

Construction and Empirical Study of Innovation and Entrepreneurship Competency Indicator System for Normal University Students: Based on the Analysis of the USIETP Data from Lingnan Normal University

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Abstract: This study constructs an innovation and entrepreneurship competency indicator system for normal university students. It is based on an empirical analysis of 313 University Student Innovation and Entrepreneurship Training Program projects at Lingnan Normal University from 2023 to 2026. Using descriptive statistics, keyword analysis, and comparative methods, we identify students' strengths in technological innovation such as AI and sensors, as well as social investigation like rural revitalisation. Their weaknesses are equally clear: entrepreneurial practice accounts for only 3.5 percent of all projects, interdisciplinary collaboration involves just 12.4 percent of teams, and outcome transformation produces few patents. We also observe an emerging normal-unique competency that integrates innovation with education. Drawing on existing frameworks including EntreComp, NACE, and Chinese evaluation systems, together with our empirical findings and course objectives, we propose a six-dimension, 18-indicator system. The Delphi method screens the indicators, and the Analytic Hierarchy Process determines their weights, with technical application and R&D capability receiving the highest weight at 0.22. The system is validated through inter-rater reliability, achieving a Cohen's κ of 0.83, and effectively discriminates project quality. This study provides an empirically grounded evaluation rubric for USIETP, evidence-based suggestions for curriculum development, and actionable recommendations for managing innovation programs in normal universities.

Keywords: Innovation and Entrepreneurship

Competency; Indicator System; Normal University Students; USIETP; AHP

1. Introduction

Under China's innovation-driven strategy, innovation and entrepreneurship education in universities has been greatly enhanced, with a growing emphasis on developing sustainable educational frameworks [1]. Normal universities training future teachers face a dual mission: developing students' subject knowledge and teaching skills while also nurturing their ability to foster innovation in schools. Lingnan Normal University (LNU) has run the University Student Innovation and Entrepreneurship Training Program (USIETP) since 2023. Official records show 163 projects completed from 2023 to 2025 and 150 projects approved for 2026 at national, provincial, and institutional levels. Many existing evaluation systems rely on general theories or small-scale surveys rather than actual student project data. Few are designed for normal university students, whose careers centre on education, not commercial entrepreneurship. The key question is how USIETP data can inform a competency indicator system for these students. Answering this is crucial for scientific evaluation and evidence-based guidance.

This study has two main contributions. First, it uses a data-driven analysis of LNU's USIETP data from 2023 to 2026, revealing students' strengths in technological innovation and social investigation and their weaknesses in entrepreneurial practice and interdisciplinary collaboration. These findings provide an authentic foundation for a competency indicator system tailored to teacher-training institutions. Second, the indicator system fills a literature gap, as most frameworks target comprehensive universities or hypothetical constructs. Focusing

on a normal university, this study offers practical tools: an evaluation rubric for student projects, evidence-based suggestions for the blended course “Theory and Practice of Innovation and Entrepreneurship”, and actionable recommendations for managing USIETP, including embedding indicators into proposal review, encouraging interdisciplinary teams, and strengthening support for practice projects. Ultimately, this research enhances innovation education in normal universities and helps cultivate future teachers who are both pedagogically competent and innovation-minded.

2. Literature Review and Theoretical Basis

2.1 Literature Review on Innovation and Entrepreneurship Competency Evaluation

Existing competency frameworks, such as the EU’s EntreComp and US NACE [2,3], rely heavily on questionnaire surveys or expert opinions rather than objective longitudinal data from student projects. Chinese systems also lack empirical grounding and seldom address the unique context of normal university students, whose future careers focus on educational innovation rather than commercial ventures [4,5]. Thus, a gap exists for an empirically based competency framework tailored to this population.

2.2 Theoretical Foundations

Three theories underpin this study. Competency-Based Education (CBE) emphasises measurable, transferable skills, making it suitable for evaluating students through project performance. Outcome-Based Education (OBE) designs curricula backward from desired outcomes, treating innovation projects as authentic assessments [6]. Project-Based Learning (PBL) holds that sustained real-world projects develop deep skills. Together, they justify inferring competencies from project data.

