

## Evaluation Model and Empirical Analysis of the Graduate Mentor-Student Relationships from the Perspective of Academic Norms

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### Abstract

The rising incidence of academic misconduct has led to a heightened emphasis on academic norms. Consequently, the graduate mentor-student relationship, when viewed through the lens of academic norms, has emerged as a pivotal research topic in educational studies. This paper presents a logical association analysis between academic norms and the mentor-student relationship. It delineates the mentor-student dynamic into four distinct categories based on two core dimensions: academic cultivation and moral cultivation. An evaluative model and a range of indicator weights related to the mentor-student relationship from an academic norm perspective are established. This involves 15 level 2 indicators and 51 level 3 indicators, selected from 5 domains: quality of academic guidance, academic integrity cultivation, academic exchange and interaction, output of academic achievements, and students' academic growth. Empirical analysis is executed using data sourced from scholars' assignments and scores derived from the Likert five-point scale. The findings reveal that the weights assigned to academic integrity cultivation and quality of academic guidance, within the evaluation system for the mentor-student relationship, surpass 25%, indicating their significant influence. Notably, the "academic guidance-moral guidance" type of mentor-student relationship exhibits the highest degree of similarity to the reference sequence (the ideal mentor-student relationship).

**Keywords:** *Academic norms; Graduate mentor-student relationships; Evaluation index system; Empirical analysis; Higher education.*

### A. Introduction

Universities play a strategic role in talent cultivation and scientific research, serving as a crucial foundation for advancing education, science, and technology in nation-building (Xue & Li, 2022). In this context, graduate education is vital for nurturing innovative talents, strengthening research capacities, and advancing the modernization of governance systems. However, the achievement of these goals is closely tied to the quality of the mentor-student relationship, which not only shapes academic interactions but also carries the fundamental mission of moral education, the cultivation of academic ethics, and the fostering of research integrity. In recent years, the prevalence of academic misconduct within the context of educational reforms has highlighted significant challenges, emphasizing the urgent need to build harmonious mentor-student relationships grounded in academic norms.

Previous studies underline the critical role of mentors in shaping the academic and ethical development of graduate students. Toklu and Fuller (2017) emphasize that a healthy mentor-

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student relationship directly determines the overall quality of graduate education. Various international practices have also demonstrated efforts to institutionalize positive mentoring environments through clear regulations and ethical standards. For example, the Council of Graduate Schools (CGS) in the United States has issued Guidelines for Mentoring Graduate Students, stressing continuous communication, anonymous feedback mechanisms, and prohibitions against exploiting students as inexpensive labor. Similarly, the International Association of Universities (IAU) released a Joint Statement on Preventing Academic Harassment, urging the establishment of codes of conduct for mentors, mandatory anti-harassment training, and independent appeals committees to resolve conflicts. In China, the Ministry of Education promulgated the Guidelines for Postgraduate Mentors' Guidance Behavior in 2020, affirming that mentors bear the primary responsibility for cultivating high-level innovative talents and are obliged to uphold rigorous academic standards. These international practices and scholarly discussions reflect growing global concern for building mentor–student relationships rooted in academic ethics.

Against this backdrop, the present study aims to explore the graduate mentor–student relationship from the perspective of academic norms. Specifically, it seeks to construct the key attributes that define this relationship, classify its distinct types, and conduct empirical evaluations to identify the ideal model of interaction within the framework of graduate education. Moreover, this research examines the weight and influence of various normative indicators—including the quality of academic guidance, cultivation of academic integrity, the mentor's moral influence, the student's learning attitudes and abilities, as well as participation in research activities. By doing so, this study not only contributes to the theoretical discourse on academic ethics but also provides an empirical foundation for designing policies and practices that can enhance the quality of graduate education.

The significance of this research lies in the argument that the mentor–student relationship is more than a personal interaction; it is a strategic mechanism that shapes student outcomes, academic culture, and the institutional reputation of universities. Without the guidance of well-defined academic norms, such relationships risk becoming transactional or even exploitative, undermining both research quality and students' moral development. Conversely, when grounded in strong ethical standards, exemplary mentoring, and the cultivation of academic integrity, the mentor–student relationship can drive a vibrant academic ecosystem characterized by harmony, innovation, and excellence. Therefore, this study underscores the necessity of re-examining and reconstructing the mentor–student relationship through the lens of academic norms as a strategic pathway to advancing the competitiveness and quality of graduate education in the global arena.

## **B. Methods**

This study employed a quantitative evaluative research design to analyze the graduate mentor–student relationship through the lens of academic norms. The design integrates model construction and empirical testing, with the primary objective of establishing a structured evaluation system. The framework categorized mentor–student relationships into four types, based on two dimensions: academic cultivation and moral cultivation. Furthermore, the study applied a logical association analysis to determine the weight and influence of multiple indicators, thereby enabling a systematic examination of the relationship patterns.

The research was conducted in two main stages. First, a conceptual framework was developed, consisting of five core domains: quality of academic guidance, academic

integrity cultivation, academic exchange and interaction, output of academic achievements, and student academic growth. From these domains, 15 level-2 indicators and 51 level-3 indicators were defined. Second, empirical testing was carried out by collecting data from graduate mentors and students. Participants were assigned evaluation tasks and asked to provide responses using a standardized five-point Likert scale. The results were then aggregated to generate an evaluative dataset for subsequent analysis.

Data were collected through structured questionnaires distributed to graduate mentors and students. The questionnaire items were developed based on the established evaluation framework, covering all five domains and their respective indicators. Respondents rated each indicator using a five-point Likert scale (ranging from “strongly disagree” to “strongly agree”). To ensure validity and reliability, the questionnaire was reviewed by experts in higher education studies and pre-tested on a pilot group before formal administration. In addition, secondary data, such as graduate assignment evaluations and institutional records, were incorporated to complement the survey results.

The data were analyzed using a combination of descriptive statistical analysis and a weighted evaluation model. Indicator weights were calculated to determine the relative influence of each factor within the mentor–student relationship. The analysis emphasized the contribution of first-level indicators, particularly quality of academic guidance and cultivation of academic integrity, which demonstrated the highest weighting (above 25%). Furthermore, similarity evaluation methods were applied to compare the empirical data with the reference sequence, representing the ideal mentor–student relationship. This approach enabled the identification of the most favorable type of relationship—academic guidance, moral guidance, as well as the less ideal types.

