*Original research article*

# Integrating ideological and political education into clinical pharmacology: reforming medical education

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## ABSTRACT

**Objective:** To explore the integration of ideological and political education into clinical pharmacology courses and assess its impact on student engagement, knowledge, and professional readiness.

**Methods:** This study employed a mixed-methods approach involving surveys, examination score analysis, and educational material reviews. Pre- and post-course surveys assessed changes in student attitudes, knowledge, and engagement. Examination scores were analyzed to evaluate academic performance. Statistical analyses included paired t-tests, Wilcoxon signed-rank tests, ANOVA, and regression models. Exploratory Factor Analysis (EFA) and k-means clustering identified distinct student groups based on engagement and attitudes.

**Results:** The integration of ideological and political education significantly enhanced student engagement and knowledge. Pre- and post-course surveys indicated improvements in understanding clinical pharmacology ($t = 8.611$, $p < 0.001$) and ethical issues ($t = 3.197$, $p = 0.001$). Examination scores showed higher median and mean values post-reform: Regular Score remained similar, with a median of around 69.0, while the Final Examination Score increased from 73.0 to 77.0, and the Final Score rose from 72.0 to 74.0. Standard deviations decreased, indicating more consistent performance. Regression analysis confirmed the intervention's positive impact (coefficient = 2.2043, $p < 0.001$), with regular scores as strong predictors of final scores (coefficient = 0.6054, $p < 0.001$). K-means clustering identified three distinct groups: low, moderate, and high engagement, with the highest engagement group showing substantial educational enhancements.

**Conclusion:** Integrating ideological and political education into clinical pharmacology enhances the overall quality of medical education, fostering well-rounded, ethically grounded,

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and socially responsible medical professionals. Future studies should expand to larger, more diverse samples and other medical disciplines to validate and extend these findings.

**Keywords:**  ideological education, political education, clinical pharmacology, medical education, professional ethics

## 1. Introduction

The evolving landscape of medical education demands a comprehensive approach that bridges basic research with clinical practice, ensuring that future healthcare professionals are well-prepared to address complex medical challenges. Clinical pharmacology plays a critical role in this continuum as it integrates the foundational principles of pharmacology with their practical applications in patient care.[1] This discipline focuses on evaluating the efficacy and safety of new drugs, understanding drug interactions, and optimizing therapeutic regimens tailored to various patient populations. As such, clinical pharmacology inherently emphasizes patient-centered care and individualized treatment, incorporating numerous ethical, moral, and humanistic elements essential for holistic medical practice.[2]

In response to these evolving educational demands, there is a growing recognition of the need to integrate ideological and political education into clinical pharmacology courses. This integration aims to enhance student engagement and prepare them for their future professional careers by fostering a deeper understanding of their ethical and social responsibilities as medical practitioners.[3] The concept of "curriculum-based ideological and political education" seeks to weave moral and political education seamlessly into the professional knowledge imparted through clinical pharmacology courses.[4]

The primary objective of integrating ideological and political education into clinical pharmacology is to develop medical professionals who are not only technically proficient but also morally grounded and socially responsible. By embedding ethical and political education within the clinical pharmacology curriculum, educators can provide students with a more comprehensive educational experience that goes beyond the acquisition of technical skills. This approach aims to cultivate a strong moral compass and a sense of social responsibility among students, enhancing their readiness for professional careers and their ability to navigate the complex ethical landscapes they will encounter.[5]

Several theoretical frameworks underpin the integration of ideological and political education into clinical pharmacology. Dewey's concept of "learning by doing" emphasizes the importance of experiential learning, which is integral to clinical education.[6] Vygotsky's socio-cultural theory highlights the role of social interaction and cultural context in learning, underscoring the necessity of incorporating societal values and ethical considerations into the educational process.[7] Freire's critical pedagogy advocates for an education that empowers students to question and transform their social realities, aligning well with the goals of ideological and political education.[8]

Practical implementations of this integrative approach can be observed through various case studies and examples. For instance, the ethical considerations in research are exemplified by the story of Chinese virologists Tang Feifan and Zhang Xiaolou, who conducted self-experiments to study trachoma.[9] This case serves as a powerful illustration of scientific dedication and ethical conduct, teaching students about the humanistic aspects of medical research. Similarly, the work of Lin Kezeng in developing gastrointestinal treatments during wartime highlights the role of medical professionals in national service and innovation.[10] This narrative can inspire students to appreciate the broader societal impact of their work and cultivate a sense of

patriotism. Additionally, the discovery of artemisinin by Tu Youyou, which revolutionized the treatment of malaria worldwide, exemplifies the global impact of medical research conducted in China, instilling a sense of national pride and global responsibility in students.[11] Integrating ideological and political education into clinical pharmacology presents numerous opportunities but also poses several challenges. Ensuring that the ideological content is relevant and engaging to students requires careful curriculum design and continuous feedback from both students and educators. Balancing the inclusion of ideological education with the rigorous scientific content of clinical pharmacology necessitates thoughtful pedagogical strategies and innovative teaching methods.[12,13]

This study aims to explore the methods and effectiveness of integrating ideological and political education into clinical pharmacology courses. By examining various theoretical frameworks, practical implementations, and case studies, the study seeks to develop a comprehensive approach that enhances student engagement, prepares them for professional careers, and ensures they are ethically and socially responsible medical professionals.

## 2. Methods
### 2.1 Study design and setting

This study employs a mixed-methods approach, combining qualitative and quantitative research to evaluate the impact of integrating ideological and political education into clinical pharmacology courses. Conducted from April 20 to May 20, 2024, the study was carried out in medical universities across Yunnan province, China. Participants included only students from the clinical pharmacology department at these universities. Students were eligible if they were enrolled in the clinical pharmacology course and consented to participate. Exclusion criteria included students who had previously taken a similar course or those unwilling to participate. Although the study involved students from

several institutions, the primary analysis was limited to one institution due to data availability. This allowed for a focused examination of the intervention's effectiveness, while future studies could explore broader, multi-institutional analyses. The study design included the analysis of exam scores, survey responses, and interview data to assess the impact of the educational intervention.

### 2.2 Data collection

To comprehensively evaluate the integration of ideological and political education into the clinical pharmacology curriculum, this study selected students enrolled in the clinical pharmacology course at Kunming Medical University in Yunnan Province, using stratified random sampling to ensure a representative sample across different demographics, including gender and year of study. Students were divided into two groups based on their enrollment period: the "Before-implementation" group included students who participated in the course prior to the integration of ideological and political education, while the "After-implementation" group consisted of those who took the course following the integration. This approach allowed for effective comparison of pre- and post-implementation changes.

Pre- and post-course surveys were administered to assess changes in student attitudes, knowledge, engagement, and employment readiness. The surveys consisted of Likert scale questions, multiple-choice questions, and open-ended questions, designed to capture students' perceptions and experiences. The pre-course survey established baseline data, while the post-course survey evaluated the impact of the course on various educational outcomes.

