

Synergistic Governance of Research Integrity and Mentorship under the PI System: A “Co-construction” Model for Pharmacy Education

Jian Yang, M.Med^{1,2,3}, Ji Li, Ph.D.^{1,3}, Peng Wang, M.Med.^{1,3}

¹School of Pharmaceutical Sciences & Yunnan Provincial Key Laboratory of Pharmacology for Natural Products, Kunming Medical University, Kunming 650500, Yunnan, China.

²Yunnan Provincial Center for Drug Policy Research, Kunming 650500, Yunnan, China.

³College of Modern Biomedical Industry, Kunming Medical University, Kunming 650500, Yunnan, China.

ABSTRACT

Objective: This study aims to dissect the institutional mechanisms of mentorship alienation under the Principal Investigator (PI) system in pharmacy education and to propose a systemic governance model for research integrity. The transition to the PI system, while boosting innovation, has inadvertently induced a “Pressure Cascade” that strains the traditional educational bond. This systemic pressure often rationalizes Questionable Research Practices (QRPs), which directly threaten the reliability of pharmaceutical research and national bio-security.

Material and Methods: As a theoretical analysis and policy perspective, this study integrates Social Learning Theory and Ethical Leadership Theory to deconstruct the mechanisms of ethical erosion and the “knowledge-behavior gap” within the laboratory microcosm. Furthermore, an institutional analysis is utilized to examine the structural constraints imposed by the PI system, specifically the invasion of instrumental rationality and the formation of an interest-bound community under rigid Key Performance Indicators (KPIs).

Results: Our analysis reveals that the PI system often forces supervisors to prioritize task leadership over explicit ethical management, resulting in a deficit of the “Moral Manager” dimension. To address this root cause, we developed the “Mentorship Co-construction” (Dao-Xue-Gong-Jian) model, which shifts the paradigm from unilateral supervision to systemic co-governance. The model synergizes three dimensions: 1) reconstructing bilateral subjectivity by establishing “Bilateral Integrity Pacts” at entry; 2) integrating ethics into the daily scientific process through the “Glass Box” protocol for routine data auditing and normalizing negative results; and 3) providing ecological support by decoupling tenure reviews from purely quantitative metrics and establishing an independent Ombudsperson System.

Corresponding author: Peng Wang, M.Med.
School of Pharmaceutical Sciences & Yunnan Provincial Key Laboratory of Pharmacology for
Natural Products, Kunming Medical University, Kunming 650500, Yunnan, China.
E-mail: vaporwp@126.com
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Conclusion: Safeguarding research integrity in the PI era demands a systemic reconstruction of the mentorship ecosystem. The “Co-construction” model offers a sustainable path to harmonize high-efficiency scientific production with high-standard ethical cultivation, ensuring the reliability of pharmaceutical research.

Keywords: co-construction model; ethical leadership; mentorship alienation; pharmacy education; principal investigator (PI) system; research integrity

INTRODUCTION

The strategic imperative: national modernization and the bio-security context

In the contemporary era, characterized by intensifying global technological competition and rapid scientific paradigm shifts, the synergistic integration of education, science, and talent development has ascended to the forefront of national strategy in China. The recent Third Plenary Session of the 20th Central Committee explicitly emphasized the necessity of deepening comprehensive reforms in the mechanisms of talent development to support Chinese-style modernization¹. Within this macro-strategic framework, the discipline of Pharmaceutical Sciences occupies a unique and critical ecological niche. Unlike general academic disciplines, pharmaceutical research serves as the cornerstone of the national healthcare system and biological security. The authenticity, reproducibility, and ethical compliance of pharmaceutical data are not merely academic standards but are directly linked to public safety, clinical efficacy, and the credibility of the national innovation system². Consequently, safeguarding research integrity in pharmacy graduate education is an imperative that transcends the ivory tower, requiring robust institutional governance that goes beyond traditional moral exhortation.

The institutional transformation: the rise of the PI system

To align with international standards and maximize the efficiency of resource allocation, Chinese high-level research universities have undergone a profound structural transformation over the past decade: the transition

from traditional, collective-based teaching-research sections to the Principal Investigator (PI) System³. This system grants PIs significant autonomy over human, financial, and material resources, successfully stimulating innovation vitality by mimicking the efficiency of corporate management. However, this “project-based” governance model has fundamentally reshaped the ecological niche of postgraduate education. The mentor-student relationship is transitioning from a traditional educational bond centered on the Confucian ideal of “Moral Cultivation” (Li-De-Shu-Ren) to a complex, performance-driven dynamic⁴. While the PI system drives scientific output, it inadvertently introduces a form of “instrumental rationality” into the laboratory, where the production of data often takes precedence over the ethical cultivation of the researcher. The laboratory, once a sanctuary for academic exploration, increasingly resembles a production unit; wherein, efficiency is the paramount metric.

The core dilemma: “alienation” of mentorship and the pressure cascade

This structural shift has precipitated a significant risk of “alienation” in mentorship. In the resource-constrained academic environment, the mentor-student dyad has, in many instances, devolved into a transactional “Employer-Employee” contract or an “Interest-bound Community” (Li-Yi-Kun-Bang)⁵. Under the systemic imperative of “Publish or Perish,” PIs facing rigid Key Performance Indicators (KPIs)—such as high-impact publications, grant acquisition targets and “Up-or-Out” tenure reviews—often lack the “psychological bandwidth” to act as ethical role models.