## **C. Results and Discussion**

### **1. Conceptual Definition and Educational Landscape of Academic Norms**

The disparity between academic norms and academic conventions pertains to the varying standards of academic writing, communication, and evaluation among scholars from diverse cultural backgrounds (Yang and Valentín-Rivera 2023). This refers to a set of academic standards and regulations that carry binding force in the technical, content, and ethical aspects of academic work. This includes both academic research and the publication of academic results, among other activities (Braxton 2010). Academic norms encompass two distinct levels of significance: firstly, they delineate the behavioral guidelines that govern how academicians conduct scientific research, literary and artistic endeavors, among other cultural activities, ensuring adherence to established standards; secondly, they pertain to the regulatory mechanisms addressing academic malfeasances such as plagiarism, piracy, and forgery by the competent academic entities (McCambridge 2021). Academic norms represent a form of behavioral adaptation concentrated on scholarly activities (Dill and Beerkens 2013). For example, within the realm of academic research, these norms establish the genre structure for empirical research papers and set standards for citation practices. These conventions not only bolster the validity and reliability of research outcomes but also ensure the robustness of the derived conclusions (Saidi and Talebi 2021).

Academic norms serve as a crucial institutional foundation for a country or region, safeguarding academic freedom and fostering academic creativity (Azeem et al., 2009). International educational organizations, university alliances, and national education regulatory agencies have issued a series of policy documents designed to bolster the academic code of

conduct education for graduate students. Globally, policies emphasize mentor accountability and procedural safeguards to uphold academic integrity. The European Code of Conduct for Research Integrity (ALLEA) mandates fair authorship attribution, prohibition of data manipulation, and prevention of academic bullying. In the U.S., the Federal Policy on Research Misconduct (OSTP) defines academic misconduct, including the exploitation of student work by mentors, and requires universities to implement independent investigation protocols, establish whistleblower protections, and define clear supervisory responsibilities. Australia's Higher Education Academic Integrity Standards (TEQSA) enforce transparency in mentor-student relationships, allowing students to request mentor reassignment without justification and requiring institutions to facilitate rematching within 30 days. In China, academic integrity is prioritized through policies like the 1980 "Regulations on Degrees of China" and the 2012 "Measures for Dealing with Deceptive Behavior in Dissertations" (Ministry of Education of China No. 34), linking degree conferral to academic norms and standardizing thesis management. As the administration of graduate academic norms intensifies, there is a marked improvement in the awareness of academic norms. However, evident deficiencies exist within the current academic norms education, specifically in areas such as academic standard systems, educational methodologies, and their subsequent impacts (Rola Ajjawi & Boud, 2021; Sharp 2017). There is a marked absence of comprehensive, systematic instruction on academic ethical standards for students, resulting in students possessing an incomplete understanding of these norms (Peng, 2024). There is an urgent need to evaluate and improve academic norms education to enhance scientific ethics among graduate students.

## **2. Concept Definition of the Graduate Mentor-Student Relationship**

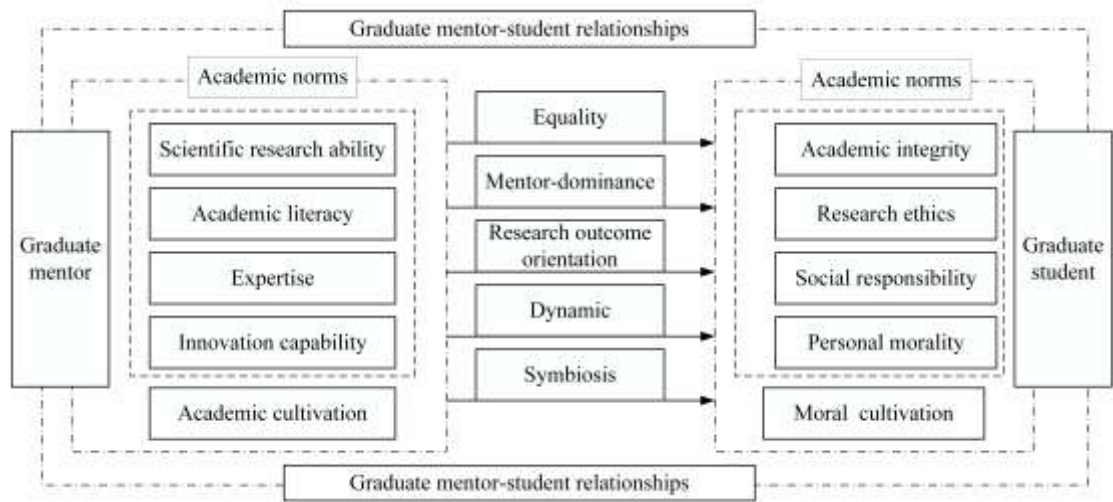
The graduate mentor-student relationship, the most common form of teacher-student relationship in universities (Chukwu and Walker 2023), is widely acknowledged as central to graduate education (Gershenson et al. 2016). This complex dynamic process (Stes et al. 2012), is a "multidimensional structural relationship system" characterized by distinct institutional, cultural, and social constructs, influenced by individual traits, subject interactions, and social environments (Shutaleva et al. 2023). The academic community has offered various interpretations of the intrinsic meaning of this relationship, which can be broadly divided into two categories. On one hand, it is viewed as an educational relationship where mentors perform their duties according to educational work, and students earn degrees through learning, establishing a fundamental and stable mentor-student relationship. As suggested by Li et al., this relationship is a complex, interactive relationship between mentors, in their role as academic advisors, and graduate students, who are learners or researchers (Li et al. 2024). In this context, mentors assume a supervisory role in the mentor-student relationship, overseeing the academic and research processes of graduate students (Jarvis 1984). The number and academic level of graduate students under a mentor significantly shape this relationship (Cotten and Wilson 2006). Conversely, it is suggested that the mentor-student dynamic in graduate studies constitutes a bidirectional interactive relationship, established through mutually dependent and equal interactions between educators and students, centered around teaching events and research guidance activities (Irvine 1986). In this context, a positive mentor-student relationship typically exhibits a pattern wherein "mentors offer guidance and support to joint exploration and creation by both mentors and students" (Nurmi 2012).