A pilot study with 30 participants was conducted to refine the questionnaire and enhance its reliability and validity. This preliminary phase was critical in ensuring that the survey effectively captured the necessary data.

In addition to the surveys, student examination scores from both groups were

collected retrospectively to quantitatively assess the course's impact on academic performance. The "Before-implementation" group's scores represent results from the regular teaching sessions prior to the educational reform, while the "After-implementation" group's scores were collected after the new curriculum was implemented. The analysis involved comparing average scores and examining changes in score distributions. Furthermore, educational materials such as course syllabi, lecture notes, and assessments were reviewed to evaluate how ideological and political education content was integrated into the curriculum.

The baseline characteristics of the sample are essential for assessing the impact of integrating ideological and political education into the clinical pharmacology course. By analyzing demographic data, we ensure that the two student populations are comparable from the outset. Consistency in characteristics such as gender distribution and academic standing reduces potential biases, enabling a more accurate interpretation of performance changes. Including these characteristics supports the validity of the findings, confirming that any improvements in exam scores are attributable to the educational intervention rather than pre-existing differences between groups.

It is important to note that the datasets for exam scores and survey responses are distinct and may not completely overlap. The differences arise for the following reasons: 1) Participation in the survey was voluntary, while exam scores were recorded for all students enrolled in the course; 2) Some students may have taken the exam but did not complete the survey, even though they were registered for the course. This distinction clarifies the differences in sample sizes and ensures that both datasets remain valid for their respective analyses.

### 2.3 Sample size determination

The sample size was calculated using the formula: $z^2 \times p \times (1-p)/d^2$, where 'z' represents the z-score for a 95% confidence level (1.96), 'p' is the estimated proportion of an attribute in the population (set at 0.5 due to lack of prior data), and 'd' is the margin of error (typically set at 0.07). This resulted in an initial target of 196 samples. To ensure data integrity, responses were required to be unique (verified by IP addresses), valid if the completion time exceeded 5 minutes, and correctly answered two logical questions. A total of 513 original questionnaires were collected. After excluding 183 invalid responses, 330 valid questionnaires were retained for analysis.

### 2.4 Assessment methods

In the "Before-implementation" phase, the assessments primarily employed traditional examination formats, including multiple-choice questions and short answer questions. These assessments focused mainly on core clinical pharmacology concepts, assessing students' foundational knowledge and recall abilities. The evaluation criteria were straightforward, aimed at determining the students' grasp of essential pharmacological principles.

In contrast, the "After-implementation" phase introduced a more diverse range of assessment methods to better reflect the integration of ideological and political education into the curriculum. New formats included case studies that required students to apply their pharmacological knowledge to real-world ethical dilemmas and reflective essays that encouraged critical thinking about the social responsibilities of healthcare professionals. This shift aimed to deepen students' understanding of how clinical pharmacology intersects with broader ethical and societal issues.

Moreover, the assessments in the "After-implementation" phase were designed to evaluate not just technical knowledge but also students' ability to analyze and discuss ethical considerations related to their field. This included assessing their ability to recognize the implications of drug therapy decisions in various contexts, such as patient safety and public health.

The regular score primarily reflects students' ongoing performance throughout the course, including their understanding of core concepts and participation in assessments such as quizzes, assignments, and midterm exams. This score serves as an indicator of students' consistent engagement and grasp of the material over time. In contrast, the final score is derived from a comprehensive evaluation at the end of the course and includes both the regular scores and the final exam scores. It incorporates all learning outcomes, including the application of knowledge in practical and theoretical contexts.

## 2.5 Data analysis

Quantitative data from surveys and examination scores were analyzed using SPSS and R. Initial steps included data cleaning to ensure completeness and encoding qualitative data into numerical form. Descriptive statistics such as mean, standard deviation, and median were calculated for each survey question, analyzing the distribution of responses across gender, grade level, and major. Paired t-tests or Wilcoxon signed-rank tests compared pre- and post-course survey results, examining changes in student attitudes, knowledge, engagement, and employment readiness. Examination scores were also assessed using paired t-tests. Group differences were analyzed using independent t-tests, ANOVA, or Kruskal-Wallis tests to identify significant differences based on demographic factors. Correlation and regression analyses were performed to examine relationships between survey questions and identify factors influencing attitudes towards ideological and political education. Factor analysis grouped survey questions into underlying factors, while cluster analysis categorized students with similar attitudes.

## 2.6 Ethical considerations

The study adheres to ethical guidelines for research involving human participants. Ethical approval was obtained from the Institutional Review Board (IRB) of the Kunming medical university. Informed consent was obtained from all participants, ensuring they are aware of the study's purpose, procedures, and their right to withdraw at any time. Data confidentiality and anonymity are maintained throughout the study to protect participants' privacy.

## 3. Course design and implementation
### 3.1 Integration strategy

The integration of ideological and political elements into the clinical pharmacology curriculum was designed to seamlessly incorporate these themes into existing coursework, enhancing educational outcomes. This strategy aligned ideological and political education with core clinical pharmacology concepts through direct methods, such as including specific topics in lectures and discussions, and indirect methods, like embedding these elements into case studies and classroom activities that naturally led to discussions on ethics, social responsibility, and patriotism.[14]

### 3.2 Teaching methods

Innovative teaching methods were employed to integrate ideological and political education effectively. Real-life case studies highlighted ethical dilemmas and social responsibilities faced by medical professionals. For example, Tu Youyou's development of artemisinin was used to discuss research ethics and scientific dedication. Problem-based learning (PBL) sessions included scenarios requiring students to apply their clinical pharmacology knowledge while considering ethical, social, and political implications, fostering critical thinking and a deeper understanding of the societal impacts of medical decisions.[15]

In the flipped classroom model, students accessed pre-recorded lectures and reading materials that included ideological and political content before class. Classroom time was then used for interactive discussions, debates, and group activities that reinforced these concepts. This approach allowed for an in-depth exploration of topics such as the role of medical professionals in society and the importance of social responsibility. Interactive

discussions revolved around current events, historical examples, and ethical case studies, providing a platform for students to express their views and learn from different perspectives.