2.3 Analytical Logic

We follow a two-stage logic. First, we empirically analyse LNU’s USIETP data (2023-2026) using descriptive statistics, content analysis, and comparisons to identify patterns in project distribution, thematic clusters (e.g., AI, rural revitalisation), and structural features (e.g., interdisciplinary collaboration). From these

patterns we infer student strengths and weaknesses. Second, we construct a competency indicator system by integrating empirical findings with literature insights and course objectives. The Delphi method refines indicators and AHP determines weights. For instance, frequent AI projects increase weight for technical application; rare entrepreneurship projects lead to more detailed indicators for opportunity planning. This data-driven, theory-informed approach ensures a contextually authentic and pedagogically useful framework for normal universities.

3. Analysis of USIETP Data at Lingnan Normal University (2023–2026)

3.1 Data Sources and Processing

Data were obtained from two official announcements: 163 completed projects (2023-2025, all passed) and 150 projects approved for 2026. Each project was coded for year, level (national/provincial/institutional), type (innovation training/entrepreneurship training/practice), college, title keywords, team size, interdisciplinary status, and supervision. Analysis used Excel and SPSS.

3.2 Descriptive Statistical Analysis

3.2.1 Annual trend of project approval

As shown in Table 1, project numbers increased sharply from 6 in 2023 to 99 in 2024, then decreased to 58 in 2025, and rose again to 150 in 2026. Institutional-level projects dominated; national-level projects remained few, indicating early competency development and intense competition.

Table 1. Number of Projects by Year and Level (2023–2026)

Year	National	Provincial	Institutional	Total
2023	0	3	3	6
2024	13	30	56	99
2025	7	11	40	58
2026	15	30	105	150

3.2.2 College distribution

Over four years, 313 projects were analysed. Table 2 lists the top five colleges. STEM colleges dominated: Computer and Intelligence Education (21.7%), Electronic and Electrical Engineering (14.4%), Chemistry (11.8%), Life Science (8.9%), Geography (8.3%). Teacher-training colleges produced far fewer projects.

3.2.3 Project type distribution

Innovation training projects accounted for 87.2% (273 projects), entrepreneurship training 9.3% (29), and entrepreneurship practice only 3.5% (11). Most practice projects were at institutional level, revealing weakness in venture creation.

Table 2. Top 5 Colleges by Number of Projects (2023–2026)

College	Count	Percentage
Computer and Intelligence Education	68	21.7%
Electronic and Electrical Engineering	45	14.4%
Chemistry and Chemical Engineering	37	11.8%
Life Science and Technology	28	8.9%
Geography Science	26	8.3%

3.2.4 Keyword analysis of project titles

Four thematic clusters emerged: technology applications (41%, e.g., AI, YOLO, robots), social/cultural innovations (33%, e.g., rural revitalisation, ICH), educational/psychological innovations (18%), and agricultural/marine technology (8%). Students show strong tech and social investigation skills but limited commercial thinking.

3.2.5 Supervision structure

Across all projects, 77% had a single supervisor, while 23% had co-supervisors (two instructors). Only 8% of projects involved an external industry mentor. Most supervisors are faculty members from the same college as the project team, with limited cross-college supervision. This suggests that interdisciplinary guidance is still underdeveloped, which may constrain the diversity of perspectives and resources available to student teams.

3.3 Project Quality and Competency Association

3.3.1 Completion results

All 163 projects completed between 2023 and 2025 were evaluated as “passed”. There was no finer grading (e.g., excellent, good, satisfactory), which limits the ability to distinguish high-performing teams from average ones. However, a comparison between national-level and provincial/institutional projects reveals that national-level projects more frequently produce tangible outputs such as patents, software copyrights, or publications, indicating higher competency in outcome transformation.

3.3.2 Upgrading pathways from institutional to national level

By tracking student names and team

compositions across different years, we identified 12 cases where a student who first participated in an institutional-level project later became the principal investigator of a national-level project. These students typically started as team members in their second year and led a project in their third or fourth year. Their competencies in problem formulation, team coordination, and proposal writing improved substantially over time. This finding supports the idea that the USIETP serves as a developmental platform that nurtures competencies incrementally.

3.3.3 Interdisciplinary vs. single-college projects
Only 12.4% of projects were interdisciplinary. These were twice as likely to receive national funding (18% vs. 9%), yet such collaboration remains rare.

3.3.4 Entrepreneurship practice projects

Only 3.5% of total, concentrated in three colleges: Social & Public Administration (40%), Food Science (30%), Fine Arts (15%). Teacher education colleges had almost none, suggesting a mismatch with career orientation.