This institutional stress creates a “Pressure Cascade” mechanism⁶. The anxiety of university rankings is transmitted to the PI, who, in turn, transmits this survival pressure to the graduate student through aggressive deadlines and result-oriented supervision. Consequently, students may internalize the “hidden curriculum” that positive results are the only currency for survival. Recent empirical studies, including data from medical professionals in Ningxia and qualitative research on European supervision, reveal a persistent “Knowledge–Behavior Gap” in research integrity^{7,8}. While students and mentors possess high levels of ethical knowledge, they often rationalize “Questionable Research Practices” (QRPs)—such as selective reporting, p-hacking or data beautification—as necessary survival strategies (Table 1 for a typology of QRPs specific to pharmaceutical sciences). This “conspiracy of silence” suggests that punitive measures and didactic education alone are insufficient to address the root causes of misconduct, which are structural rather than merely individual.

Theoretical lens: social learning and ethical leadership

To deconstruct these systemic challenges, this study adopts a dual theoretical framework comprising of Social Learning Theory⁹ and Ethical Leadership Theory¹⁰. Bandura’s Social Learning Theory posits that individuals acquire behaviors by observing and modeling “significant others”

in their environment. In the semi-closed microsystem of a pharmaceutical laboratory, the PI represents the absolute authority and primary role model. If a PI demonstrates “ethical ambiguity”—prioritizing speed over rigor or implicitly rewarding “perfect” data regardless of its origin—students are likely to model this behavior, normalizing misconduct as a professional norm. Complementing this, Ethical Leadership Theory distinguishes between the “Moral Person” (personal traits) and the “Moral Manager” (explicit influence). We argue that the PI system creates a deficit in the “Moral Manager” dimension: PIs may be personally honest but fail to provide explicit ethical leadership due to the overwhelming focus on task performance¹¹. This lack of explicit guidance leaves the laboratory’s ethical climate vulnerable to the erosion of utilitarianism.

Study objectives: towards a “co-construction” model

Addressing the alienation of mentorship requires a paradigm shift from unilateral supervision to systemic co-governance. This paper aims to: (1) Theoretically dissect the institutional mechanisms of mentorship alienation under the PI system; and (2) Propose a novel “Mentorship Co-construction” (Dao-Xue-Gong-Jian) Model. Unlike traditional top-down policing, this model advocates for Bilateral Subjectivity (shared responsibility), Process Integration (situated ethical education), and Ecological

Table 1 Typology and risks of questionable research practices (QRPs) in pharmaceutical sciences

Research stage	Specific QRP examples in pharmacy	Potential consequences / bio-security risks
Pharmacology / Molecular Biology	Image Manipulation: Splicing Western Blot bands from different gels; adjusting contrast to hide background noise.	Misleading conclusions on drug targets; irreproducible mechanism studies.
Pharmaceutical Analysis	Selective Reporting: Excluding “outlier” data points in HPLC/GC integration without justification to Improve R ² .	Inaccurate impurity profiling; potential toxicity risks in quality control.
Clinical Trials	Outcome Switching: Changing primary endpoints post-hoc; underreporting Adverse Drug Reactions (ADRs).	Compromised patient safety; approval of ineffective or unsafe drugs.
Data Management	“P-hacking”: Testing multiple statistical models until a significant p-value is found.	False positives; waste of resources in subsequent drug development phases.

Support (institutional buffering). By reconstructing the ethical pact between mentor and student, this study seeks to provide a sustainable theoretical and practical framework for harmonizing scientific efficiency with moral integrity in the high-stakes field of pharmacy education.

MATERIAL AND METHODS

Theoretical framework: the dual coupling of social learning and ethical leadership

To provide a robust theoretical basis for analyzing the micro-mechanisms of mentor-student interactions under the Principal Investigator (PI) system reform, this study integrates Social Learning Theory and Ethical Leadership Theory. These two frameworks complement each other, offering a comprehensive lens to understand how institutional pressures are transmitted within the laboratory and how a specific mentorship model can serve as a corrective mechanism for research misconduct.

Social learning theory: behavioral acquisition in the laboratory microcosm

Albert Bandura's Social Learning Theory posits that complex human behaviors are acquired, not merely through direct trial-and-error, but primarily through observing the actions of significant others and the consequences that follow¹². In the specific context of pharmacy graduate education, the laboratory functions as a high-density social microsystem; wherein, the Principal Investigator (PI) holds absolute authority over academic direction, resource allocation and career recommendation. Consequently, the PI naturally constitutes the most influential "role model" for graduate students that are in the critical phase of constructing their professional identities¹³.

According to this theory, students acutely observe their mentor's behavioral patterns when handling critical incidents; such as dealing with negative data that contradicts a hypothesis or assigning authorship in collaborative projects. This process involves two key psychological mechanisms: observational learning and vicarious reinforcement. If a

PI demonstrates "ethical ambiguity"—for instance, by implicitly encouraging data beautification to meet a grant deadline—and if such behaviors lead to visible professional rewards like high-impact publications, students are likely to internalize these violations as necessary professional survival skills through vicarious reinforcement. Conversely, a PI's explicit adherence to rigorous standards and zero tolerance for misconduct serves as a powerful inhibitory signal. Thus, under the PI system, the laboratory acts as a primary field for social learning where ethical or unethical behaviors are transmitted and reproduced¹⁴.

Ethical leadership theory: the dual dimensions of the PI role

To further clarify the specific responsibilities of mentors in interrupting negative social learning processes, this study incorporates Ethical Leadership Theory. Defined by Brown et al., ethical leadership is the demonstration of normatively appropriate conduct through personal actions and interpersonal relationships. Additionally, the promotion of such conduct to followers through two-way communication, reinforcement, and decision-making. This theory conceptualizes the leader as a unified entity comprising of two distinct dimensions: the "Moral Person" and the "Moral Manager."