**3.3 Course content modifications**

To integrate patriotic education, humanistic spirit, and social responsibility into the clinical pharmacology curriculum, several modifications were made. Examples of significant contributions by Chinese scientists to global health, such as the discovery of artemisinin, were included to instill a sense of national pride and highlight the global impact of Chinese medical research. The curriculum emphasized the humanistic aspects of medical practice by discussing cases like the adverse effects of drugs such as thalidomide, and the importance of patient safety.[16]

Additionally, the course content underscored the social responsibilities of medical professionals. Classroom discussions and assignments focused on the broader societal implications of medical decisions, the importance of ethical practices, and the role of healthcare professionals in addressing public health challenges. Specific cases such as traditional Chinese medicine, including Li Shizhen's *Compendium of Materia Medica*, and modern examples like the synthesis of crystalline bovine insulin by Chinese scientists, were incorporated. Case studies on adverse drug reactions, such as the "Thalidomide tragedy" and incidents of drug-induced hearing loss, were used to emphasize patient safety and ethical medical practice. Theoretical discussions on pharmacokinetics and pharmacodynamics were also applied to teach individualized treatment principles, linking scientific theory with compassionate patient care.[17,18]

To further support the integration of ideological and political education, approximately 20% of the course content was directly related to these topics, primarily embedded through case studies, classroom discussions, and specific lecture topics. About 5% of the course hours were dedicated to explicit ideological discussions, while an additional 15% of the assignments and interactive activities were designed to reflect the integration of political, ethical, and humanistic considerations into medical decision-making.

For instance, case studies that explored ethical dilemmas in drug development were combined with discussions on moral responsibilities in clinical practice. Practical examples, such as Tu Youyou's development of artemisinin, were utilized not only to teach scientific innovation but also to emphasize the broader social and ethical impacts of medical research. These examples served as platforms for engaging students in deeper reflections on their future roles as medical professionals, fostering a sense of responsibility toward both patients and society.

This integration was carefully designed to align seamlessly with core clinical pharmacology concepts, ensuring that students were not only technically proficient but also ethically aware and socially responsible. This thoughtful and comprehensive approach enriched both the educational experience and the professional development of students, preparing them to navigate the complex ethical and social landscapes they will encounter in their medical careers (Table 1).

**4 Results**

**4.1 Descriptive statistical analysis of clinical pharmacology exam scores**

It comprises a total of 478 samples, divided into two groups based on the timing of intervention implementation. Specifically, the "After Implementation" group includes 251 samples, with a gender distribution of 134 females and 117 males. The "Before Implementation" group consists of 227 samples, with 122 females and 105 males. This data was used to compare the exam scores of students in a clinical pharmacology course, with regular scores and final scores recorded for each student. A descriptive statistical analysis was conducted on students' exam scores before and after integrating ideological and political education into clinical pharmacology. The analysis focused on regular score, final examination score, and final score.

**Table 1** Integration of ideological and political elements in clinical pharmacology teaching.

| Teaching Content | Teaching Methods | Ideological and Political Cases | Ideological and Political Goals |
|---|---|---|---|
| **History of clinical pharmacology** | Guided teaching | Introducing "Qian Xuesen's Question"; China's earliest pharmacological text "Shennong Bencao Jing"; Tu Youyou's inspiration from "Emergency Prescriptions Kept Up One's Sleeve" to develop artemisinin, saving millions of lives. | Patriotic education, humanistic spirit, humanitarian spirit, cultural confidence |
| **Introduction** | Guided teaching | "Compendium of Materia Medica" by Li Shizhen; treating night blindness using animal liver by Sun Simiao; the first synthetic crystalline bovine insulin; Tu Youyou's development of artemisinin; Xu Shuyun's theory of anti-inflammatory immunopharmacology. | Patriotism, cultural confidence, humanistic spirit, humanitarian spirit |
| **Clinical pharmacokinetics** | Guided teaching | Individual differences in drug absorption, distribution, metabolism, and excretion, and personalized treatment plans illustrate dialectical materialism's universal and particular contradiction principles. | Dialectical materialism, scientific worldview |
| **Medication for pregnant and lactating women, newborns, children, and the elderly** | Case teaching | Cases such as thalidomide causing phocomelia, DES-induced miscarriages, increased jaundice in neonates from ketoconazole, aminoglycoside-induced deafness, tetracycline teeth, and increased hepatic and renal damage in the elderly emphasize prioritizing patient safety and health. | Humanistic care, medical ethics |
| **Clinical rational use of cardiovascular drugs** | Case teaching | Academician Chen Haozhu's pioneering contributions to cardiovascular interventional treatment; Combined use of Chinese and Western medicines for hypertension; Amiodarone reducing renal clearance of digoxin causing digitalis toxicity; Chronic fatigue as a trigger for sudden heart attack. | National pride, scientific spirit, ethical awareness |
| **Clinical rational use of anti-tumor drugs** | Interactive teaching | Expanded reimbursement policies for tumor patients; Effective reduction in cervical and breast cancer incidence due to "Two Cancer Screening" policies; Efforts of Academician Martin in HPV vaccine localization, breaking foreign monopolies. | Social responsibility, humanistic spirit, national pride |

**Table 1** (Cont.)

| Teaching Content | Teaching Methods | Ideological and Political Cases | Ideological and Political Goals |
|---|---|---|---|
| **Clinical rational use of genetic pharmacology** | Case teaching | Professor Zhou Honghao's pioneering work in genetic pharmacology; China's first hypertension gene chip for Chinese populations; Tailored medication based on genetic testing for personalized treatment. | Scientific spirit, cultural confidence, responsibility awareness |
| **Genetic pharmacology and clinical rational drug use, chrono-pharmacology and clinical rational drug use** | Case teaching | Succinylcholine sensitivity and ethanol toxicity highlight the importance of personalized treatment; domestically innovated hypertension gene chips develop innovation awareness; insulin and corticosteroid timing elucidate chronopharmacology's impact, emphasizing adherence to natural laws. | People-oriented approach, innovation consciousness |
| **Therapeutic drug monitoring and individualized dosing, clinical pharmaco-dynamics** | Discussion teaching | Differences in plasma concentrations of drugs like salicylic acid, procainamide, anticonvulsants, and digoxin emphasize individualized treatment and effective communication with patients; pharmacokinetics and pharmacodynamics principles foster dialectical thinking. | Comprehensive quality, dialectical thinking |
| **Clinical rational use of chronopharmacology** | Discussion teaching | Sensitivity of digoxin at night versus day; Optimal timing for antihypertensive and hypoglycemic drugs based on circadian rhythms; Cholesterol synthesis increases at night; Optimal administration time for doxorubicin. | Scientific spirit, patient-centered care, social responsibility |
| **Clinical rational use of anti-inflammatory and immunomodulatory drugs** | Guided teaching | History of aspirin; Professor Xu Shuyun's theory that inflammation and immunity are two sides of the same coin; Development of China's first I-class anti-inflammatory drug total paeoniflorin capsules. | National pride, humanistic spirit, professional ethics |
| **Clinical rational use of neuropsychopharma-cology** | Enlightening teaching | "Opium War", Lin Zexu's destruction of opium; Mental health service guidelines; Rising rates of anxiety and depression among college students; Alzheimer's disease due to aging population; Contributions of Murong Shenxing to neurology. | Humanistic spirit, social responsibility, professional dedication |