Despite the lack of consensus on the definition of the graduate mentor-student relationship, it is widely accepted that this dyad encompasses five core dimensions. Primordially, equality serves as the cornerstone, highlighting the necessity for mutual respect and equitable communication between mentors and graduate students. Secondly, the mentor-dominance is manifest in the provision of research direction, scholarly mentorship, and assistance with career development. The third dimension, research outcome orientation, positions the quality and

quantity of research output as critical metrics for assessing the efficacy of the relationship. The dynamism, fourthly, signifies that this relationship is subject to evolution in response to temporal shifts, environmental changes, and individual development. Finally, the symbiosis underscores a profound merging of both parties' academic, emotional, and value systems, culminating in a model of interdependence and collective advancement. Therefore, the mentor-student relationship is a symbiotic one, predicated on mentor-student equality, guided by the mentor, valuing research outcomes, and adapting to changing circumstances.

**3. The Logical Connection Between Academic Norms and Graduate Mentor-Student Relationship**

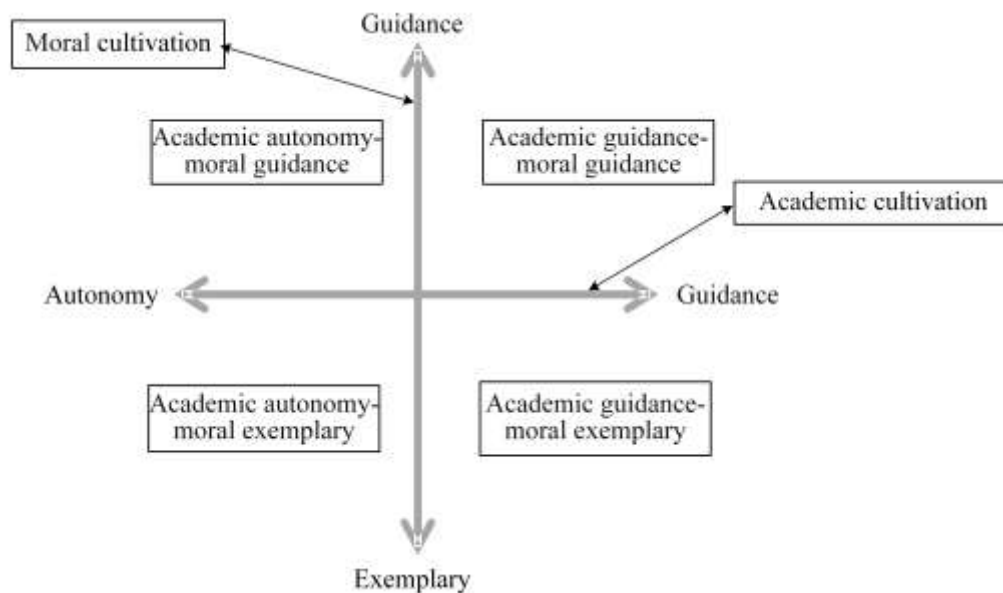
The graduate mentor-student relationship, grounded in research supervision and academic engagement, adheres to Habermas' framework of communicative action (J. Johnson 1991). This relationship treats academic norms as the fundamental guidelines for interaction, with the objective of preserving academic integrity, bolstering academic excellence, and igniting the scholarly passion and innovative potential of graduate students (Austin 2002). Academic norms serve not only as an embodiment of the academic community's values but also as the cornerstone for establishing a concordant mentor-student relationship. As depicted in Fig. 1, the mentor-student interaction is defined by two pivotal dimensions: academic cultivation and moral cultivation. These dimensions highlight the mentor's role in steering the development of research proficiency and academic literacy, as well as shaping the principles of academic honesty and research ethics. By providing academic guidance that encourages autonomy and by modeling moral guidance through personal example, mentors facilitate the cultivation of graduates' moral character, academic standing, research authenticity, and overall personal development. Consequently, a harmonious mentor-student relationship, in synergy with adherence to academic norms, is instrumental in nurturing high-caliber research talent, thereby ensuring alignment between the objectives of academic progress and the tenets of moral pedagogy.



**Figure 1.** The analytical examination of the correlation between academic norms and the graduate mentor-student relationship.

This paper employs the classification concept of two-dimensional coordinate axes (Castañeda-Miranda et al. 2021), utilizing academic cultivation and moral cultivation as the horizontal and vertical axes of the two-dimensional coordinate system. A theoretical derivation of a four-quadrant model of graduate mentor-student relationships is presented. As depicted in Fig. 2, derived with "Guidance-Autonomy" and "Guidance-Exemplary" as the horizontal and vertical axes, the four types of mentor-student relationships are: Academic

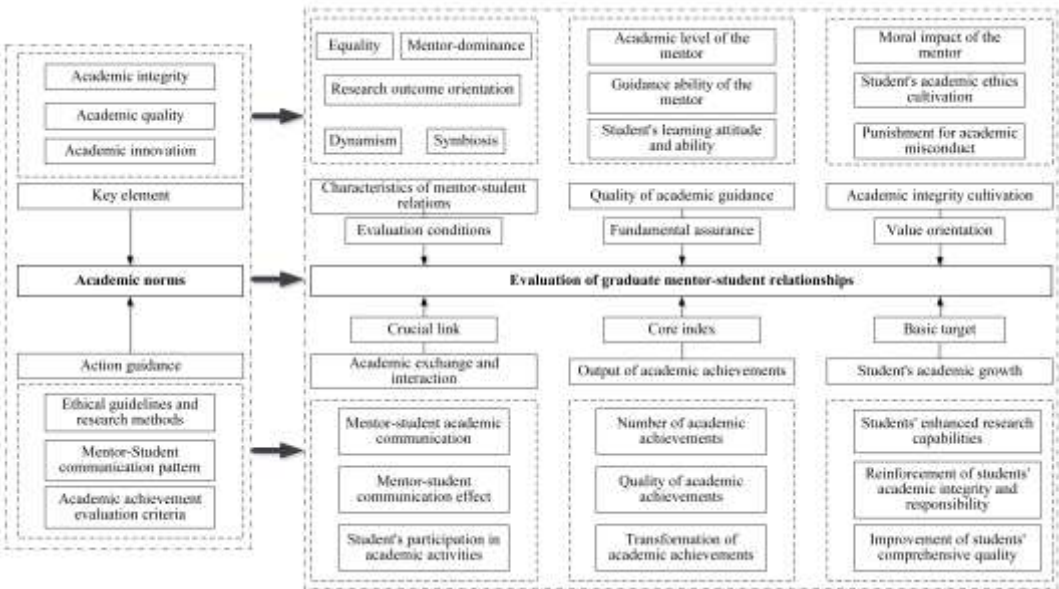
guidance-moral guidance type, Academic autonomy-moral guidance type, Academic autonomy-moral exemplary type, and Academic guidance-moral exemplary type.



