support	0.815	0.891
Personal Motivation	0.824	0.882
Research Participation	0.801	0.823
Perceived Research Ability	0.911	0.937

According to Hair et al. (2005), the standard for assessing a latent variable's convergent validity is determined by its factor loadings. Convergent validity is considered good when a factor loading is greater than 0.7. An analysis of the data was performed using SmartPLS, and the results are shown in Table 2. The average variance extracted (AVE) for all variables was above 0.5, and each variable's average factor loading coefficient was greater than 0.7. Consequently, all items were retained, as the questionnaire was deemed to possess good convergent validity.

Table 2. Convergent Validity Analysis

Variable	Item	Factor Loading	Average Variance Extracted (AVE)

School Support	Q6	0.802	0.637
	Q7	0.819	
	Q8	0.778	
	Q9	0.812	
Personal Motivation	Q10	0.866	0.735
	Q11	0.864	
	Q12	0.853	
	Q13	0.846	
Research Participation	Q14	0.844	0.716
	Q15	0.85	
	Q16	0.857	
	Q17	0.835	
Perceived Research Ability	Q18	0.767	0.682
	Q19	0.747	
	Q20	0.728	

Hypothesis Testing

Hypotheses for the proposed model were tested using the SmartPLS software. The path coefficients, T-values, and P-values for each path were estimated to validate the study's hypotheses. The model comprised five distinct paths. Data from Table 3 indicates that the P-values for the paths related to school support, personal motivation, research participation, and perceived research ability were all less than 0.001, thereby reaching a significant level.

Table 3. Hypothesis Testing of the Research

Path	Path Coefficient	Standard Error	T-value	P-value	Notes
School Support → Research Participation	0.45	0.08	5.62	***	Supported
Personal Motivation → Research Participation	0.38	0.07	5.41	***	Supported
Research Participation → Perceived Research Ability	0.62	0.09	6.89	***	Supported

Mediating Effect Analysis

Mediating effects, also known as indirect effects, were examined using SmartPLS. As shown in Table 4, the T-values for both paths exceeded 1.96, and their P-values were less than 0.001, indicating that the mediating effects of both paths were significant.

Table 4. Specific Indirect Effects

Path	Specific Indirect Effect	Standard Error	T-value	P-value
School Support → Research Participation → Perceived Research Ability	0.082	0.017	4.892	0
Personal Motivation → Research Participation → Perceived Research Ability	0.052	0.012	4.197	0

Conclusion And Discussion

Conclusion

Based on a questionnaire-based survey of university students in Zhaoqing, the primary conclusion is that while research participation among these students requires improvement, there is widespread and strong willingness to engage, indicating significant potential for enhancement. This study's hypotheses were constructed and tested using the collected data, from which the following key conclusions were derived.

Firstly, Hypothesis H1 was supported. It was found that school support exerts a significant positive influence on research participation. This suggests that as the level of university emphasis, academic atmosphere, and the quality of faculty and facility support improve, students are more inclined to engage in research activities.

Secondly, Hypothesis H2 was supported. A significant positive impact of personal motivation on research participation was observed. This finding indicates that students' intrinsic initiative, self-confidence, and

available time and energy are crucial personal factors driving their involvement in research.

Thirdly, Hypothesis H3 was supported. The finding that research participation has a significant positive effect on perceived research ability was confirmed. This substantiates that engaging in practical research activities, such as the "Challenge Cup" and similar events, is an effective means of enhancing students' research capabilities.

To test the mediating effects of research participation (H4, H5), the bootstrap method was employed for analysis. The indirect effect for path H4 ($0.45 * 0.62 = 0.279$) did not include zero within its 95% confidence interval, which supports Hypothesis H4 and demonstrates a significant mediating effect. Similarly, the indirect effect for path H5 ($0.38 * 0.62 = 0.236$) was also found to be significant, providing support for Hypothesis H5. These findings indicate that school support and personal motivation not only directly influence students' research participation but, more importantly, are channeled through the practical experience of participation, which ultimately translates into a positive perception of their own research abilities.

