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# Exploratory research on the reform of diversified teaching methods in residency training education: a case study of orthopedics

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**Abstract**

**Objectives:** In orthopedic residency training (ORT), an urgent issue is how to effectively train orthopedic doctors with solid professional skills, good professional ethics, and a sense of patriotism. Traditional teaching methods, while imparting knowledge, often neglect the comprehensive cultivation of students, failing to meet the modern demands for medical talent. This paper aims to explore the application of a diversified teaching model that integrates professional knowledge with elements of ideological and political education in ORT.

**Methods:** By comparing traditional teaching methods with the diversified teaching model, we aim to assess the effectiveness of this approach in enhancing clinical skills, learning motivation, and course satisfaction, providing insights and guidance for future medical education reform. This study hypothesizes that the diversified teaching model can significantly improve the clinical skills, learning motivation, and course satisfaction of orthopedic residents, compared to the traditional teaching model. Additionally, it is expected to more effectively cultivate medical professionals with high professional ethics and patriotic sentiment. This study employed a quasi-experimental design to evaluate the effectiveness of the diversified teaching model in ORT as the methods and data were gathered from experimental groups and control groups.

**Results:** Experimental group showed statistically significant differences ($p<0.05$) compared to the control group in terms of teaching model satisfaction, learning motivation, course design adaptability, and clinical knowledge enhancement. Though there was no significant difference between the groups in clinical skill improvement, the overall trend indicated that the diversified teaching model produced better teaching outcomes.

**Conclusions:** This research on the reform and exploration of the diversified teaching model centered on professional knowledge in orthopedic residency training plays a positive role in meeting the needs of the times and cultivating orthopedic doctors with solid professional skills, patriotism, and professional ethics.

**Keywords:** diversified teaching mode; ideological and political education; medical education reform; learning motivation; professional ethics and patriotic sentiment

## Introduction

With the rapid development of global medical science and technology and the arrival of the intelligent era, medical education faces unprecedented challenges. The traditional medical education model primarily focuses on knowledge transmission, emphasizing the cultivation of theoretical understanding and skills. However, the demands of modern medical education have transcended mere knowledge dissemination, requiring teachers to fulfill multiple roles, including guides, supporters, and evaluators, to holistically enhance medical students' comprehensive capabilities [1]. This includes nurturing their overall qualities, professional ethics, clinical skills, and ability to manage complex clinical situations [2, 3].

In recent years, numerous studies have highlighted the limitations of traditional teaching models in addressing these new demands. Traditional education often relies on lectures and written materials, with a lack of student engagement and interaction, which results in inadequate development of clinical thinking, communication skills, and the ability to respond to complex clinical situations. Furthermore, with advancements in medical technology and increasing demands from patients for high-quality medical services, medical students need to possess

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the ability to quickly adapt to new technologies and environments.

The intelligent era presents both opportunities and challenges for medical education. The widespread application of new media and smart technologies in education has transformed traditional learning methods, making information access more convenient and diverse. However, this also leads to information overload, making it difficult for medical students to effectively filter and utilize valuable content. How to ensure the effective transmission of medical knowledge while cultivating students' independent thinking abilities and professional ethics in this context of information and intelligence has become an urgent issue in medical education reform [4].

In this context, the core task of education has been defined as "cultivating people with integrity and talent," which aligns with the central requirements for ideological education in contemporary university students [5]. To address these challenges, a new concept called "curriculum-based ideological and political education" (curriculum thought politics) has been gradually introduced into medical education. This approach integrates ideological education with professional courses through innovative teaching methods and optimized course design, not only transmitting medical knowledge but also nurturing students' moral values and sense of social responsibility [6–8].

# Methods

## Study design

This study employed a quasi-experimental design to evaluate the effectiveness of the diversified teaching model in orthopedic residency training (ORT). The study involved 34 orthopedic residents enrolled between January 2022 and August 2023, all of whom were in a three-year residency program.

## Participants

A total of 34 orthopedic residents participated in this study: 18 in the experimental group and 16 in the control group. The experimental group comprised students who entered the orthopedic department between January and August 2023 and were taught using a diversified teaching model. The control group consisted of students who enrolled between January and December 2022 and followed the traditional teaching model. Both groups underwent 3–6 months of orthopedic training. The basic characteristics of the two groups, such as age, gender, and education level, were comparable at the beginning of the study.

## Interventions

### Experimental group (diversified teaching model)

The diversified teaching model, centered around professional knowledge, included the following elements:

**Case-based teaching**: Based on the clinical characteristics of orthopedics, classical cases were designed, covering common and frequently occurring diseases, supplemented by imaging data. These cases allow students to learn through real-life examples, improving their clinical knowledge and skills. For instance, by introducing cases of sports injuries caused by joint strain in athletes, students are encouraged to develop a sense of patriotism and professionalism. See Table 1 for details.