**Figure 3.** Four types of graduate mentor-student relationships from the perspective of academic norms.

#### 4. The Theoretical Exploration of Constructing a Graduate Mentor-Student Relationship Evaluation Model

The rising prevalence of academic misconduct necessitates integrating academic norms into graduate mentor-student relationship evaluations, with integrity, quality, and innovation as core criteria. These norms provide ethical frameworks, methodological standards, and bidirectional communication models, enabling systematic assessment of relational dynamics grounded in professionalism. Mentor-dominance is pivotal, encompassing two dimensions: 1) imparting cutting-edge perspectives and methodologies to cultivate students' independent research capabilities, contingent on mentors' expertise and tailored pedagogical alignment with students' needs; 2) instilling academic integrity through ethical scholarship, anti-misconduct mechanisms, and value-driven mentorship, reinforcing mutual accountability. The relationship exhibits symbiotic dynamics, sustained through scholarly dialogues, collaborative academic activities, and measurable outputs (publication quality, interdisciplinary applications). Evaluations must consider evolving objectives: while prioritizing students' research competency and ethical responsibility, assessments should balance achievement metrics (innovation, societal impact) with process indicators (communication efficacy, mentorship adaptability). This dual focus ensures holistic development, aligning short-term academic outputs with long-term ethical scholarship. As illustrated in **Fig. 3**, the proposed framework synthesizes five primary dimensions to establish a multi-layered evaluation system that advances institutional integrity while fostering sustainable academic ecosystems.



**Figure 3.** Evaluation analysis framework for graduate mentor-student relationship from the perspective of academic norms.

**5. Evaluation Index System of Graduate Mentor-Student Relationship**

From an academic norm viewpoint, this research proposes an evaluation framework to assess the mentor-student relationship. This framework comprises five principal evaluation indicators: quality of academic guidance, academic integrity cultivation, academic exchange and interaction, output of academic achievements, and students' academic growth. Fifteen level 2 indicators are formulated based on the substance encompassed by the primary indicators, and fifty-one level 3 indicators are chosen for more precise measurement and data collection. The specific details can be found in Table 1.

**Table 1.** Evaluation indicators system of graduate mentor-student relationship from the perspective of academic norms.

| Level 1 indicators                                 | Level 2 indicators                      | Level 3 indicators                                                         | Unit       | Symbol          |
|----------------------------------------------------|-----------------------------------------|----------------------------------------------------------------------------|------------|-----------------|
| Quality of academic guidance (Overall et al. 2011) | Academic level of the mentor            | Research funding: mentor's annual research grant applications              | /          | X <sub>1</sub>  |
|                                                    |                                         | Publication quality: mentor's high-impact journal publications             | /          | X <sub>2</sub>  |
|                                                    |                                         | Academic influence: citation counts of mentor's publications               | Times      | X <sub>3</sub>  |
|                                                    |                                         | Innovation output: mentor's authorized patents                             | /          | X <sub>4</sub>  |
|                                                    |                                         |                                                                            | /          | X <sub>5</sub>  |
|                                                    | Guidance ability of the mentor          | Faculty resources: student-to-faculty ratio                                | Times      | X <sub>6</sub>  |
|                                                    |                                         | Guidance frequency: mentor-student consultation frequency (online/offline) | Hour       | X <sub>7</sub>  |
|                                                    |                                         | Mentorship intensity: time commitment per student guidance                 | Point      | X <sub>8</sub>  |
|                                                    | Student's learning attitude and ability | Academic performance: students' average course grades                      | Percentage | X <sub>9</sub>  |
|                                                    |                                         | Learning initiative: proactive learning student ratio                      | /          | X <sub>10</sub> |



| Level 1 indicators                                                   | Level 2 indicators                             | Level 3 indicators                                               | Unit       | Symbol          |
|----------------------------------------------------------------------|------------------------------------------------|------------------------------------------------------------------|------------|-----------------|
|                                                                      |                                                | Research participation: student co-authored projects/articles    |            |                 |
| <b>Academic integrity cultivation (Rose 2005)</b>                    | Moral impact of the mentor                     | Ethical awareness: mentor's academic integrity recognition       | Percentage | X <sub>11</sub> |
|                                                                      |                                                | Publication rigor: mentor's paper resubmission rate              | Percentage | X <sub>12</sub> |
|                                                                      |                                                | Citation integrity: mentor's paper similarity index              | Percentage | X <sub>13</sub> |
|                                                                      |                                                | Disciplinary standards: field recognition of mentor's rigor      | Percentage | X <sub>14</sub> |
|                                                                      |                                                | Research validity: authenticity of mentor's research outputs     | Percentage | X <sub>15</sub> |
|                                                                      |                                                | Ethics dialogue: mentor-student integrity discussions            | Times      | X <sub>16</sub> |
|                                                                      | Student's academic ethics cultivation          | Format compliance: student paper standardization rate            | Percentage | X <sub>17</sub> |
|                                                                      |                                                | Ethics training: student ethics workshop attendance              | Times      | X <sub>18</sub> |
|                                                                      |                                                | Retraction records: mentor-student paper retractions             | Times      | X <sub>19</sub> |
|                                                                      |                                                | Sanction severity: revoked projects/funding counts               | /          | X <sub>20</sub> |
|                                                                      | Punishment for academic misconduct             | Award revocation: rescinded honors/bonuses                       | /          | X <sub>21</sub> |
|                                                                      |                                                | Misconduct penalties: academic dismissal/degree revocation cases | /          | X <sub>22</sub> |
|                                                                      |                                                |                                                                  |            |                 |
|                                                                      |                                                |                                                                  |            |                 |
| <b>Academic exchange and interaction (D. R. Johnson et al. 2020)</b> | Mentor-student academic communication          | Direct interaction: face-to-face meeting ratio                   | Percentage | X <sub>23</sub> |
|                                                                      |                                                | Content focus: research-focused guidance proportion              | Percentage | X <sub>24</sub> |
|                                                                      | Quality of academic achievements               | Communication efficacy: student comprehension level              | Percentage | X <sub>25</sub> |
|                                                                      |                                                | Academic progress: research/thesis advancement rate              | Percentage | X <sub>26</sub> |
|                                                                      |                                                | Leadership roles: student-led or co-participated projects        | /          | X <sub>27</sub> |
|                                                                      |                                                | Collaborative learning: mentor-student co-creation index         | Percentage | X <sub>28</sub> |
|                                                                      | Student's participation in academic activities | Institutional engagement: campus academic event participation    | Times      | X <sub>29</sub> |
|                                                                      |                                                | Regional impact: provincial-level academic activities            | Times      | X <sub>30</sub> |
|                                                                      |                                                | Global reach: national/international conference attendance       | Times      | X <sub>31</sub> |
|                                                                      |                                                |                                                                  |            |                 |
| <b>Output of academic achievements (Sharmini and Kumar 2018)</b>     | Number of academic achievements                | Collaborative output: mentor-student co-authored papers          | /          | X <sub>32</sub> |
|                                                                      |                                                | Joint initiatives: mentor-student collaborative projects         | /          | X <sub>33</sub> |
|                                                                      |                                                | Conference presence: co-presented conference papers              | /          | X <sub>34</sub> |
|                                                                      |                                                | International impact: co-authored SCI publications               | /          | X <sub>35</sub> |
|                                                                      | Quality of academic achievements               | Domestic recognition: core Chinese journal co-publications       | /          | X <sub>36</sub> |
|                                                                      |                                                |                                                                  |            |                 |



