Education Reform and Development, 2026, Volume 8, Issue 6
https://ojs.bbwpublisher.com/index.php/ERD
Online ISSN: 2652-5372
Print ISSN: 2652-5364

Exploring Innovative Paths to Improve the Quality of Undergraduate Supervision in Innovation and Entrepreneurship Education Reform: Practical Reflections Based on Three Undergraduate Innovation Training Projects

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Abstract: Based on the authors' hands-on experience supervising three Undergraduate Innovation Training Program projects at Xinjiang Medical University, this paper explores effective approaches to improving the quality of undergraduate supervision. It identifies major problems in current innovation training programs, shares practical insights drawn from three real cases, and proposes reform strategies in five dimensions: strengthening practicality, promoting interdisciplinary collaboration, fostering an innovation-friendly atmosphere, optimizing the supervisor system, and improving evaluation criteria. The study aims to provide a reference for innovation and entrepreneurship education in universities and colleges.

Keywords: Innovation and entrepreneurship education; Quality of undergraduate supervision; Innovation training program; Flexible sensors; Interdisciplinary supervision

Online publication: July 20, 2026

1. Introduction

Over the years of supervising undergraduate innovation training projects, I have developed a strong conviction: completing a project is not difficult; the real challenge is helping students truly grow capabilities through the process. Although innovation and entrepreneurship education reform has been promoted for years, many practical problems remain to be solved in supervision [1–3]. As a frontline instructor, I keep asking: What kind of guidance truly helps students? What can we achieve with limited resources?

In the past three years, I have supervised three undergraduate-led innovation projects: "Rapid Measurement of Blood Viscosity by 'Shape Comparison' Based on Flexible Composite Films" (2023–2025), "Research on Flexible Portable Wearable Sensors for Multi-Index Sweat Detection" (approved 2024), "3D-Printed Self-Powered Flexible Wearable Sensors for Monitoring Lung Impedance to Assess Heart Failure Recurrence Risk" (approved 2025). These projects involve interdisciplinary fields including flexible materials, electrochemical sensing, and biomedical engineering. Team members come from pharmacy, clinical medicine, and clinical pharmacy, with more than 20 undergraduates participating overall.

This paper reflects on the supervision process based on real experience, honestly recording pitfalls encountered and lessons learned. I hope that these reflections can provide reference for fellow supervisors.

2. Current situation and problems of undergraduate innovation training programs

2.1. Insufficient resources

Funding for innovation training projects is usually between several thousand and 20,000 yuan, which is very tight for material-based projects [4]. For the blood viscosity measurement project, the team originally planned to compare four carbon nanomaterials but had to limit testing to the lowest-cost single-layer graphene oxide due to budget constraints. For the lung impedance monitoring project, the team intended to purchase ready-made wireless transmission modules but had to adopt a more difficult homemade solution.

2.2. Inadequate support

Supervisors are burdened with teaching and research duties in addition to innovation project work, resulting in limited energy [5]. The sweat sensor project had seven students covering multiple technical steps. Students often asked questions when encountering problems, but I could not always reply promptly, slowing project progress.

2.3. Traditional teaching methods

Students are accustomed to waiting for answers rather than exploring independently [6]. In the early stage of the sweat sensor project, students only read review articles. When experiments failed, their first response was "Teacher, is the material defective?" Later, I guided them to keep standardized lab notebooks and troubleshoot variables step by step, and they gradually learned to think independently.

2.4. Lack of interdisciplinary competence

Innovation training projects are usually comprehensive and require integration of multidisciplinary knowledge. However, university courses are discipline-separated, providing few opportunities for cross-disciplinary training [7]. Such fragmented thinking becomes a bottleneck when solving real-world problems.

The lung impedance monitoring project was typical. It required three types of expertise: conductive hydrogel preparation (materials science), heart failure animal model establishment (clinical medicine), and wireless signal processing (electronic engineering). Our students were either clinical medicine or pharmacy majors; they performed well in their own fields but struggled with cross-disciplinary content.

In the first two months, the team spent most of their time "catching up." Clinical students learned conductive polymers and tensile testing; pharmacy students studied heart failure pathology and rabbit anatomy. Progress was slow and students felt anxious. Yet I knew this slowness was necessary — without foundational knowledge, later results would be superficial. Fortunately, students helped one another: pharmacy students taught material characterization, and clinical students explained heart failure models. This mutual support became valuable learning in itself.

2.5. Imperfect evaluation mechanism: Overemphasis on outcomes over process

University evaluation of innovation projects still focuses heavily on final outputs: papers, patents, prototypes, and other tangible results [8]. Under this orientation, both students and supervisors prioritize producing results rather than learning and growth during the process.

In the early stage of the blood viscosity measurement project, students fabricated many film devices that repeatedly fractured during laser engraving, yielding unusable data. Students were discouraged; one female student even asked, "Teacher, will we never succeed?" Worse, the existing evaluation system offers no recognition for such "failures" — no matter how much students learn and grow, a project without impressive final results is graded as "unsatisfactory."

This leads many students to view failure as wasted effort rather than learning. It encourages safe, low-risk topics rather than truly innovative exploration.

3. Experience in supervising undergraduate innovation training projects

3.1. Inspiring innovation: Starting from interest

Intrinsic motivation often comes from interest [9]. Ms. Gai Yunru, from the blood viscosity project, became excited after watching a video of droplet shape changes on stretched flexible films. She independently researched the principle and drove the project forward steadily. Mr. Zheng Longyu, from the sweat sensor project, had family members with diabetes and felt personally connected to non-invasive glucose monitoring. This original motivation sustained him through the hardest phases.