**Table 1** (Cont.)

| Teaching Content | Teaching Methods | Ideological and Political Cases | Ideological and Political Goals |
|---|---|---|---|
| **Clinical rational use of drugs in special populations** | Case teaching | "Thalidomide tragedy" causing phocomelia; Diethylstilbestrol and vaginal cancer; Chloramphenicol causing "Gray Baby Syndrome"; Tetracycline staining teeth and slowing bone development; Long-acting benzodiazepines causing falls in elderly. | Humanistic spirit, patient safety, ethical awareness |
| **Adverse drug reaction monitoring, drug vigilance, drug interactions, drug abuse and dependence** | Case teaching | Cases such as phototoxic dermatitis from ciprofloxacin, the Contac incident, and Houttuynia cordata injection incident emphasize drug safety and adverse reaction monitoring, reinforcing social responsibility and legal awareness. | Social responsibility, legal education |
| **Rational use of antibiotics, clinical application of antiviral drugs** | Responsibility consciousness | The emergence of "superbugs" highlights the importance of rational drug use and responsibility consciousness; penicillin discovery history teaches preparedness and attention to detail; COVID-19 treatment and drug development enhance national pride and social responsibility. | Responsibility consciousness, national pride |
| **Clinical application of anticancer drugs, anti-inflammatory and immunosuppressive drugs** | Interactive teaching | Movies like "Dying to Survive" emphasize intellectual property rights and humanistic care for cancer patients; the history of aspirin and domestically developed new drug "total paeoniflorin" cultivate innovation and scientific spirit. | Humanistic care, scientific spirit |
| **Clinical drug research, drug registration and management** | Professional ethics | The status of new drug development in China inspires enthusiasm and confidence in medical students; contributions of drugs to human health foster professional ideals and commitment to alleviating human suffering; participation in clinical trials enhances respect for life and the growth of compassionate doctors. | Professional ethics, career ideal education |
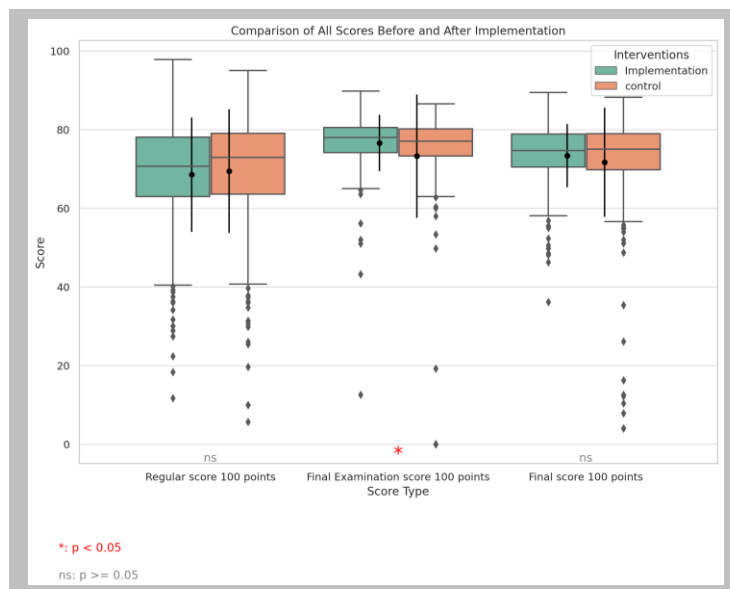
**Fig. 1.** Comparison of all scores before and after implementation.

Fig. 1 indicates that median scores improved post-reform: Regular Score remained similar at around 69.0, Final Examination Score increased from 73.0 to 77.0, and Final Score increased from 72.0 to 74.0. Mean scores also changed: Regular Score slightly decreased from 69.47 to 68.56, indicating a small variation in student performance in regular assessments, while other scores improved. The Final Examination Score increased from 73.25 to 76.61, and the Final Score rose from 71.74 to 73.39. The standard deviations decreased, indicating reduced score variability. Specifically, Regular Score standard deviation dropped from 15.71 to 14.55, Final Examination Score from 15.65 to 7.19, and Final Score from 13.89 to 8.05. T-tests showed improvements with p-values of 0.5133 for Regular Score, 0.0033 for Final Examination Score, and 0.1171 for Final Score. These findings suggest that integrating ideological and political education positively impacted student performance, resulting in higher median scores and decreased variability.

**4.2 Regression analysis of clinical pharmacology exam scores**

A multiple linear regression analysis was conducted to assess the impact of integrating ideological and political education

into clinical pharmacology on final scores, controlling for regular scores. The regression model showed a significant positive effect of the intervention, with a coefficient of 2.2043 ($p < 0.001$), indicating that students scored on average 2.2043 points higher after the intervention. Regular scores were also a strong predictor of final scores (coefficient = 0.6054, $p < 0.001$). The overall model was significant (F-statistic = 477.2, $p < 0.001$) with an R-squared value of 0.668, explaining 66.8% of the variance in final scores. While the regular score is a strong predictor of the final score and reflects students' continuous learning process, the final score incorporates both regular scores and final exam scores. This score assesses students' cumulative knowledge and ability to synthesize information at the end of the course, providing a comprehensive evaluation of their overall performance. These findings suggest that integrating ideological and political education into the curriculum significantly improves student performance, with consistent performance throughout the course also being crucial. The regression equation is $y = 0.6054x + 2.2043z + 29.6834$, where y is the final score, x is the regular score, and z is the intervention indicator

(1 for post-intervention, 0 for pre-intervention). The R-squared value of 0.6677 indicates that 66.8% of the variability in final scores can be explained by the model (Fig. 2).

## 4.3 Gender impact analysis on clinical pharmacology exam scores

To explore the differential impact of integrating ideological and political education into clinical pharmacology on male and female students, a multiple linear regression model was employed. The model included an interaction term between gender and the intervention to assess whether the intervention's effect varied by gender. The regression equation used in the analysis was as follows: $y = \beta_0 + \beta_1 \times Regular\ Score + \beta_2 \times Gender + \beta_3 \times Intervention + \beta_4 \times (Gender \times Intervention) + \epsilon$ In this model, y represents the final exam score, the regular score ($\beta_1$) is a strong predictor of final scores, gender ($\beta_2$) represents male or female students, intervention ($\beta_3$) denotes the presence of the educational intervention, and the interaction term ($\beta_4$) captures any gender-based differences in the intervention's effect. The term $\epsilon$ represents the error term, accounting for the variability in final scores that cannot be explained by the predictors in the model.