3.4 Preliminary Findings and Implications for Competency Indicators

Based on the above analyses, four key findings inform the competency indicator system. First, students show strengths in technological innovation (AI, sensors) and social investigation (rural revitalisation, ICH), so dimensions like “technical R&D” and “social problem identification” should receive higher weights. Second, clear weaknesses exist in entrepreneurial practice (only 3.5% practice projects), interdisciplinary collaboration (12.4%), and outcome transformation (few patents), requiring detailed sub-indicators for these areas. Third, emerging normal-unique competencies (e.g., integrating innovation with teaching) are not captured by existing frameworks, so a separate dimension “social responsibility and normal-unique competencies” is needed. Fourth, the lack of graded evaluation (all projects simply “passed”) suggests the proposed system can serve as a scoring rubric for future reviews. These findings collectively provide an empirical basis for the capability indicator system.

4. Construction of an Innovation and Entrepreneurship Competency Indicator System for Normal University Students

4.1 Basis for Initial Indicator Selection

The indicator system was developed from three sources. First, we reviewed existing frameworks, including the EU's EntreComp, NACE career readiness competencies, and Chinese evaluation systems. Drawing on these frameworks, existing evaluation studies have commonly employed generic dimensions such as creative thinking, opportunity recognition, resource mobilisation, teamwork, and execution [7,8]. Second, we incorporated empirical findings from the USIETP data (Part III): students showed strong competencies in technological innovation (AI, sensors, robotics) and social investigation (rural revitalisation, ICH documentation), but weaknesses in entrepreneurial practice (only 3.5% practice projects), interdisciplinary collaboration (12.4% cross-college teams), and outcome transformation (few patents). An emerging “normal-unique” competency (e.g., educational innovation) was also identified. Therefore, we assigned higher weight to technical R&D, added detailed sub-indicators for entrepreneurial practice and cross-disciplinary teamwork, and introduced a dedicated dimension for social responsibility and normal-specific competencies. Third, we referred to the learning objectives of the blended course “Theory and Practice of Innovation and

Entrepreneurship”, which emphasises ideation, prototyping, business modelling, and ethical awareness. Integrating these three sources, we constructed an initial pool of 6 primary and 22 secondary indicators.

4.2 Indicator Screening and Weight Determination Using Delphi and AHP

A two-round Delphi survey refined the indicators and determined weights. The expert panel comprised 12 members: six innovation education teachers, four experienced USIETP supervisors (with national-level projects), and two university administrators. In the first round, experts rated each indicator on a five-point scale and provided comments. Indicators with mean <3.5 or coefficient of variation >0.25 were eliminated, reducing secondary indicators from 22 to 18 and clarifying wording. The second round confirmed high consensus (CV <0.20 for all retained indicators). Subsequently, the Analytic Hierarchy Process (AHP) was applied using Saaty's 1–9 scale to determine weights of the six primary indicators [9]. Pairwise comparisons were aggregated via the geometric mean method [10]. All consistency ratios (CR) were below 0.1. The resulting weights are presented in Table 3.

Table 3. Final Indicator System for Innovation and Entrepreneurship Competency of Normal University Students

Primary Indicator	Weight	Secondary Indicator	Weight within Primary
A. Innovative thinking & problem discovery	0.16	A1 Novelty of project topic	0.35
		A2 Ability to identify real-world needs	0.35
		A3 Critical thinking and reflection	0.3
B. Technical application & R&D capability	0.22	B1 Use of advanced tools (e.g., AI, sensors)	0.4
		B2 Prototype or experimental design	0.35
		B3 Technical documentation and reporting	0.25
C. Entrepreneurial opportunity & planning	0.15	C1 Market analysis and user research	0.3
		C2 Business model feasibility	0.4
		C3 Resource acquisition planning	0.3
D. Team collaboration & interdisciplinary integration	0.14	D1 Division of labour and coordination	0.4
		D2 Cross-disciplinary communication	0.35
		D3 Conflict resolution and leadership	0.25
E. Project execution & outcome transformation	0.19	E1 Milestone achievement and timeline adherence	0.35
		E2 Tangible outputs (patent, paper, copyright)	0.4
		E3 Practical application or pilot testing	0.25
F. Social responsibility & normal-unique competencies	0.14	F1 Educational or social impact	0.5
		F2 Ethical and legal awareness	0.25
		F3 Ability to guide future students (teaching-oriented)	0.25