The "Moral Person" dimension refers to the leader's personal traits; such as honesty, trustworthiness and integrity. While most PIs inherently possess these qualities, this study argues that the structural flaw of the current PI system lies in the deficit of the "Moral Manager" dimension. Driven by performance-based evaluations, PIs are often forced to prioritize "Task Leadership" focused on resource acquisition; thereby, crowding out the psychological bandwidth required for moral management. Many mentors fall into the trap of "implicit modeling," mistakenly assuming that their personal integrity is self-evident to their students. They consequently neglect the necessity of explicit rule-setting, ethical dialogue, and the enforcement of standards. This absence of active moral management leaves the

laboratory without clear normative guidance, rendering students vulnerable to ethical compromises when facing systemic pressure¹⁵.

The mediation mechanism: bridging the knowledge-behavior gap

Empirical research suggests that a mentor's ethical leadership does not influence student behavior directly; however, it operates through key mediating variables, specifically the team ethical climate and moral efficacy. This mediation model provides a theoretical explanation for the "knowledge-behavior gap" prevalent in current integrity education¹⁶.

First, the PI's values and decision-making patterns directly shape the shared perceptions known as the team ethical climate. An instrumental climate that prioritizes "fast results" over "true results" can weaken the binding force of formal institutional rules, causing students to rationalize misconduct. Second, ethical leadership significantly enhances students' moral efficacy, defined as an individual's belief in their capability to organize and mobilize resources to achieve moral goals, despite adversity. A supportive PI who emphasizes procedural justice empowers students with the psychological safety to report data anomalies or ethical concerns without fear of retaliation¹⁷. Therefore, the theoretical justification for the "Mentorship Co-construction" model proposed in this study lies in restoring the PI's function as a "Moral Manager." By explicitly shaping a positive ethical climate and boosting students' moral efficacy, the model aims to facilitate the transition from mere ethical cognition to actual ethical behavior.

Analysis of institutional challenges: ethical dilemmas under the PI system

To understand the prevalence of research misconduct in the current academic landscape, one must look beyond individual moral failures and examine the structural constraints imposed by the institutional environment. This study argues that the Principal Investigator (PI) system,

while successfully enhancing scientific productivity and resource allocation efficiency, has created a unique set of ethical dilemmas that alienate the mentor-student relationship. This section deconstructs these challenges through three dimensions: the invasion of instrumental rationality, the mechanism of the pressure cascade, and the formation of an interest-bound community.

The invasion of instrumental rationality and corporate logic

The transition to the PI system represents a fundamental shift in the governance of Chinese research universities, moving from a traditional discipline-based model to a modern project-based model. While this reform has revitalized scientific vitality by granting PIs autonomy over human and financial resources, it has inadvertently introduced "instrumental rationality" into the heart of higher education. In this corporate-like structure, the laboratory operates akin to a small enterprise; wherein, the PI functions as the CEO responsible for securing funding (revenue) and producing publications (products), while graduate students often serve as the primary workforce¹⁸. This structural isomorphism prioritizes "efficiency" and "output" over the slower, less tangible process of "Moral Cultivation" (Li-De-Shu-Ren). [Table 2](#) provides a comparative analysis of the governance logic and ethical risks between the traditional "Teaching-Research Section" system and the current PI system. Consequently, the ethical climate of the laboratory is often captured by market logic, where the value of research is measured more by its exchange value—defined by impact factors and grant acquisitions—than by its epistemic value of truth and rigor. This environment creates fertile ground for utilitarian behaviors, where ethical norms are viewed as bureaucratic hurdles, rather than intrinsic professional principles¹⁹. It is crucial to note that while this paper specifically analyzes the structural transformation within Chinese institutions, the alienation of mentorship under high-stakes, grant-driven KPIs is not a uniquely Chinese phenomenon. Rather, it represents a universal

challenge shared by Western and other Asian academic environments operating under the global ‘publish or perish’ paradigm, making the need for a ‘Co-construction’ model globally relevant.

The transmission of the “pressure cascade” mechanism

The ethical vulnerability of the PI system is not inherent to the individuals involved but is a product of systemic design. We identify a “Pressure Cascade” mechanism that transmits institutional stress top-down, eventually eroding the ethical defense line at the bottom: as illustrated in Figure 1. At the top level, driven by the “Double First-Class” initiative and global university rankings, higher education institutions impose rigid quantitative Key Performance Indicators (KPIs) on faculty members. These metrics typically include specific thresholds for impact factors, citation counts and national grant acquisition²⁰.

The PI serves as the critical choke point in this cascade. Facing the “Up-or-Out” tenure-track pressure, young PIs often operate in a state of high survival anxiety. This intense professional insecurity depletes their “psychological bandwidth,” leaving them with little mental redundancy to attend to the moral details of mentorship. In extreme cases, PIs may unconsciously transmit a signal of “results at all costs” to their students, implicitly encouraging data manipulation to secure positive results or adopting an attitude of “willful blindness” toward student misconduct to transfer risk. At the bottom level, graduate students situated at the receiving end of this cascade face aggressive deadlines and high graduation thresholds. In the field of pharmaceutical sciences, where experiments have long cycles and high failure rates, the pressure to produce positive data is particularly acute²¹. To meet their supervisor’s expectations and secure their own degrees, students often find their moral defenses overwhelmed, incentivizing the fabrication or falsification of data as a rational coping strategy.