The interaction coefficient ($\beta_4$ = -0.9540, p = 0.425) suggested a slightly negative effect, though it was not statistically significant, indicating that gender did not significantly moderate the impact of the intervention. The gender coefficient ($\beta_2$ = 0.9653, p = 0.266) suggested that male students had slightly higher final scores, but this was not significant either. On the other hand, the intervention coefficient ($\beta_3$ = 2.6314, p = 0.001) was both positive and significant, suggesting that the educational intervention had a notable positive impact on final scores. Regular scores ($\beta_1$ = 0.6042, p < 0.001) remained a strong and significant predictor of final exam scores.
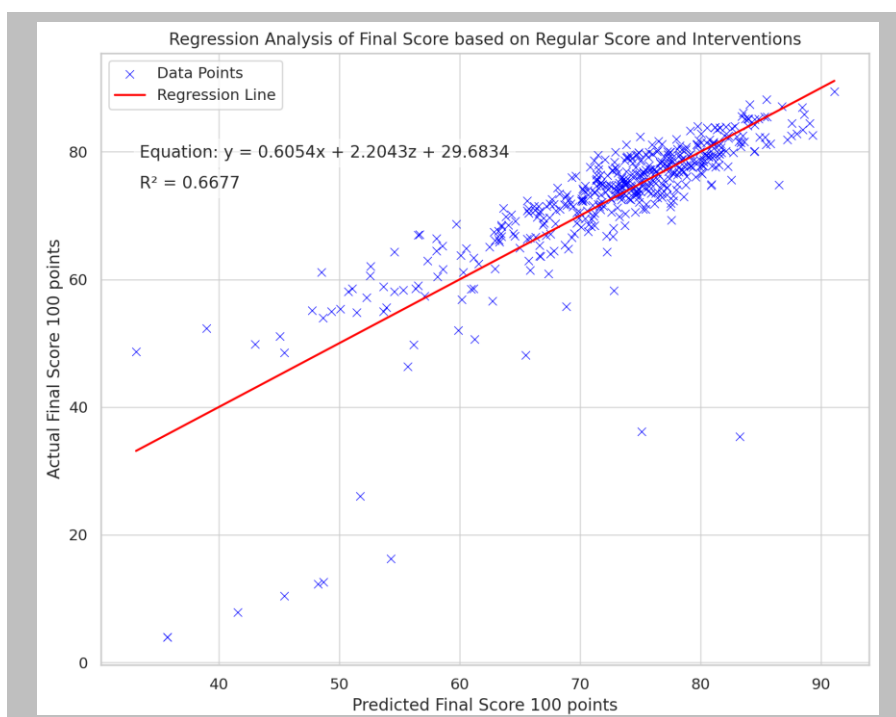


**Fig. 2.** Regression analysis of final score based on regular score and interventions.
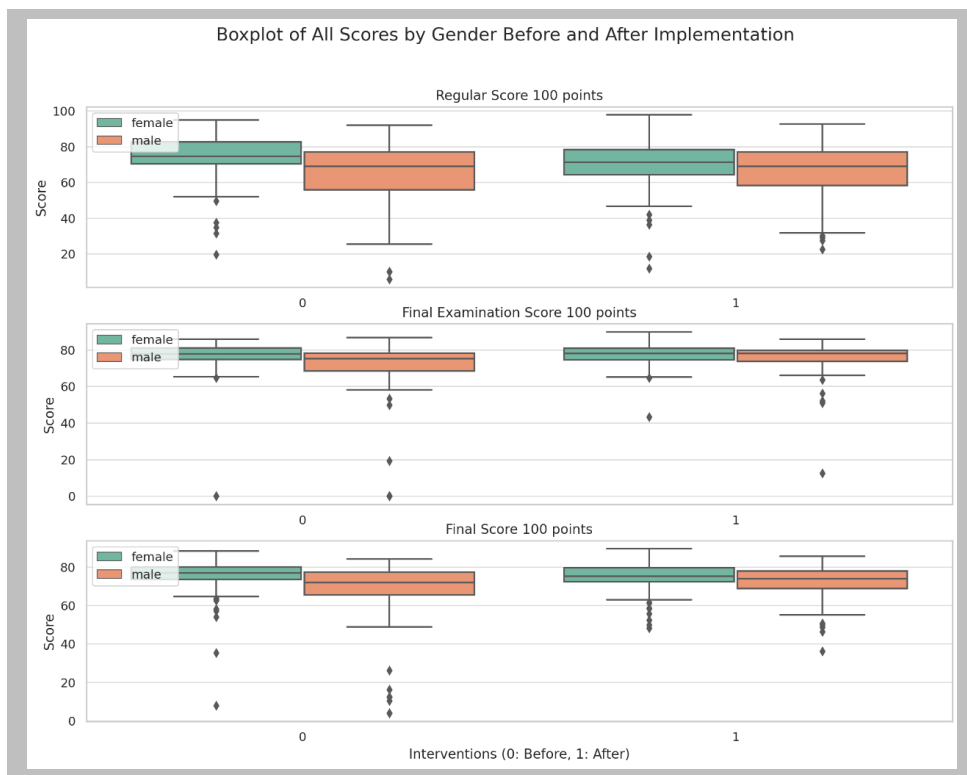
**Fig. 3.** Boxplot of all scores by gender before and after implementation.

Fig. 3 illustrates that both male and female students benefited from the reform, with a more pronounced improvement seen among female students. Although the interaction term was not statistically significant, suggesting no strong evidence of gender moderating the intervention's effect, the trends observed highlight the potential importance of considering gender differences in educational research and interventions.

**4.4 Descriptive statistics and distributions of student responses**

The pilot test conducted with 30 participants demonstrated that the questionnaire had strong content validity, confirmed by expert reviews ensuring the relevance and clarity of each item. The reliability of the questionnaire was assessed using Cronbach's alpha, yielding a score of 0.85, indicating high internal consistency. These results affirm the questionnaire's effectiveness in capturing students' perceptions and experiences regarding the integration of ideological and political education into the clinical pharmacology curriculum.