| Level 1 indicators                                      | Level 2 indicators                                               | Level 3 indicators                                                                                                                                                                                                                                                                      | Unit                                                 | Symbol                                                                                      |
|---------------------------------------------------------|------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|---------------------------------------------------------------------------------------------|
|                                                         | Transformation of academic achievements                          | General publications: non-core journal co-articles<br>Intellectual property: co-owned patents/monographs<br>Policy influence: national-level endorsed reports<br>Regional policymaking: provincial-endorsed research reports<br>Commercialization: economic returns from joint research | /<br>/<br>/<br>/<br>/                                | X <sub>37</sub><br>X <sub>38</sub><br>X <sub>39</sub><br>X <sub>40</sub><br>X <sub>41</sub> |
| <b>Student's academic growth (Moulding et al. 2014)</b> | Students' enhanced research capabilities                         | Publication growth: student publication trajectory<br>Project development: student project volume trends<br>Innovation milestones: student award progression                                                                                                                            | Percentage<br>Percentage<br>Percentage               | X <sub>42</sub><br>X <sub>43</sub><br>X <sub>44</sub>                                       |
|                                                         | Reinforcement of students' academic integrity and responsibility | Regulatory awareness: normative practice improvement<br>Legal literacy: compliance consciousness enhancement<br>Service orientation: social responsibility cultivation                                                                                                                  | Percentage<br>Percentage<br>Percentage               | X <sub>45</sub><br>X <sub>46</sub><br>X <sub>47</sub>                                       |
|                                                         | Improvement of students' comprehensive quality                   | Value orientation: life purpose understanding level<br>Strategic vision: macro-perspective grasp capacity<br>Theoretical application: logical framework implementation<br>Practical innovation: applied research novelty index                                                          | Percentage<br>Percentage<br>Percentage<br>Percentage | X <sub>48</sub><br>X <sub>49</sub><br>X <sub>50</sub><br>X <sub>51</sub>                    |

## 6. Construction of a Graduate Mentor-Student Relationship Evaluation Model

The Analytic Hierarchy Process (AHP) is a decision-making methodology that amalgamates both qualitative and quantitative analysis (Podvezko 2009). Notable for its structured analysis and quantitative weighting attributes, AHP is prevalently employed in the evaluation of teaching methods, teacher performance assessments, and curriculum optimization. This study employs the AHP-Grey Relational Analysis-TOPSIS methodology to construct an evaluation model. The process involves identifying a reference series, processing raw data, and calculating correlation coefficients, closeness, and relative closeness in order to assess the relationships between graduate students and their mentors. Firstly, the three-level indicators within this system are bifurcated into two distinct categories: benefit-type (positive) indicators, which include specific elements:  $x_{1-11}, x_{14-18}, x_{23-51}$ , and cost-type (negative) indicators, encompassing specific elements:  $x_{12-13}, x_{19-22}$ . The raw data from the evaluation indices is subjected to a standard 0-1 transformation as part of the preprocessing phase.

Secondly, AHP is employed to develop a model for computing the weights of evaluation indicators. This process involves examining the interrelations among the fundamental elements within the evaluation model, formulating a hierarchical structure for the system, and constructing judgment matrices for both the target layer in relation to the criterion layer and the criterion layer in relation to the scheme layer using the 1-9 scale (see Table 2 for details). The consistency of

the judgment matrices thus constructed is subsequently assessed. Through the sum-product method, weights for the 5 level 1 indicators, 15 level 2 indicators, and 51 level 3 indicators within the evaluation index system are determined based on these matrices. Subsequently, the maximum value for benefit-type indicators and the minimum value for cost-type indicators are identified as the ideal solutions, while the minimum value for benefit-type indicators and the maximum value for cost-type indicators are designated as the negative ideal solutions. Data is then processed using an averaging technique to compute the correlation coefficient and degree of association for each indicator. Ultimately, leveraging the weights of each indicator, the TOPSIS method is utilized to calculate both the closeness and relative closeness values. A superior relative closeness value denotes a heightened comprehensive evaluation index for the graduate mentor-student relationship.