The “interest-bound community” and the conspiracy of silence

Perhaps the most profound challenge under the PI system is the structural transformation of the mentor-student bond from a loose pedagogical relationship to a tightly coupled “Interest-Bound Community” (Li-Yi-Kun-Bang). Unlike the traditional master-disciple relationship, which was relatively detached from immediate material gain, the PI system aligns the interests of the mentor and the student in a way that creates a structural conflict of interest. The student needs papers to graduate, while the mentor needs the same papers to pass performance reviews and renew grants²².

This alignment creates a dangerous “Conspiracy of Silence.” When faced with “Questionable Research Practices” (QRPs)—such as “salami slicing” publications, omitting outliers or p-hacking—both parties possess a perverse incentive to look the other way. The mentor’s role as an ethical “gatekeeper” is compromised by their role as a stakeholder in the student’s “success.” In this context, minor breaches of integrity are often rationalized as necessary tactics for the team’s survival, leading to a normalized deviance where the pursuit of truth is subordinated to the pursuit of metrics. This is further exacerbated in pharmaceutical research where commercial interests and complex conflicts of interest (COI) involving drug development can induce bias, making the maintenance of neutrality even more precarious²³.

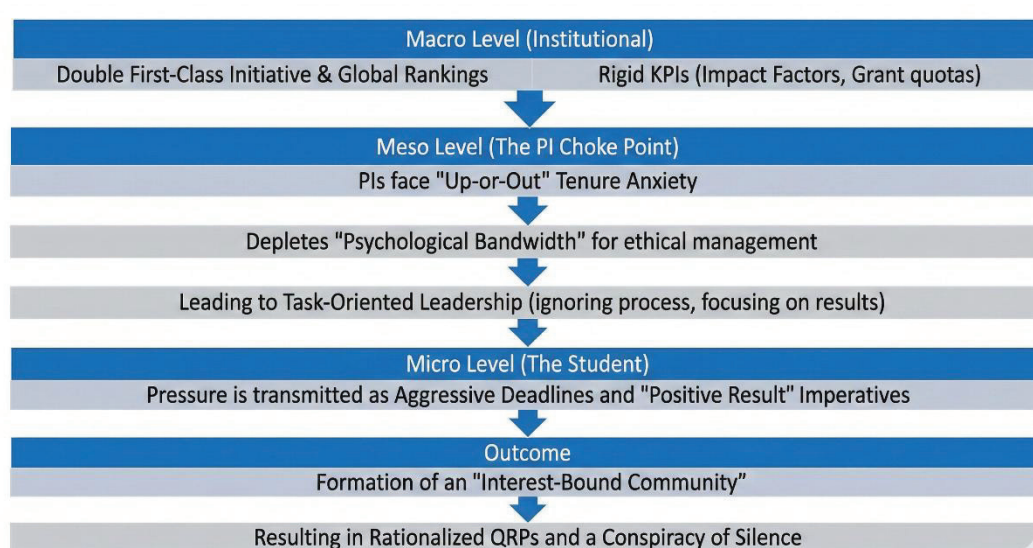
RESULTS

The “mentorship co-construction” model: a systemic solution

Addressing the alienation of mentorship and the pressure cascade under the Principal Investigator (PI) system requires a fundamental paradigm shift from traditional top-down indoctrination to a model of systemic co-governance. Drawing upon the educational concept of “co-construction,” where knowledge and skills are developed through collaboration and dialogue, this

Table 2 Comparison of governance logic and ethical risks: traditional system vs. PI system

Dimensions	Traditional “teaching-research section” system	Principal investigator (PI) system
Core Goal	Discipline construction & Teaching stability	Resource efficiency & Innovation output
Resource Control	Centralized at Department/School level	Decentralized to Individual PIs
Mentorship Bond	Master–Disciple (Pedagogical & Emotional)	Employer–Employee (Contractual & Transactional)
Evaluation Logic	Seniority & Teaching Load	“Up–or–Out” & Quantitative KPIs
Ethical Risk	Lack of vitality; Academic inbreeding	“Pressure Cascade” & Conspiracy of Silence
Student Status	Educatee / Mentee	Labor force / Stakeholder in production

**Figure 1** The “pressure cascade” mechanism and the alienation of mentorship under the PI system

study proposes the “Mentorship Co-construction” (Dao–Xue–Gong–Jian) model (Figure 2). Unlike conventional approaches that rely on unilateral supervision or individual moral exhortation, this model views research integrity as a shared asset co-created by the mentor, the student, and the institution. Table 3 outlines the fundamental paradigm shift from unilateral supervision to the proposed systemic co-construction approach. By reconstructing bilateral subjectivity, integrating ethics into the scientific process, and establishing ecological support, this model aims to reconcile the structural tension between scientific efficiency and moral cultivation²⁴.