Responses from 382 students, categorized by gender, grade, and major. The gender distribution includes 222 females and 160 males. The grade distribution is as follows: 216 juniors, 109 sophomores, 34 seniors, 21 fifth-year students, and 2 freshmen. Regarding majors, the distribution is: Clinical Pharmacy (56 students, 14.66%), Pharmacy (143 students, 37.43%), Anesthesiology (29 students, 7.59%), Medical Laboratory Science (1 student, 0.26%), Biomedical Engineering (1 student, 0.26%), and Forensic Medicine (1 student, 0.26%). This data provides a comprehensive overview of the demographic and academic characteristics of the students who participated in the survey.
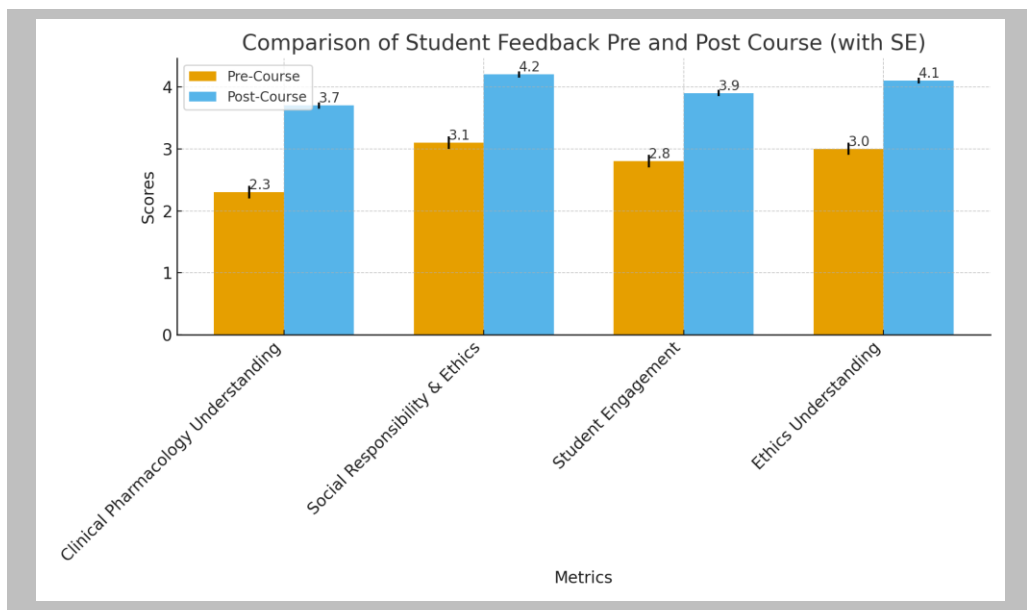
**Fig. 4.** Comparison of student feedback pre and post course with SE.

A comprehensive analysis of student responses was conducted to evaluate the integration of ideological and political education into a clinical pharmacology course. Fig. 4 descriptive statistics revealed significant improvements across various metrics. The average understanding of clinical pharmacology increased from a pre-course mean of 2.3 to a post-course mean of 3.7, with the standard deviation decreasing from 0.8 to 0.5, indicating a more uniform understanding among students. Attitudes towards the integration of ideological and political education shifted positively, with the proportion of students expressing strong support rising from 30% to 45%. The perceived importance of this integration remained high, with a median score of 4 (important) both before and after the course, and post-course responses skewed more towards 'very important' (5).

The enhancement of social responsibility and professional ethics was affirmed, with mean scores improving from 3.1 to 4.2 post-course. Engagement levels and understanding of ethical issues also showed significant improvements, with mean scores rising from 2.8 to 3.9 and from 3.0 to 4.1, respectively. These results highlight the effectiveness of the course in increasing student involvement and ethical awareness, demonstrating the value of integrating ideological and political education into the clinical pharmacology curriculum.

**4.5 Comparative analysis of pre- and post-course student responses**

A comparative analysis using paired t-tests and Wilcoxon signed-rank tests was conducted to evaluate changes in students' understanding of clinical pharmacology, attitudes toward ideological and political education, and related measures before and after the course. Significant improvements were found in understanding clinical pharmacology ($t = 8.611$, $p < 0.001$) and social and ethical issues ($t = 3.197$, $p = 0.001$). The importance of integrating ideological and political education also showed a significant positive change ($t = 3.001$, $p = 0.003$). No significant differences were found in attitudes towards ideological and political education ($t = -0.251$, $p = 0.802$), perception of career preparation ($t = -0.268$, $p = 0.789$), and engagement levels ($t = -0.169$, $p = 0.866$). Wilcoxon signed-rank tests confirmed these findings, with significant p-values for clinical pharmacology understanding (W =

2035.5, p < 0.001), importance of integration (W = 1286.5, p = 0.003), and understanding ethical issues (W = 2195.0, p = 0.002). These results highlight the course's effectiveness in enhancing students' knowledge and the perceived importance of ideological and political education, although further efforts may be needed to influence attitudes and career preparation perceptions significantly.

**4.6 Group differences in student responses based on gender, grade, and major**

Independent samples t-tests, ANOVA, and Kruskal-Wallis tests were conducted to assess differences in student responses based on gender, grade, and major. The gender-based analysis revealed that most measures showed no significant differences between male and female students; for example, the p-value for understanding clinical pharmacology was 0.157. The grade-based analysis using

ANOVA indicated significant differences in course engagement (p = 0.049) and understanding of ethical issues (p = 0.032), suggesting that students' engagement and ethical understanding varied across different grades. The major-based analysis using Kruskal-Wallis tests revealed significant differences in pre-course understanding of clinical pharmacology (p = 0.0002), indicating that students from different majors had varying levels of initial understanding. Additionally, post-course understanding of clinical pharmacology showed significant differences among majors (p = 0.027). These findings highlight the need to consider gender, grade, and major when integrating ideological and political education into the curriculum, as these factors can influence students' perceptions and engagement (Table 2).

**Table 2** Summary of statistical analysis grouped by gender, grade, and major on key student response variables.

| Variable Group | Variable | Test Type | p-value | Conclusion |
|---|---|---|---|---|
| Gender | Understanding clinical pharmacology | T-test | 0.157 | No significant difference |
| | Helpful for Career | T-test | 0.306 | No significant difference |
| Grade | Engagement | ANOVA | 0.049 | Significant difference |
| | Understanding ethical issues | ANOVA | 0.032 | Significant difference |
| | Enhance responsibility | ANOVA | 0.370 | No significant difference |
| Major | Pre-course understanding clinical pharmacology | Kruskal-Wallis | 0.0002 | Significant difference |
| | Post-course understanding clinical pharmacology | Kruskal-Wallis | 0.027 | Significant difference |
| | Importance of integration | Kruskal-Wallis | 0.769 | No significant difference |
| | Understand ethical issues | Kruskal-Wallis | 0.052 | Marginally significant difference |

**4.7 Correlation Analysis of Student Responses**

The correlation matrix revealed several significant relationships between the measured variables. Pre-course understanding of clinical pharmacology showed a moderate positive correlation with post-course attitudes towards ideological and political education (r = 0.28), indicating that students with better

initial understanding were more likely to have a positive attitude towards integrated education after the course. A strong correlation was observed between post-course helpfulness for career preparation and post-course attitudes towards ideological and political education (r = 0.80), suggesting that students who found the course helpful for

their careers were more likely to have a positive attitude towards the ideological and political education components. Additionally, post-course understanding of clinical pharmacology was positively correlated with post-course attitudes towards ideological and political education ($r = 0.50$), further emphasizing the importance of subject understanding in shaping students' attitudes. Engagement levels post-course were also moderately correlated with attitudes towards ideological and political education ($r = 0.60$), highlighting that higher engagement in the course is associated with more positive attitudes towards the integrated education content (Fig. 5).