**Table 2.** 1-9 Scale of Judgment Matrix.

| Scale      | Definition and description                                                                                               |
|------------|--------------------------------------------------------------------------------------------------------------------------|
| 1          | Two elements are equally important or strong compared to each other                                                      |
| 3          | Two elements are compared, and one element is slightly more important or stronger than the other                         |
| 5          | Two elements are compared, and one element is somewhat more important or stronger than the other                         |
| 7          | Two elements are compared, one element is very important or strong compared to the other                                 |
| 9          | Two elements are compared, and one element is extremely important or strong compared to the other                        |
| 2,4,6,8    | This scale is used to represent the need for a compromise between the two criteria mentioned above                       |
| $1/a_{ij}$ | If element $i$ is compared to $j$ and obtains $a_{ij}$ , then the comparison of element $j$ to $i$ results in $1/a_{ij}$ |

## 7. Evaluation and Empirical Evidence

To ascertain the validity and rigor of the evaluation model of graduate mentor-student relationships from an academic norm perspective, further empirical assessment is conducted. Ten postgraduate mentors were specifically invited to allocate representative and differentiated initial values to the four categories of mentor-student relationships: academic guidance-moral guidance type, academic guidance-moral exemplary type, academic autonomy-moral guidance type, and academic autonomy-moral exemplary based on the three-level evaluation index system depicted in Table 1. These values were averaged to derive the primary evaluation data for the four mentor-student relationship categories. Some data were sourced from the "2021 Statistical Data of Chinese S&T Papers" and the official website of the Ministry of Education of the PRC. For "degree" type indicators, which involve subjective judgment and perception, the Likert five-point scale was employed as a quantification instrument. This scale objectively gauges the level of agreement of graduate mentors with various indicators across five levels (1 to 5): 1 signifies a "very shallow degree"; 2 denotes a "relatively shallow degree"; 3 represents a neutral attitude of "uncertainty"; 4 indicates a "relatively deep degree"; and 5 denotes a "very deep degree". Based on these parameters, four distinct groups evaluating different types of mentor-student relationships were formed, and empirical analyses were executed using IBM SPSS software. The raw data from four distinct evaluation groups was meticulously preprocessed, as shown in Table 3.

**Table 3** Data preprocessing results.

| Academic guidance-moral guidance | Academic guidance-moral exemplary | Academic autonomy-moral guidance | Academic autonomy-moral exemplary | Academic guidance-moral guidance | Academic guidance-moral exemplary | Academic autonomy-moral guidance | Academic autonomy-moral exemplary |
|----------------------------------|-----------------------------------|----------------------------------|-----------------------------------|----------------------------------|-----------------------------------|----------------------------------|-----------------------------------|
| 1.000000                         | 0.433774                          | 0.144282                         | 0.000000                          | 0.333333                         | 1.000000                          | 0.666667                         | 0.000000                          |
| 1.000000                         | 0.181818                          | 0.000000                         | 0.363636                          | 1.000000                         | 0.000000                          | 0.520227                         | 0.420156                          |
| 1.000000                         | 0.525773                          | 0.000000                         | 0.597938                          | 0.166667                         | 0.000000                          | 1.000000                         | 0.333333                          |
| 0.666667                         | 0.000000                          | 1.000000                         | 0.333333                          | 1.000000                         | 0.500000                          | 0.500000                         | 0.000000                          |
| 1.000000                         | 1.000000                          | 1.000000                         | 1.000000                          | 0.000000                         | 1.000000                          | 0.000000                         | 0.500000                          |
| 1.000000                         | 0.470588                          | 0.588235                         | 0.000000                          | 0.000000                         | 0.000000                          | 1.000000                         | 0.333333                          |
| 1.000000                         | 1.000000                          | 1.000000                         | 1.000000                          | 0.500000                         | 0.500000                          | 1.000000                         | 0.000000                          |
| 0.000000                         | 0.493506                          | 0.258442                         | 1.000000                          | 0.000000                         | 1.000000                          | 0.333333                         | 0.666667                          |
| 0.000000                         | 0.371763                          | 0.795931                         | 1.000000                          | 0.000000                         | 0.500000                          | 1.000000                         | 0.500000                          |
| 0.250000                         | 0.500000                          | 1.000000                         | 0.000000                          | 0.500000                         | 0.000000                          | 0.500000                         | 1.000000                          |
| 1.000000                         | 0.461719                          | 0.610156                         | 0.000000                          | 0.500000                         | 0.500000                          | 1.000000                         | 0.000000                          |
| 1.000000                         | 0.296296                          | 0.000000                         | 0.248366                          | 1.000000                         | 0.844444                          | 1.000000                         | 0.000000                          |
| 0.494100                         | 1.000000                          | 0.727876                         | 0.000000                          | 0.000000                         | 1.000000                          | 0.000000                         | 0.000000                          |
| 1.000000                         | 0.000000                          | 0.380909                         | 0.451818                          | 1.000000                         | 0.000000                          | 0.000000                         | 0.000000                          |
| 1.000000                         | 0.241706                          | 0.921801                         | 0.000000                          | 0.448252                         | 0.000000                          | 1.000000                         | 0.236364                          |
| 0.285714                         | 0.000000                          | 1.000000                         | 0.428571                          | 0.000000                         | 0.253515                          | 0.707821                         | 1.000000                          |
| 1.000000                         | 0.000000                          | 0.406504                         | 0.654472                          | 0.688000                         | 0.407333                          | 1.000000                         | 0.000000                          |
| 0.000000                         | 0.400000                          | 1.000000                         | 0.600000                          | 1.000000                         | 0.000000                          | 0.553219                         | 0.696137                          |
| 1.000000                         | 0.500000                          | 1.000000                         | 0.000000                          | 0.000000                         | 0.412762                          | 0.778664                         | 1.000000                          |
| 1.000000                         | 0.000000                          | 1.000000                         | 1.000000                          | 0.216667                         | 1.000000                          | 0.000000                         | 0.481667                          |
| 1.000000                         | 0.000000                          | 1.000000                         | 1.000000                          | 0.559369                         | 0.420223                          | 1.000000                         | 0.000000                          |
| 1.000000                         | 1.000000                          | 1.000000                         | 0.000000                          | 1.000000                         | 0.000000                          | 0.482625                         | 0.713320                          |
| 0.000000                         | 0.522298                          | 1.000000                         | 0.918039                          | 0.000000                         | 1.000000                          | 0.580931                         | 0.851441                          |
| 0.109854                         | 0.000000                          | 0.626498                         | 1.000000                          | 0.600601                         | 0.318318                          | 0.000000                         | 1.000000                          |
| 0.339934                         | 1.000000                          | 0.330033                         | 0.000000                          | 1.000000                         | 0.358974                          | 0.500000                         | 0.000000                          |
| 1.000000                         | 0.628426                          | 0.000000                         | 0.338579                          |                                  |                                   |                                  |                                   |

## 8. Evaluation Index Weight Calculation Results

Based on the specific design of each level of indicators, a judgment matrix was formed, encompassing 1 level 1 indicator, 5 level 2 indicators, and 15 level 3 indicators, yielding a total of 21 judgment matrices. Five scholars in educational research, 35 graduate mentors from institutions such as the School of Economics and Management, School of Mathematics, and School of Energy and Mechanical Engineering, along with 75 graduate students specializing in fields like Management Science and Engineering, and Education, were invited to rate the judgment matrix on a 1-9 scale (as depicted in Table 2). From this endeavor, 105 valid judgment matrices were garnered. The mean value of each level of the indicator judgment matrix was computed. For instance, the final level 1 indicator judgment matrix (shown in Table 4) was derived by averaging all judgment matrices pertaining to that level. Subsequent steps involved calculating the eigenvalues and eigenvectors of each judgment matrix and performing a consistency check. The judgment matrix underwent iterative adjustments until  $CR = \frac{CI}{RI} < 0$ , at which point the weights for each evaluation indicator level were finalized and detailed in Tables 5 and 6.