3.2. Providing resources and support: Hardware and psychological support

For hardware, I helped the team access the School of Pharmacy's scanning electron microscope, contact angle meter, and other equipment. Psychological support was equally important. When students repeatedly ruined devices during laser engraving, I shared my own experience of three months of failed experiments during doctoral study, telling them, "Every failure tells you one path that does not work." Students eventually recorded every failed parameter and successfully fabricated stable devices. In the final presentation, they included a special slide titled "Failure Records."

3.3. Applying new teaching methods

(1) Project-based learning [10]: I posed the real problem "How to measure blood viscosity rapidly using flexible films" and let students design plans and learn by doing. Their understanding of the research workflow far exceeded passive learning.

(2) Flipped classroom [11]: I recorded short videos on carbon nanomaterial preparation and electrochemistry for students to watch before class. Class time was used for discussing experimental plans and solving problems. Once, students independently discovered that unstable sensor current resulted from inactive electrode surfaces and designed experiments to verify it. This discovery was more meaningful than any lecture.

(3) Peer learning [12]: In the lung impedance project, pharmacy students taught SEM image analysis, and clinical students taught heart failure assessment in rabbits. Teaching others helped them truly understand the value of interdisciplinary collaboration.

4. Reform proposals

4.1. Strengthen practicality: Bringing real problems into the curriculum

For innovation projects to benefit students, topic selection is critical. The best topics are real problems arising from practical needs, not just extracted from literature [13].

The lung impedance monitoring project originated from a real clinical need in the Department of Cardiology: How to detect pulmonary congestion early after heart failure discharge? Mr. Zhou Yu noticed during clinical practice that many patients already had severe congestion when they felt unwell; a home-use monitor would be transformative.

This real problem kept the team grounded throughout the project. They knew they were not building a "toy" but something with genuine clinical value. This sense of mission cannot be replaced by funding or paper rewards. I recommend that universities encourage students to identify topics from clinical and social needs rather than only searching literature.

4.2. Promote interdisciplinary collaboration: Breaking down school barriers

Interdisciplinarity is a major source of innovation [14]. Yet in practice, students from different schools rarely collaborate. At our university, the School of Pharmacy and School of Clinical Medicine are under the same medical faculty but differ in curricula, labs, and even schedules, creating barriers to cross-school teams.

I suggest universities intentionally encourage cross-school teams in project applications and even establish special "interdisciplinary innovation funds." Meanwhile, a dual-supervisor system can be implemented, with instructors from different disciplines jointly supervising projects.

In the lung impedance project, I co-supervised with Prof. Zhou Xianhui from the First Clinical Medical College, an expert in cardiovascular diseases. She provided critical guidance on clinical needs and animal experiments. Such collaboration achieves 1 + 1 > 2 effects for student training. Students not only learn materials science but also understand clinical logic, exactly the composite capability future innovative talents need.

4.3. Foster a failure-tolerant environment: Making failure valuable

Innovation inevitably involves failure [15]. Yet current evaluation systems tolerate student failure poorly. Many students avoid risk and only pursue "guaranteed success"; this is not innovation; it is safe homework.

In the early stage of the sweat sensor project, students repeatedly tried and failed to synthesize carbon nanotubes by chemical vapor deposition. By outcome-based evaluation, these experiments were "useless." But in my view, students learned to troubleshoot equipment, optimize parameters, and document failure data, all essential research skills.

If failure records, problem analysis, and iterative processes were included in evaluation, students would no longer see failure as wasted effort but as part of research. I recommend universities assign weight to "process outcomes" in innovation project evaluation, encouraging students to document and share failure experiences so that trial and error becomes valuable learning.

4.4. Optimize the supervisor system: Recognizing supervisory effort

Currently, universities provide low recognition for faculty supervision of innovation projects. Supervisors invest tremendous time from application to conclusion, yet this time is often excluded from teaching workload and research assessment [16]. Many young faculty are willing but unable to commit fully.

I suggest universities establish a supervisor training mechanism, especially for young faculty, with specialized training on effective student supervision. Meanwhile, supervision workload should be counted in teaching assessment or supported by performance incentives. Only when instructors' time and effort are recognized can enthusiasm be truly mobilized and students receive high-quality guidance.

4.5. Establish a process-based evaluation mechanism

Most importantly, the evaluation system must change. Evaluation should not only consider final papers and patents but also student growth throughout the project. For example: Are lab notebooks standardized? How do students analyze problems? Do they take responsibility in teamwork? Such process performance is equally important for project quality. In the final review of the blood viscosity measurement project, we introduced a "process material score" (40% of the total grade) including lab records, periodic reports, and problem-solving documentation. Students responded very positively — they felt their effort was seen. If widely adopted, I believe more students will engage deeply in innovation projects and pursue genuine exploration.

5. Conclusion

Reflecting on supervising these three projects, my strongest realization is: The true value of undergraduate innovation training lies not in what is produced, but in what students become.

Gai Yunru from the blood viscosity project told me at completion: "Teacher, now when I read a paper, my first thought is not what it says, but how I can verify it." That alone made the project successful. Zheng Longyu from the sweat sensor project contacted me afterward, hoping to make popular science videos to inform diabetes patients about non-invasive detection. Zhou Yu from the lung impedance project began asking: "What if we make the sensor biodegradable?" He was already planning the next step.

These are the changes innovation projects bring to students, the best measure of supervision quality. When students no longer settle for "completing the task" but ask "How can we improve?" "Where else can this apply?" "What real problems can we solve?" they have developed genuine innovative capability.

In the future, I will continue exploring deeper integration of teaching, research, and innovative practice, helping undergraduate innovation projects shift from "task completion" to "student empowerment." If these reflections provide even a little inspiration for fellow supervisors, my goal will be achieved.

Disclosure statement

The author declares no conflict of interest.

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