Reconstructing bilateral subjectivity: the bilateral integrity pact

The foundation of the co-construction model lies in dismantling the “employer–employee” dynamic and restoring the “academic community” ethos by redefining the subjects of integrity governance. Traditional integrity commitments are often administrative formalities unilaterally signed by the student, which reinforces their passive status as a regulated entity. To counter this, we advocate for the implementation of a “Bilateral Integrity Pact” or a double-signature psychological contract established at the entry level. Table 4 presents a sample checklist for this pact,

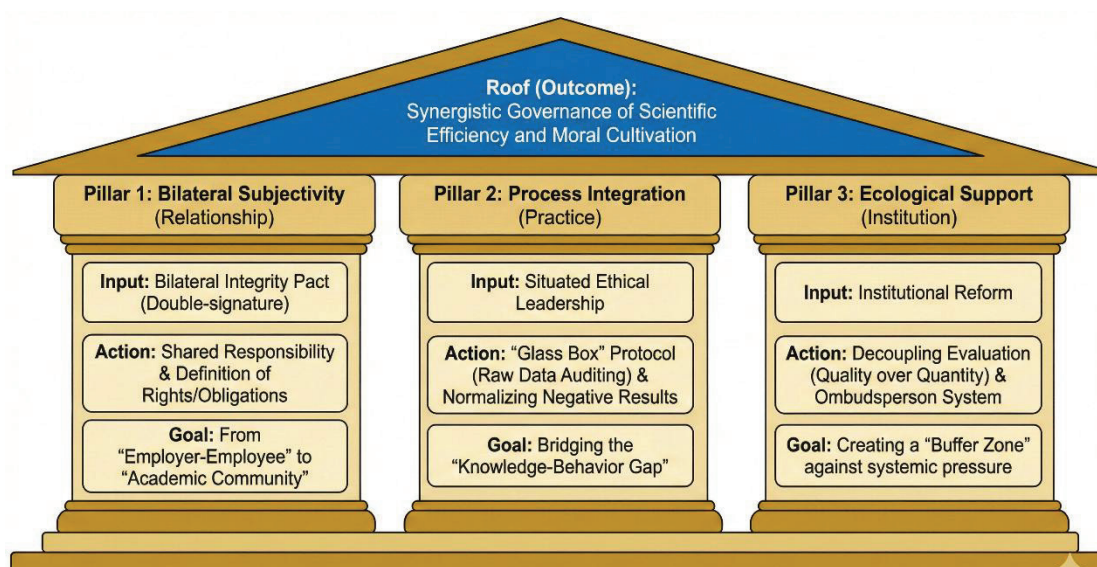


Figure 2 The "mentorship co-construction" (Dao-Xue-Gong-Jian) model for research integrity governance

Table 3 Paradigm shift in integrity education: from unilateral supervision to systemic co-construction

Dimension	Current paradigm (unilateral supervision)	Proposed "Co-construction" paradigm
Commitment Form	Student signs a unilateral pledge upon entry.	Bilateral Integrity Pact (Mentor & Student double signature).
Data Management	"Black Box": Checked only when suspicion arises.	"Glass Box" Protocol: Routine, non-punitive auditing (like clinical rounds).
Handling Negativity	Often hidden or viewed as "failure" to publish.	Normalization: Discussed openly in lab meetings as valuable scientific evidence.
Evaluation Focus	Quantitative (Impact Factor, Grant Sums).	Qualitative Decoupling: Mentorship quality & Ethical climate included.
Conflict Resolution	Informal, often suppressed by power hierarchy.	Ombudsperson System: Independent, neutral third-party mediation.

delineating specific actionable clauses for both mentors and graduate students in pharmaceutical research. This pact explicitly delineates the reciprocal ethical obligations of both parties, transforming abstract moral requirements into actionable behavioral standards²⁵.

In this bilateral framework, the mentor commits to "Academic Fairness" and "Responsible Supervision," which includes providing regular academic guidance, ensuring the frequency of data verification, respecting student authorship and offering psychological support. Simultaneously, the

student commits to "Raw Data Transparency" and strict adherence to standard operating procedures (SOPs), ensuring that all experimental anomalies are reported, rather than concealed. This contractual ritual serves to awaken the student's sense of ownership, transforming them from a passive subject of regulation into an active stakeholder in the laboratory's ethical reputation. By establishing this clear consensus on rights and responsibilities, the pact lays a solid institutional foundation for a mentorship relationship built on trust and mutual respect.

Table 4 Sample checklist for the “Bilateral Integrity Pact” in pharmaceutical research

Responsible subject	Key commitment domain	Specific actionable clause (the pact)
Mentor (PI)	Authorship & Credit	I commit to defining clear authorship criteria, based on contribution before the project starts; strictly avoiding “gift authorship.”
	Data Oversight	I will review raw data (e.g., original Western Blot images, HPLC chromatograms) at least once a month, rather than relying solely on processed figures.
	Psychological Safety	I will foster an environment where reporting “negative results” or experimental failures is treated as scientific evidence, rather than a mistake to be punished.
	Conflict of Interest	I will transparently disclose any industry ties or financial interests that might bias the research direction to the student.
Graduate Student	Data Transparency	I adhere to the “Glass Box” Protocol: All raw data generated must be uploaded to the lab server/cloud within 24 hours without unauthorized modification.
	AI Integrity	I confirm that I will not use Generative AI tools (e.g., ChatGPT, Midjourney) to generate data, write manuscripts, or modify images without explicit authorization and disclosure.
	Deviation Reporting	I commit to reporting any experimental anomalies, outliers, or unexpected deviations to the mentor immediately, ensuring the traceability of the research process.
	Record Keeping	I understand that a standardized, unalterable lab notebook is as important as the experiment itself and will maintain it according to GLP (Good Laboratory Practice) standards.

Process integration: situated ethical leadership in the laboratory

Under the high-pressure environment of the PI system, ethics is often silenced by the noise of productivity; therefore, the co-construction model demands the explicit integration of ethical discourse into the daily scientific process. We propose the “Glass Box” Protocol as a mechanism to institutionalize data transparency. This involves establishing a real-time laboratory electronic recording system where raw data is uploaded and immutable, allowing mentors to conduct routine, non-punitive data audits. Unlike forensic investigations triggered only by suspicion of misconduct, these routine audits function like clinical rounds, normalizing scrutiny as a standard scientific quality control measure, rather than a disciplinary threat.