## 4.8 Regression analysis of factors influencing students' attitudes towards integrated ideological and political education in clinical pharmacology courses

A linear regression model was constructed to analyze the factors influencing students' attitudes toward ideological and political education. The regression formula used was:

$$Post\_Attitude\_Ideology = \beta_0 + \beta_1 \times Pre\_Clinical\_Understanding + \beta_2 \times Post\_Helpful\_Career + \beta_3 \times Gender + \beta_4 \times Grade + \beta_5 \times Major$$

Table 3 shows that the most significant predictor of post-course attitude towards ideological and political education was the perceived helpfulness of the course for career preparation ($\beta_2 = 0.645$, $p < 0.001$). Additionally, pre-course understanding of clinical pharmacology had a positive influence ($\beta_1 = 0.119$, $p = 0.002$). Other factors, such as gender ($\beta_3 = -0.063$, $p = 0.293$), grade ($\beta_4 = -0.036$, $p = 0.342$), and major ($\beta_5 = -0.009$, $p = 0.237$), did not show significant effects. The intercept was $\beta_0 = 0.361$, $p = 0.049$. These results indicate that students' attitudes towards ideological and political education are primarily influenced by how helpful they perceive the course to be for their career preparation and, to a lesser extent, by their initial understanding of clinical pharmacology.
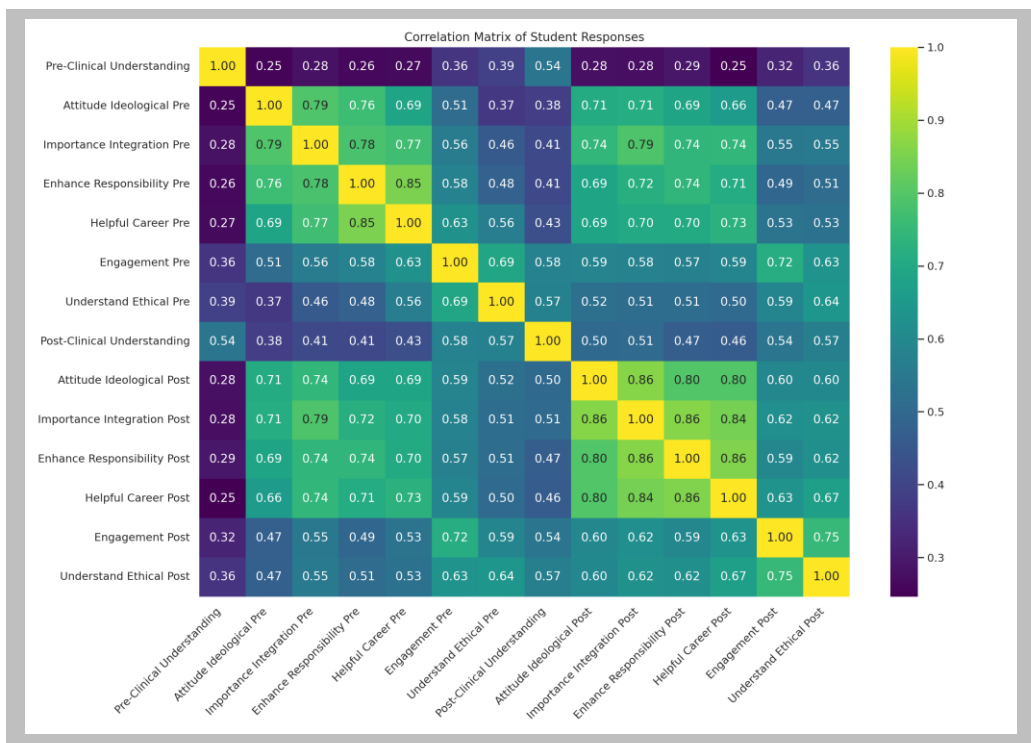


**Fig. 5.** Correlation matrix of student responses.

**Table 3** Linear regression analysis of factors influencing students' post-course attitudes.

| Measure | Coefficient | Standard Error | t-value | p-value |
|---------|-------------|----------------|---------|---------|
| **Intercept** | 0.361 | 0.183 | 1.978 | 0.049 |
| **Pre-Course Understanding of Clinical Pharmacology** | 0.119 | 0.039 | 3.074 | 0.002 |
| **Helpfulness for Career Preparation (Post-Course)** | 0.645 | 0.038 | 16.782 | < 0.001 |
| **Gender** | -0.063 | 0.060 | -1.053 | 0.293 |
| **Grade** | -0.036 | 0.038 | 0.951 | 0.342 |
| **Major** | -0.009 | 0.007 | -1.185 | 0.237 |

## 4.9 Clustering analysis of student engagement and attitudes towards integrated ideological and political education

To assess the impact of integrating ideological and political education into clinical pharmacology courses, an exploratory factor analysis (EFA) and k-means clustering were conducted on student questionnaire responses. Principal Component Analysis (PCA) identified factors related to career readiness, social responsibility, and professional ethics, with the first two components explaining most of the variance. K-means clustering identified three groups: Cluster 0 (Low Engagement) had the lowest scores in clinical pharmacology understanding (mean 2.20), attitude towards ideological education (mean 1.23), and engagement (mean 1.45), showing minimal change. Cluster 1 (Moderate Engagement) showed moderate scores, with clinical pharmacology understanding (mean 2.73), neutral attitude towards ideological education (mean 1.76), and average engagement (mean 2.08). Cluster 2 (High Engagement) had the highest scores, with clinical pharmacology understanding (mean 2.95), positive attitude towards ideological education (mean 2.89), and high engagement (mean 3.33), advocating significant educational enhancements. This analysis provides insights into student perceptions and engagement, highlighting distinct groups that can inform targeted educational strategies. The Fig. 6 supports these findings by showing clear separation between clusters.