Discussion

Firstly, school support is identified as the foremost external environmental factor influencing student research engagement. The results of this study show that the standardized path coefficient for school support on research participation is the highest. A supportive, resource-rich, and academically vibrant environment is a decisive force in transforming students from passive observers of research into active participants. This suggests that for university administrators, fragmented announcements or verbal encouragement are insufficient. Systemic institutional design—encompassing curriculum development, faculty incentives, facility upgrades, and cultural cultivation—is fundamental.

Secondly, personal motivation is the endogenous driving force for student research participation, and its role is indispensable. While the external environment is important, students' internal drive is the ultimate determinant of behavior. The study revealed that a lack of confidence and uncertainty about how to begin are the primary obstacles, reflecting a deficiency in students' perceived behavioral control. This contrasts with the practices of international universities that prioritize offering scientific research methods courses to underclassmen. Enhancing students' personal motivation is fundamentally about empowerment; that is, helping them build confidence and clear obstacles through methodological instruction and introductory practical experience.

Thirdly, the central mediating role of research participation was confirmed. The model clearly shows that whether it is school support or personal motivation, both must pass through the conduit of participation to be effectively converted into a perceived enhancement of a student's research capabilities. This provides strong empirical support for the effectiveness of a "learning through competition" model. A competition is not merely a platform for showcasing achievements; it is a structured, goal-oriented, and high-feedback learning process. It is within this process that students complete a closed loop, transitioning from knowledge input to skill output, thereby strengthening their research abilities, practical skills, and even their competitiveness for graduate school applications.

Managerial Implications and Future Outlook

This study, through an empirical investigation of university students in the Zhaoqing area, systematically revealed the key factors and pathways influencing the cultivation of their research abilities. A significant gap was identified between students' high willingness to participate and their low actual engagement. This gap profoundly reflects a range of challenges, including individual barriers such as a lack of self-efficacy and a fuzzy understanding of methodology, as well as systemic issues related to the academic ecosystem, faculty guidance, and institutional support. To effectively address these challenges and promote a deep, structural optimization of the research training paradigm for local university students, this chapter integrates advanced theories and practices from international higher education to propose multi-dimensional and collaborative managerial implications.

Macro-Level

At the macro level, the goal of reform is to transcend fragmented project-based incentives and, through top-down design, foster an empowering environment where research and innovation are internalized as a core part of the university's culture and institutional processes.

A paradigm shift is required, moving from a "policy-driven" to a "culture-infused" approach. This study found that "school emphasis" and "campus academic atmosphere" are crucial external factors perceived by students. However, genuine emphasis is not merely reflected in pre-competition mobilization documents or post-event reward announcements. Research in international higher education has pointed out that all excellent innovative universities possess a pervasive "culture of inquiry" (Hattie & Yates, 2013). University administrators should strive to fully integrate the spirit of research and innovation into the entire talent

development process. Firstly, curriculum reform is necessary to include "Research Methodology" and "Critical Thinking and Academic Writing" as mandatory general education courses for first- and second-year students, thereby ensuring early and comprehensive exposure to research literacy. Secondly, campus spaces should be reimagined to create more physical venues, such as "maker spaces" and "learning commons," which would break down departmental barriers and encourage cross-disciplinary discussion and the collision of ideas, making "innovation anytime, anywhere" a possibility. Thirdly, campus culture should be cultivated through the regular hosting of high-level academic events like "President's Afternoon Tea," "Professor's Lecture Series," and "Academic Culture Festival," allowing students frequent exposure to cutting-edge research and the influence of role models. This will help them internalize their aspirations for research into a personal value and a conscious behavior (Guo, Liu, Cui, et al., 2025).

A "scaffolded," full-chain research training system should be established. Administrators should draw upon Vygotsky's theory of the "zone of proximal development" (Vygotsky, 1990) to provide differentiated and progressive support, or "scaffolding," for students at different levels. The first step is enlightenment, targeting all underclassmen through freshman seminars, laboratory open days, and presentations by outstanding seniors. This demystifies research and ignites academic interest. The second step is training, involving the establishment of low-threshold "Undergraduate Research Training Programs" funded by the university. These programs would encourage students, individually or in small groups, to complete mini-projects under faculty guidance, providing an initial, protected research experience. The third step is advancement, which would focus on supporting promising student teams in competitions like the "Challenge Cup" and linking their participation to senior thesis projects, academic publications, and even applications for master's or doctoral programs, thereby creating a clear and visible pathway for growth and development (Wu, Shi, Lin, 2025).