Furthermore, mentors must actively lead the normalization of negative results to dismantle the psychological drivers of data fabrication. In lab meetings, the PI should encourage the open discussion of failed

experiments and anomalous data, validating their scientific value. By engaging in “self-disclosure” about their own past failures or ethical dilemmas, mentors can reduce the power distance and alleviate the student’s fear of reporting “bad news”. Additionally, collective decision-making mechanisms should be adopted for critical issues; such as journal selection and authorship ordering. Allowing students to participate in these decisions exposes them to the ethical reasoning behind academic choices; thereby, bridging the gap between theoretical ethical knowledge and practical scientific conduct²⁶.

Ecological support: institutional buffering and decoupling

The effectiveness of the micro-level co-construction model is contingent upon macro-level institutional support, as mentors cannot function as effective “Moral Managers” if they are isolated in a survival mode. Institutions must establish a “buffer zone” to interrupt the pressure cascade. This requires a systemic reform of the evaluation system,

moving away from a purely “quantity-based” assessment of PIs to a “quality-based” composite index, echoing the principles of the San Francisco Declaration on Research Assessment (DORA). Indicators, such as “talent cultivation quality” and “laboratory ethical climate,” should be structurally decoupled from project output metrics; like grant sums and impact factors, ensuring that mentorship quality is a substantive factor in tenure reviews²⁷.

In the context of Chinese administrative frameworks, rather than creating an entirely new structural entity from scratch, this Ombudsperson function could be practically integrated as a structurally independent, advisory sub-committee under the university's existing Academic Committee (Xue-Shu-Wei-Yuan-Hui) or the Union (Gong-Hui), deliberately kept separate from the disciplinary functions of the PI's host faculty. To further break the “interest-bound community” and the “conspiracy of silence,” institutions should establish an independent Ombudsperson System or a specialized research integrity office that functions as a service provider, rather than just a regulator. This mechanism provides a safe, confidential harbor for both mentors and students to report coercive pressures or seek advice on ethical grey areas without fear of retaliation. By offering professional support and conflict resolution, the institution empowers the co-construction model, ensuring that the pursuit of scientific innovation does not come at the expense of ethical integrity.

Systemic guarantees and implementation strategies

The “Mentorship Co-construction” model operates effectively at the micro-level of the laboratory only when sustained by a supportive macro-level ecosystem. As indicated in the literature, mentors cannot function effectively in a vacuum; institutional support is a key variable in determining the quality of the mentor-student relationship. Therefore, to mitigate the alienation caused by the PI system, universities must transition from a passive role of a regulator to an active role of an enabler, providing systemic

guarantees that reinforce the co-construction framework through institutional empowerment, differentiated guidance, and administrative synergy.

Institutional empowerment: from regulation to service

To operationalize the co-construction model, higher education institutions must assume the primary responsibility for research integrity by shifting their governance focus from post-hoc punishment to preventative service. First, universities should establish specialized research integrity offices or ethical consultation bodies that function differently from traditional disciplinary committees. These bodies should provide confidential advisory services, answering specific queries regarding data management, authorship disputes, and conflict of interest disclosures; thereby, encouraging faculty and students to seek guidance before ethical breaches occur, rather than waiting for investigations after a crisis. Second, a comprehensive and mandatory training system is essential. Universities should mandate curriculum for mentors that covers not only research ethics regulations but also the psychology of mentorship and laboratory management arts. Evidence suggests that strengthening training is perceived as one of the most effective measures²⁸. Furthermore, acknowledging the “Pressure Cascade” inherent in the PI system, institutions must provide psychological support services specifically for PIs. Addressing the mental health and professional burnout of mentors is crucial to preventing the displacement of stress onto students, which often manifests as “micro-violence” or unethical inducement.

Differentiated guidance mechanisms

Recognizing the heterogeneity of the academic workforce, the implementation of the co-construction model requires a “Classified Guidance” strategy, rather than a “one-size-fits-all” approach. Special attention must be paid to Junior PIs that are often under the immense pressure of the “Up-or-Out” tenure track system. To prevent these

young investigators from relaxing ethical requirements due to assessment anxiety, institutions should implement a “Dual Mentorship” or “Mentoring the Mentor” system. This is where senior PIs provide guidance on managing the ethical stresses of career advancement. Additionally, gender-responsive strategies should be adopted²⁹. Encouraging female mentors to leverage their strengths in establishing emotional connections and ethical care can enhance student identification, while male mentors should be supported in developing communication strategies that bridge the perception of instrumentality, ensuring their ethical leadership is received with trust.