## 5. Discussion

This study highlights the significant positive impact of integrating ideological and political education into clinical pharmacology courses. The educational reform led to notable improvements in student performance, with increased consistency in exam scores and overall course performance. This integration not only enhanced academic outcomes but also fostered a more comprehensive understanding and appreciation of clinical pharmacology among students.[19] One of the most remarkable findings was the differential impact on male and female students. While both groups benefited from the reform, female students showed more pronounced improvements. This suggests that integrating ideological and political education can play a critical role in promoting gender equity in medical education. Trends indicated that gender differences are significant in educational outcomes, emphasizing the need to consider these factors in future educational reforms.[20]

Student responses also provided valuable insights into the effectiveness of the educational intervention. The comprehensive analysis of responses revealed significant improvements in the understanding of clinical pharmacology, attitudes towards ideological and political education, and social responsibility. The shift in student

attitudes towards strong support for the integration of ideological and political education highlights its perceived importance and value in the curriculum.[21] Comparative analyses demonstrated that the integration significantly enhanced students' understanding of clinical pharmacology and social and ethical issues. However, attitudes towards ideological and political education and perceptions of career preparation showed less pronounced changes, indicating areas where further efforts are necessary. This suggests that while the integration has immediate academic benefits, its full impact on attitudes may require more time or additional strategies.[22]
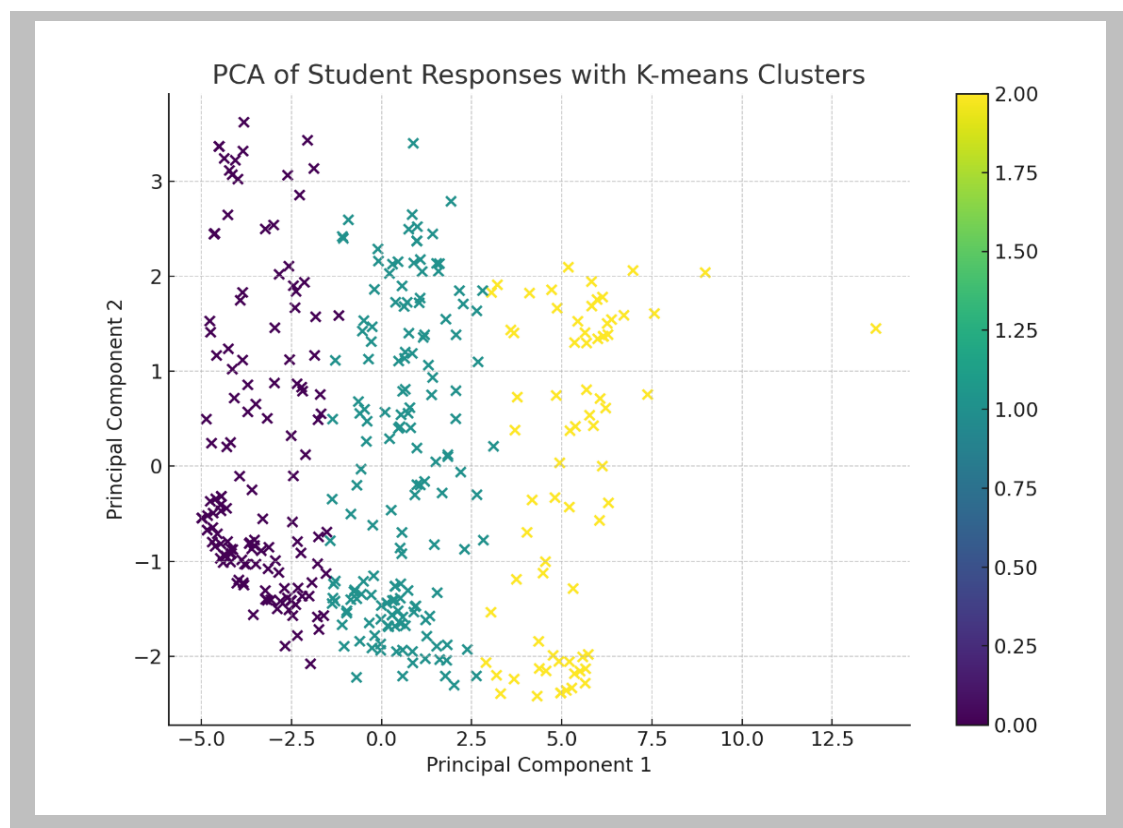


**Fig. 6.** PCA plot of student responses with K-means Clusters.

The analysis of differences based on gender, grade, and major highlighted the varying levels of initial understanding and engagement among different student groups. This underscores the importance of tailoring educational interventions to address the specific needs and backgrounds of diverse student populations. Understanding these differences can help in designing more effective educational strategies that maximize the benefits of ideological and political education.[23] The study also explored the relationships between various educational factors. Positive correlations between pre-course understanding and post-course attitudes, as well as between career preparation and attitudes towards ideological education, suggest that students who see the practical benefits of the course are more likely to appreciate its ideological and political components. This finding highlights the importance of linking educational content to students' future professional roles and responsibilities.[24] A clustering analysis

further identified distinct groups of students based on their engagement and attitudes towards the integrated education. The High Engagement group, which showed the most significant educational enhancements, advocates for targeted educational strategies that cater to different levels of student engagement. This approach can help in maximizing the overall effectiveness of educational reforms.[25]

Despite the promising results, the study's limitations must be acknowledged. Although the study was conducted at multiple medical universities across Yunnan Province, the data analysis primarily focused on results from a single institution due to concerns regarding data availability and consistency. This limitation highlights that while the findings may provide valuable insights, they may not be fully generalizable to other contexts. Additionally, while significant improvements were observed, changes in attitudes were less pronounced, suggesting the need for further research to explore long-term effects and broader implementation. Future studies should aim to include multiple institutions and investigate specific components of ideological and political education to provide deeper insights and enhance the applicability of the results.[26]

## 6. Conclusion

This study demonstrates that integrating ideological and political education into clinical pharmacology courses significantly improves student engagement, knowledge acquisition, and professional ethics, particularly in the areas of career preparation and social responsibility. The reform also plays a positive role in promoting gender equity, with female students benefiting more significantly. Student feedback reveals the effectiveness of ideological and political education in enhancing understanding and engagement, and tailored educational strategies for different student groups further strengthen the educational outcomes. Although the study has its limitations, future research should expand the sample size and diversity, explore long-term effects, and extend the integration of ideological and political education to more medical disciplines to better cultivate socially responsible medical professionals.

## Important abbreviations

PCA: Principal Component Analysis; EFA: Exploratory Factor Analysis; PBL: Problem-Based Learning; ANOVA: Analysis of Variance; SPSS: Statistical Package for the Social Sciences; T-tests: Paired T-tests; W tests: Wilcoxon Signed-Rank Tests; F-statistic: F-test for overall significance in regression models; R-squared: Coefficient of determination in regression analysis; K-means: K-means Clustering.

## Conflicts of interest

The authors have no conflicts of interest to declare concerning this study. The views and conclusions expressed herein are solely those of the authors and do not necessarily reflect the official policy or position of their affiliated institutions or funding organizations.

## Author contributions

Lanjie Huang: data curation, data analysis; Yang Liu: data curation, data analysis; Keyi Peng: data curation, data analysis; Xin Chen: methodology, validation; Bingliang Li: data curation, data analysis; Mu Yan: conceptualization, writing - original draft; Beibei Ye: data curation, data analysis; Ji Li: writing - original draft preparation, writing - review & editing; Jian Yang*: supervision, funding acquisition, project administration, final approval of version to be published. All authors have read and agreed to the published version of the manuscript.

## Data availability statement:

The data supporting the findings of this study can be obtained from the corresponding author upon reasonable request.

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