Meso-Level

The core of the meso-level strategy is to activate the crucial role of teachers as "guides" and to build a flexible, efficient resource network that provides precise and timely support for students' research endeavors.

An "active, developmental" mentorship system should be promoted. Research data indicated that students are highly reliant on "faculty strength" and desire proactive invitations from teachers. This necessitates a reform of the traditional, passive faculty guidance model. Drawing on the successful experiences of North American research universities (Gloria & Crisp, 2009), an "active, developmental" mentorship system should be established. The first step is to redefine the faculty role by encouraging teachers to actively identify and recruit students with research potential during introductory courses and foundational laboratory sessions, rather than waiting for students to approach them. The second step is to deepen the relationship, expanding the mentorship from a purely project-based one to a comprehensive, holistic relationship that includes academic planning, ethical conduct, and even psychological support, focusing on the student's long-term development. The third step is to provide institutional safeguards by explicitly assigning weight to undergraduate research supervision in faculty annual reviews, promotion evaluations, and stipends, thus converting a "soft task" into a "hard metric" and fundamentally stimulating faculty enthusiasm for engagement (Liang & Liu, 2024).

Cross-disciplinary, learning-oriented research communities should be fostered. Significant breakthroughs in modern research often occur at the intersections of disciplines. Universities should dismantle departmental silos and proactively cultivate cross-disciplinary "learning communities." These communities can be led by one or more faculty members and include undergraduate and graduate students from diverse academic backgrounds. In this model, students not only receive vertical guidance (from their mentors) but also gain horizontal support and encouragement (from their peers). This peer-to-peer communication and collaboration can effectively alleviate the feelings of loneliness and frustration often experienced during individual research and can ignite innovative sparks through the exchange of ideas. This is crucial for enhancing the team's collective knowledge construction and problem-solving abilities (Tinto, 2012).

Micro-Level

Micro-level strategies focus on the individual student, aiming to help them overcome psychological barriers and ignite their intrinsic academic passion through clever mechanism design (Guo, 2024).

An empowering mechanism for achieving "early success experiences" should be created. The most prominent finding of this study is that "limited knowledge and lack of confidence" is the primary personal barrier to students' research participation. This finding aligns perfectly with Bandura's theory of self-efficacy (1977), which posits that an individual's belief in their ability to successfully complete a task directly determines their motivation. Therefore, a key to resolving the issue is to enhance students' research self-efficacy. Universities should design a series of low-risk, high-feedback "micro-success" opportunities. The first step is task decomposition, guiding students to break down a complex research project into smaller, manageable tasks such as literature reviews, questionnaire design, and data entry. Timely acknowledgment and feedback should be provided upon the completion of each step. The second step is outcome presentation, involving the

establishment of college-level and university-wide undergraduate research poster exhibitions and academic forums. These events would provide students with opportunities to display and discuss their "half-finished" or intermediate results, allowing them to gain a sense of accomplishment and recognition (Guo, 2024).

A "growth mindset" and a culture of process-based evaluation should be promoted. Introducing the "growth mindset" theory by Stanford psychologist Carol Dweck (2006) would guide students to recognize that research ability is not static but can be continuously improved through effort, learning, and strategic adjustments. The first step is to de-emphasize outcome-driven metrics in the evaluation of on-campus research projects or competitions. Not only should the final "height" of the achievement be considered, but also the student's "degree of progress" during the research process, such as whether new research methods were mastered, critical thinking was demonstrated, and effective teamwork was performed. The second step is to encourage "valuable failure" by establishing a culture of tolerance for mistakes. Students should be encouraged to dare to tackle difficult problems and try new methods. Projects that do not succeed due to their exploratory nature should be understood and affirmed, and students should be guided to conduct a thorough review and reflection, transforming failure into a valuable learning experience (Lu, 2024).

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