**Table 4.** Judgement matrix of level 1 indicators.

|                                   | Quality of academic guidance | Academic integrity cultivation | Academic exchange and interaction | Output of academic achievements | Student's academic growth |
|-----------------------------------|------------------------------|--------------------------------|-----------------------------------|---------------------------------|---------------------------|
| Quality of academic guidance      | 1                            | 1/7                            | 3                                 | 1/3                             | 1/5                       |
| Academic integrity cultivation    | 7                            | 1                              | 7                                 | 7                               | 1/2                       |
| Academic exchange and interaction | 1/3                          | 1/7                            | 1                                 | 1/5                             | 1/5                       |
| Output of academic achievements   | 3                            | 1/7                            | 5                                 | 1                               | 1/2                       |
| Student's academic growth         | 5                            | 2                              | 5                                 | 2                               | 1                         |

**Table 5.** Evaluation criteria weights of level 1 indicators and level 2 indicators.

| Level 1 indicators                | Weight value | Level 2 indicators                                               | Weight value |
|-----------------------------------|--------------|------------------------------------------------------------------|--------------|
| Quality of academic guidance      | 26.99%       | Academic level of the mentor                                     | 2.96%        |
|                                   |              | Guidance ability of the mentor                                   | 8.34%        |
|                                   |              | Student's learning attitude and ability                          | 15.69%       |
| Academic integrity cultivation    | 35.54%       | Moral impact of the mentor                                       | 23.03%       |
|                                   |              | Student's academic ethics cultivation                            | 4.34%        |
|                                   |              | Punishment for academic misconduct                               | 8.17%        |
| Academic exchange and interaction | 8.64%        | Mentor-student academic communication                            | 5.47%        |
|                                   |              | Mentor-student communication effect                              | 2.25%        |
|                                   |              | Student's participation in academic activities                   | 0.92%        |
| Output of academic achievements   | 11.51%       | Number of academic achievements                                  | 1.88%        |
|                                   |              | Quality of academic achievements                                 | 6.20%        |
|                                   |              | Transformation of academic achievements                          | 3.42%        |
| Student's academic growth         | 17.33%       | Students' enhanced research capabilities                         | 2.84%        |
|                                   |              | Reinforcement of students' academic integrity and responsibility | 5.15%        |
|                                   |              | Improvement of students' comprehensive quality                   | 9.34%        |

**Table 6.** Evaluation criteria weights of level 3 indicators.

| Symbol         | Weight value | Symbol          | Weight value | Symbol          | Weight value |
|----------------|--------------|-----------------|--------------|-----------------|--------------|
| X <sub>1</sub> | 0.79%        | X <sub>18</sub> | 1.34%        | X <sub>35</sub> | 3.60%        |
| X <sub>2</sub> | 1.54%        | X <sub>19</sub> | 0.42%        | X <sub>36</sub> | 2.17%        |
| X <sub>3</sub> | 0.42%        | X <sub>20</sub> | 1.18%        | X <sub>37</sub> | 0.44%        |
| X <sub>4</sub> | 0.21%        | X <sub>21</sub> | 2.09%        | X <sub>38</sub> | 0.14%        |
| X <sub>5</sub> | 1.18%        | X <sub>22</sub> | 4.47%        | X <sub>39</sub> | 2.07%        |
| X <sub>6</sub> | 2.78%        | X <sub>23</sub> | 0.58%        | X <sub>40</sub> | 0.71%        |
| X <sub>7</sub> | 4.38%        | X <sub>24</sub> | 1.43%        | X <sub>41</sub> | 0.51%        |

|                 |       |                 |       |                 |       |
|-----------------|-------|-----------------|-------|-----------------|-------|
| X <sub>8</sub>  | 2.57% | X <sub>25</sub> | 3.46% | X <sub>42</sub> | 1.53% |
| X <sub>9</sub>  | 4.66% | X <sub>26</sub> | 1.21% | X <sub>43</sub> | 0.84% |
| X <sub>10</sub> | 8.45% | X <sub>27</sub> | 0.37% | X <sub>44</sub> | 0.46% |
| X <sub>11</sub> | 2.74% | X <sub>28</sub> | 0.67% | X <sub>45</sub> | 1.34% |
| X <sub>12</sub> | 8.80% | X <sub>29</sub> | 0.08% | X <sub>46</sub> | 3.26% |
| X <sub>13</sub> | 1.48% | X <sub>30</sub> | 0.18% | X <sub>47</sub> | 0.55% |
| X <sub>14</sub> | 3.05% | X <sub>31</sub> | 0.66% | X <sub>48</sub> | 2.63% |
| X <sub>15</sub> | 6.96% | X <sub>32</sub> | 1.19% | X <sub>49</sub> | 4.10% |
| X <sub>16</sub> | 0.48% | X <sub>33</sub> | 0.49% | X <sub>50</sub> | 0.93% |
| X <sub>17</sub> | 2.52% | X <sub>34</sub> | 0.20% | X <sub>51</sub> | 1.68% |

In order to provide a more intuitive representation of the weights associated with these three hierarchical indicators, we employ a specific notation system. The level 1 indicators are represented by  $A_i$ , with variants including  $A_1$ ,  $A_2$ , etc. The level 2 indicators of level 1 indicators  $A_i$  are denoted as  $A_{ij}$ , with examples such as  $A_{11}$ ,  $A_{21}$ , etc. Finally, the level 3 indicators maintain their original notation, indicated as  $X_1$ - $X_{51}$ . This hierarchical structure is visually encapsulated in the Sunburst chart presented in Fig. 4. Consequently, the findings reveals that the level 1 indicator weights for "academic integrity cultivation" (35.54%) and "quality of academic guidance" (26.99%) exceed 25%, while those for "academic exchange and interaction" (8.64%) and "output of academic achievements" (11.51%) fall below 15%. These findings suggest that academic integrity cultivation and the quality of academic guidance are the two most significant factors influencing the mentor-student relationship. In the context of the level 2 indicator weights, the weighting for "moral impact of the mentor" (23.03%) and "student's learning attitude and ability" (15.69%) exceed 10%. This suggests that both the mentor's academic morality and the student's learning disposition significantly influence the mentor-student relationship. In relation to the level 3 indicator weights, the proportions for  $X_{12}$ , denoting the publication rigor: mentor's paper resubmission rate (8.80%),  $X_{10}$ , representing the research participation: student co-authored projects/articles (8.45%), and  $X_{15}$ , indicating the research validity: authenticity of mentor's research outputs (6.96%), exceed 5%.