Administrative synergy and evaluation reform

The sustainability of the co-construction model relies on a fundamental reform of the evaluation baton and the breaking of departmental silos. In response to global initiatives; like the San Francisco Declaration on Research Assessment (DORA) and the Hong Kong Principles, universities must reshape the evaluation system to solve the root causes of mentorship alienation³⁰. This involves structurally decoupling the “quantity of papers” from tenure reviews and introducing representative work systems that emphasize research quality and social contribution. Crucially, indicators; such as ‘mentorship quality,’ must be substantively incorporated into the evaluation system. In practice, this can be objectively measured by implementing standardized, 360-degree anonymous student evaluations upon graduation. In addition to requiring PIs to submit comprehensive ‘mentorship portfolios,’ detailing their training protocols, and tracking the long-term career integrity records of their alumni. To achieve this, administrative synergy is required across the Graduate School, the Office of Scientific Research, and the Human Resources Department, as outlined in the strategic directive to “comprehensively deepen reform”. Table 5 summarizes a policy recommendations matrix for university administrators, covering ethics enforcement, evaluation reform, professional development and governance structure. While the education

and technology departments manage curriculum and data supervision respectively, the human resources department must enforce a “One-Vote Veto” system. This ensures that any failure in research integrity or mentorship ethics serves as an immediate disqualification for talent recruitment and promotion, regardless of the candidate’s publication record³¹.

DISCUSSION

Bridging the theory-practice gap: from passive regulation to active construction

The primary contribution of this study is the development of the “Mentorship Co-construction” model, which offers a theoretical resolution to the persistent “Knowledge-Behavior Gap” identified in recent empirical studies on research integrity. Traditional integrity education has largely relied on a “compliance-based” paradigm, characterized by unilateral indoctrination and post-hoc punishment. However, our analysis of the “Pressure Cascade” under the PI system reveals that misconduct is often a rationalized coping strategy adopted by individuals facing structural survival anxieties, rather than a simple deficit of moral knowledge³². The “Co-construction” model addresses this by shifting the focus of control from external regulators to the mentor-student dyad itself. By establishing a “Bilateral Integrity Pact”, the model redefines the student from a passive recipient of rules to an active stakeholder in the laboratory’s ethical reputation. This shift aligns with the “Moral Manager” dimension of Ethical Leadership Theory, where explicit rule-setting and two-way communication serve to internalize ethical norms. Furthermore, by embedding ethical discourse into the daily scientific process—such as the routine auditing of raw data and the normalization of negative results—the model transforms abstract ethical principles into situated practices. This “situatedness” ensures that ethics is not viewed as an external constraint but as an intrinsic component of scientific rigor; thereby, bridging the chasm between ethical cognition and behavioral enactment³³. Furthermore, the ‘Co-construction’ model is particularly

Table 5 Policy recommendations matrix for university administrators

Policy domain	Specific measures	Implementation rationale & expected outcome
Ethics Enforcement	Establish a “Negative List” with One-Vote Veto Explicitly define red-line behaviors (e.g., coercing data falsification and appropriating authorship). Any violation results in immediate disqualification from mentorship, regardless of publication output.	To signal zero tolerance for ethical breaches and ensure that high scientific productivity cannot serve as a shield for moral failure.
Evaluation Reform	Decouple Tenure Reviews from Quantitative Metrics Reduce reliance on bibliometrics. Introduce a “Representative Work” system assessing reproducibility, alongside objective mentorship evaluations (e.g., 360-degree anonymous feedback, mentorship portfolios, and alumni tracking).	To shift the focus from “Quantity” to “Quality”, reducing the “pressure cascade” that drives PIs to prioritize speed over rigor.
Professional Development	Mandate “Mentoring the Mentor” Certification Require all new PIs to complete a certification course on “Ethical Leadership and Laboratory Management” before supervising graduate students.	To move from “Implicit Modeling” to “Explicit Leadership”, ensuring PIs have the psychological and management skills to handle mentorship stress.
Governance Structure	Create “Safe Harbors” (Ombudsperson System) Implement an independent consultation and whistleblowing channel that is administratively separate from the PI’s department to prevent retaliation.	To break the “Conspiracy of Silence” and “Interest-Bound Community” by providing a neutral third-party mechanism for conflict resolution.

highly adaptable to emerging technological disruptions; such as the rapid integration of Generative AI in academic research. Traditional compliance models often lag behind technological advancements, leaving ethical grey areas regarding AI-assisted data processing or manuscript drafting. By relying on the ‘Bilateral Integrity Pact,’ mentors and students can proactively negotiate and update AI usage boundaries (e.g., mandatory disclosure of AI tools, verifying AI-generated code) within their specific laboratory context. This shared governance ensures that AI acts as an efficiency multiplier rather than a tool for scientific obfuscation³⁴.

The imperative of pharmaceutical specificity: high stakes and bio-security

While the alienation of mentorship is a challenge across higher education, the implementation of the “Co-construction” model is particularly urgent within the discipline of Pharmaceutical Sciences. Unlike humanities or social sciences, pharmaceutical research is characterized by

long experimental cycles, high failure rates, and a direct correlation with public health safety. The prevalence of “Questionable Research Practices” (QRPs) in this field; such as data beautification in preclinical studies or the concealment of adverse effects in clinical trials, poses severe bio-security risks and threatens the validity of evidence-based medicine³⁵. Under the PI system, the complex entanglement of commercial interests—such as patent transfers and cooperation with pharmaceutical enterprises—further exacerbates the risk of bias. The “Co-construction” model mitigates these specific risks by fostering an “Open Glass Box” culture where data transparency is paramount. By institutionalizing the collective discussion of experimental anomalies and conflicts of interest, the model acts as a prophylactic against the “Conspiracy of Silence,” which can lead to catastrophic public health consequences. It also ensures that the development of new drugs remains grounded in verifiable truths³⁶.