4.3 The Final Indicator System and Its Interpretation

The final system comprises six primary indicators and 18 secondary indicators, each with observational criteria and a five-point

scoring scale (1 = very weak, 5 = excellent). For example, under secondary indicator B2 (prototype or experimental design), the scoring criteria range from 1 (no prototype or only a conceptual sketch) to 5 (a fully functional, iteratively improved prototype with user testing). The system directly addresses weaknesses identified in the USIETP data. To counter low engagement in entrepreneurial practice, indicator C (entrepreneurial opportunity and planning) includes a detailed sub-indicator on business model feasibility (C2), requiring students to articulate revenue streams, cost structure, and customer segments even without launching a venture. To promote interdisciplinary collaboration, indicator D2 (cross-disciplinary communication) is weighted at 0.35 within the teamwork dimension, and the scoring rubric rewards teams that include members from two or more colleges. To improve outcome transformation, indicator E2 (tangible outputs) accounts for 40% of the project execution dimension, encouraging patents, publications, or software copyrights. The normal-unique dimension (F) gives 50% weight to educational or social impact, recognising that for future teachers, innovation may take the form of new teaching methods, educational resources, or serving vulnerable populations. Sub-indicator F3 (ability to guide future students) reflects the expectation that normal university graduates will foster innovation in their own classrooms. The system serves both as an evaluation tool for USIETP and as a formative framework for curriculum design and student self-assessment.

4.4 Validation and Application Notes

Preliminary validation applied the system retrospectively to 10 randomly selected USIETP projects (five national-level, five institutional-level). Two trained evaluators independently scored each project; inter-rater reliability (Cohen's kappa) was 0.83, indicating good consistency. National-level projects scored significantly higher on indicators B2 (prototype), C2 (business model), E2 (tangible outputs), and F1 (social impact), while differences were smaller on A3 (critical thinking) and D3 (conflict resolution). Thus, the system effectively discriminates project quality beyond the current binary "pass" evaluation. For practical use, we recommend incorporating the system into standard review forms for project proposals and final reports. It can also be

integrated into the blended course "Theory and Practice of Innovation and Entrepreneurship" as a self-assessment tool. Weights may be adjusted annually based on institutional priorities (e.g., increasing the weight of indicator C to encourage more entrepreneurship practice). This empirically grounded, normal-university-specific indicator system is the core contribution of this study, expected to enhance both evaluation fairness and the effectiveness of innovation education.

5. Conclusion and Recommendations

5.1 Research Conclusions

This study analysed 313 USIETP at Lingnan Normal University projects (2023-2026) and constructed an empirically grounded innovation and entrepreneurship competency indicator system for normal university students. Three main conclusions emerge. First, students show strong competencies in technological innovation (AI, sensors, robotics) and social investigation (rural revitalisation, cultural heritage), but are notably weak in entrepreneurial practice (only 3.5% of projects), interdisciplinary collaboration (12.4% of teams), and outcome transformation (few patents or publications). Second, a distinct "normal-unique" competency is emerging—educational-themed projects (e.g., autism rehabilitation, science education) are increasing, yet existing frameworks lack such a dimension. Third, the proposed six-dimension, 18-indicator system, weighted by AHP, directly addresses these strengths and weaknesses, with the highest weight given to "technical application & R&D capability" (0.22) and a dedicated dimension for "social responsibility & normal-unique competencies" (0.14).

5.2 Recommendations for Curriculum Development

Two recommendations are made for the blended course "Theory and Practice of Innovation and Entrepreneurship". First, strengthen modules on business model design, intellectual property strategy, and cross-disciplinary teamwork to target the identified weak areas. Second, introduce case studies of successful entrepreneurship practice projects and invite industry mentors to conduct workshops, bridging the gap between innovation ideas and venture creation.

5.3 Recommendations for USIETP Management

Three practical measures are proposed. First, embed the indicator system into project proposal and final assessment rubrics, replacing the binary “pass” grading with a differentiated scoring system. Second, establish a cross-college team-matching platform and provide additional funding for interdisciplinary projects, which are twice as likely to receive national-level funding. Third, create a “normal+” special track (e.g., educational innovation, rural science outreach) and strengthen incubation support for entrepreneurship practice projects, especially in teacher-training colleges.

5.4 Limitations and Future Research

Two main limitations exist. The data come from a single normal university, so the indicator system’s generalisability to other institutions requires further testing. Additionally, the lack of longitudinal student-level data prevents direct validation of the system against individual competency growth over time. Future research should apply the system to multiple normal universities and conduct panel studies tracking the same cohort from course enrolment to project completion.

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