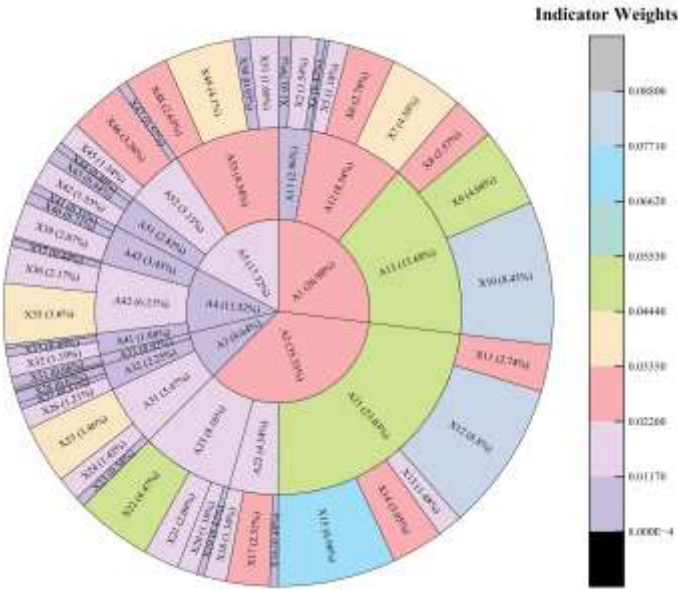


Fig. 4. Weights of three levels indicators.

9. Comprehensive Evaluation Index Calculation Results and Grey Relevance Analysis

Utilizing the original data from four evaluation object sets, we determined the ideal and negative ideal solutions for each level 3 indicator. We employed both the gray relational degree

calculation model and the comprehensive evaluation index calculation model to ascertain the TOPSIS Euclidean distance, gray relational degree, and relative closeness of the ideal and negative ideal solutions for these four evaluation object sets, the results of which are presented in Table 7. The findings indicate that the mentor-student relationship of the type academic guidance-moral guidance (0.580743) exhibits the highest relative closeness when compared to the reference sequence (ideal graduate mentor-student relationship). This is followed by the academic autonomy-moral guidance type (0.568819) and the academic guidance-moral exemplary type (0.566893), with the academic autonomy-moral exemplary type (0.399314) showing the lowest relative closeness.

**Table 7.** Comprehensive evaluation index of mentor-student relationship.

| Evaluation group                       | TOPSIS Euclidean distance |                          | Gray relational degree |                          | Relative closeness | Result of the sorting |
|----------------------------------------|---------------------------|--------------------------|------------------------|--------------------------|--------------------|-----------------------|
|                                        | Ideal solution            | Negative ideal solutions | Ideal solution         | Negative ideal solutions |                    |                       |
| Academic guidance-moral guidance type  | 0.003826                  | 0.010097                 | 0.017859               | 0.016707                 | 0.580743           | 1                     |
| Academic guidance-moral exemplary type | 0.003281                  | 0.010027                 | 0.016707               | 0.017143                 | 0.566893           | 3                     |
| Academic autonomy-moral guidance type  | 0.004146                  | 0.009980                 | 0.017527               | 0.016705                 | 0.568819           | 2                     |
| Academic autonomy-moral exemplary type | 0.010243                  | 0.002640                 | 0.016077               | 0.017913                 | 0.399314           | 4                     |

#### D. Conclusion

This study evaluates the mentor-student relationship from the perspective of academic norms, highlighting its attributes, types, and empirical assessments. Using a two-dimensional framework of academic and moral cultivation, the relationship is characterized by five attributes—equality, mentor-dominance, research outcome orientation, dynamism, and symbiosis—resulting in a four-quadrant model of mentor-student relationship types. The findings reveal that the most influential factors are academic guidance quality and academic integrity cultivation, followed by the mentor's moral impact, students' learning attitudes and abilities, and key indicators such as publication rigor, research participation, and research validity. These results underscore the need to strengthen mentors' exemplary roles, promote ethical research practices, foster academic integrity, reduce redundant submissions, and encourage student independence and active research involvement. Empirical analysis further shows that the academic guidance–moral guidance type is the most ideal mentor-student relationship, while the academic autonomy–moral exemplary type is the least ideal, suggesting that fostering strong interaction between mentors and students is essential to developing more effective and ethically grounded relationships.

This study, grounded in the five primary components of the evaluation index system for graduate mentor-student relationships, offers strategic recommendations to foster harmony in these relationships and enhance the quality of graduate education. Strengthening academic integrity requires universities to establish comprehensive ethical frameworks embedded in curricula through courses, seminars, and case-based learning, while also utilizing digital

platforms to promote ethical awareness and accountability. Mentors must play a central role in upholding research integrity, supported by monitoring systems, transparent governance, and mechanisms that both incentivize ethical conduct and deter misconduct. To stimulate innovation, institutions should encourage interdisciplinary collaboration through academic forums, mentor-student dialogues, and cross-disciplinary projects that break knowledge silos. A quality-driven approach should be reinforced by rigorous funding distribution, resource optimization, and peer-reviewed evaluation to elevate research outcomes. Moreover, personalized academic growth plans, guided by dynamic feedback and multi-dimensional support systems involving mentors and advisors, are essential for holistic student development. By integrating ethical governance, interdisciplinary cooperation, quality prioritization, and individualized mentoring, universities can build a resilient academic ecosystem that upholds integrity, fosters innovation, and advances excellence.

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