From instrumental rationality to value rationality: reshaping the scientific ethos

Beyond the immediate correction of behavioral deviations, the “Mentorship Co-construction” model serves a deeper philosophical function: addressing the imbalance between “Instrumental Rationality” and “Value Rationality” inherent in the current PI system. As analyzed in Section 3, the PI system, driven by corporate logic, tends to prioritize instrumental rationality—where scientific activities are judged solely by their efficiency in generating fundable and publishable outputs. This logic risks reducing the mentor–student relationship to a means–end calculation, where the pursuit of truth is subordinated to the pursuit of utility³⁷. The “Co-construction” model challenges this reductionism by re-embedding “Value Rationality” into the core of laboratory life. By institutionalizing the “Glass Box” protocol and validating negative results, the model explicitly signals that the process of inquiry holds intrinsic moral value, independent of the outcome’s utility. This shift is crucial for restoring the traditional scientific ethos (Mertonian norms) within the hyper-competitive environment of modern academia. It fosters a cognitive reframing where students learn to value “getting it right” over “getting it published;” thereby, immunizing them against the systemic pressure to compromise integrity for short-term survival³⁸.

The “spillover effect” of micro-governance: safeguarding the pharmaceutical ecosystem

The implications of this study extend well beyond the walls of the university laboratory, resonating with the broader pharmaceutical ecosystem. Pharmacy graduate education is the primary talent pipeline for the drug development industry, regulatory agencies, and clinical research organizations (CROs). If the “Conspiracy of Silence” regarding QRPs is allowed to persist during graduate training, these normalized deviations will inevitably spill over into the industry. This would then manifest as data

manipulation in new drug applications (NDAs) or ethical lapses in clinical trials³⁹. Therefore, the “Mentorship Co-construction” model functions not only as an educational reform but as a critical “upstream firewall” for national bio–security. By instilling a rigorous ethical baseline and a habit of data transparency in future pharmaceutical professionals, this model contributes to the long-term reliability of the national healthcare system. It suggests that the governance of academic research integrity should be viewed as an integral component of the pharmaceutical quality management system (QMS); wherein, the ethical quality of human capital is as vital as the chemical purity of the drugs they develop⁴⁰.

Limitations and future directions

This study presents a theoretical framework and a governance model, based on a synthesis of literature and institutional analysis; however, several limitations must be acknowledged. First, the “Mentorship Co-construction” model is currently a theoretical construct derived from the analysis of the PI system’s structural defects and existing socio–psychological theories. While it integrates evidence from KAP studies and qualitative interviews, it lacks longitudinal empirical data to quantify its efficacy in reducing misconduct rates over time. Future research should focus on developing psychometric scales to measure the level of “Mentorship Co-construction” and conducting multi-center intervention studies to verify its impact. Second, this study primarily focuses on the general PI team structure. Future inquiries should explore the differentiated application of this model across various types of research groups; such as basic laboratory research versus clinical trials, where ethical dilemmas may manifest differently. Finally, with the rapid integration of artificial intelligence in drug discovery, future research must address how the “Co-construction” model adapts to new ethical challenges posed by AI-assisted data generation and analysis.

CONCLUSION

The transformation of research governance toward the Principal Investigator (PI) system in Chinese pharmaceutical education represents a double-edged sword, reflecting a universal challenge shared by academic institutions globally under the “publish or perish” paradigm. While it has successfully ignited innovation vitality and resource efficiency by mimicking corporate management logic, it has structurally induced the “alienation” of the mentorship dynamic. Under the utilitarian logic of “Publish or Perish,” the traditional educational bond is at risk of devolving into an interest-bound community where the pressure for quantitative output erodes the ethical baseline. The resulting “Conspiracy of Silence” regarding research integrity is not merely an individual moral failure but a systemic symptom of the “Pressure Cascade”. Therefore, safeguarding research integrity requires a fundamental paradigm shift from punitive discipline to systemic co-governance. The proposed “Mentorship Co-construction” model offers a viable pathway for this transition. By reconstructing bilateral subjectivity, integrating ethics into the scientific process, and establishing ecological support through institutional reform, this model aims to reconcile the tension between scientific efficiency and moral cultivation. Ultimately, in the high-stakes field of pharmaceutical sciences, research integrity is not just an academic norm but a critical component of national bio-security and the modernization of the healthcare system.

Ethics approval and consent to participate

Not applicable. This study is a theoretical analysis and policy perspective, based on a synthesis of existing literature and institutional regulations. No new human participants or animal experiments were involved in this specific article. The secondary data cited have been referenced from previously published works, with their own ethical approvals.

Table 6 List of abbreviations

Abbreviation	Full term
PI	Principal Investigator
QRPs	Questionable Research Practices
KPIs	Key Performance Indicators
KAP	Knowledge, Attitude, and Practice
COI	Conflict of Interest
SOPs	Standard Operating Procedures
DORA	San Francisco Declaration on Research Assessment
CROs	Clinical Research Organizations
NDAs	New Drug Applications
GLP	Good Laboratory Practice
FFP	Fabrication, Falsification, and Plagiarism
AI	Artificial Intelligence
QMS	Quality Management System
ADRs	Adverse Drug Reactions
HPLC	High-Performance Liquid Chromatography

Consent for publication

Not applicable.

Availability of data and materials

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study. All concepts and models proposed are derived from the theoretical synthesis presented in the manuscript.

Authors' contributions

J.Y. (Jian Yang) conceived the “Mentorship Co-construction” model, designed the theoretical framework, and drafted the manuscript. J.L. (Ji Li) conducted the literature review and contributed to the analysis of institutional challenges. P.W. (Peng Wang) assisted in the formulation of policy recommendations and critically revised the manuscript. All authors have read and approved the final manuscript.

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CONFLICT OF INTEREST

The authors declare that they have no competing interests. The research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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