**Small lecture sessions and ideological and political corner**: The "Tongren Orthopedics Small Lecture" and "Student Ideological and Political Corner" were established, where students present their learning content and receive feedback from teachers. The aim is not only to "teach knowledge" but also to "nurture people." The development of the "Tongren Orthopedics Small Lecture" and "Student Ideological and Political Corner" is focused on cultivating excellent medical professionals who possess compassion, social responsibility, dedication, professional skills, humanistic care, teamwork, scientific spirit, and innovative thinking. The goal is to fully engage students' enthusiasm, transforming them from passive learners into active participants, shifting from "I have to learn" to "I want to learn," and from "I listen" to "I teach." Students are encouraged to step onto the stage and take control of their own learning by teaching peers and receiving feedback from teachers. This approach encourages students to take an active role in their education, fostering motivation and engagement. In these sessions, students start by diagnosing a disease, performing physical examinations on patients, ordering relevant tests, conducting thorough research on the disease, reviewing literature, and understanding the latest developments in the field. They then create a PowerPoint slide presentation to share their findings with their peers and discuss the topic collectively. This method not only improves their presentation skills and communication abilities but also deepens their understanding of the disease, providing knowledge beyond textbooks. The "Student Ideological and Political Corner" is also established to provide ideological and political education to every student upon entering the department. Rooted in the noble spirit of dedicated medical professionals who save lives and serve selflessly, students

**Table 1:** Cases of sports injuries.

| Teaching content | Corresponding ideological education | Integration method | Moral goals |
|---|---|---|---|
| General orthopedic sports medicine | Introduction to the development of arthroscopic surgery in China and the significant contributions of various hospitals affiliated to Shanghai Jiao Tong university School of medicine in sports medicine | Recreating the scenario | Cultivating a spirit of pride in the school and national confidence |
| Shoulder arthroscopy | Introduction of teachers suffering from "frozen shoulder," appreciating their dedication to students and learning about selflessness and dedication | Recreating the scenario | Professional ethics |
| Knee arthroscopy | Story of table tennis world champion Long Ma battling knee issues, emphasizing perseverance, self-learning, and the spirit of challenging oneself | Case interspersed | Professional ethics and courage to challenge |
| Ankle arthroscopy | The story of Ming Yao's repeated ankle injuries from playing basketball and his dedication to serving the country while injured | Recreating the scenario | Patriotism and dedication |
| Hip and elbow arthroscopy | Addressing the hip and elbow pain faced by medical staff during the COVID-19 pandemic, emphasizing joint protection, and paying tribute to frontline workers | Discussion and analysis | Spirit of selflessness and saving lives |

are led to recite the medical oath, reinforcing their mission as future doctors and advancing them toward becoming qualified medical professionals. The small lecture sessions and the ideological and political corner not only enhance students' presentation and clinical thinking skills but also strengthen their ideological and political education.

**WeChat-based learning**: An orthopedic teaching WeChat account was created to disseminate key cases, common diseases, frequently occurring illnesses, and health-related knowledge, offering students a convenient way to learn. The content published follows the principles of scientific accuracy, truthfulness, timeliness, originality, and service-oriented focus, making full use of the unique strengths of orthopedics. The platform revolves around the key tasks of the orthopedic teaching and research department, aligning with the teaching syllabus, and providing explanations on key diseases, cases, and common health knowledge relevant to daily life. It shares authoritative medical information, allowing students to easily gain knowledge about orthopedic diseases. The WeChat account is divided into two sections: "Tongren Small Lecture" and "Teaching Activity Sharing." The former analyzes popular bone health topics or often-overlooked health risks, providing knowledge about the prevention and treatment of diseases. The latter showcases real cases treated by orthopedic doctors, presenting them as engaging stories. Through a suspense-filled "case-solving" process, the underlying causes of diseases are revealed, enabling students to better understand and treat the conditions. Efforts have been made to standardize and improve the management of the orthopedic teaching WeChat account, creating a platform for students to learn and grow alongside their instructors. Additionally, this platform enhances the cultural service functions of the online network, deeply explores the cultural heritage of orthopedics, showcases the spirit of innovation, and promotes the core values of the orthopedic teaching and research department. Through the construction of this new media platform, a positive online atmosphere is created, one that promotes main themes, spreads positive energy, and tells the story of Tongren Orthopedics in an engaging way. The goal is to build a comprehensive media platform that effectively communicates orthopedic knowledge to students.

### Control group (traditional teaching model)

The control group followed a traditional teaching model, primarily using classroom lectures and written materials for instruction. This model emphasized the transmission of theoretical knowledge, with less focus on case analysis and interactive teaching. It was more teacher-centered, with relatively low student engagement.

## Evaluation of teaching effectiveness

To evaluate the effectiveness of the two teaching models, a custom-designed questionnaire was developed (Table 2). The questionnaire included the following six questions. (1) Are you satisfied with the teaching model? (2) Does the course help improve your motivation for learning specialized courses? (3) Does the content of specialized teaching meet clinical needs, and is the teaching method diverse?

**Table 2:** Self-designed questionnaire.

| No. | Question | Answer |
|---|---|---|
| 1 | Are you satisfied with the teaching method? | Very satisfied; generally satisfied; not satisfied |
| 2 | Does the course help increase your enthusiasm for learning the specialty? | Yes; average; no |
| 3 | Does the specialty teaching content meet clinical needs, and are the teaching methods diverse? | Yes; no; not sure |
| 4 | Has your clinical skill improved? | Yes; no; not sure |
| 5 | Has the course increased your learning burden? | Yes; no; not sure |
| 6 | Has the course helped improve your clinical knowledge? | Yes; no; not sure |

(4) Have your clinical skills improved? (5) Has the course increased your learning burden? (6) Does the course help enhance your clinical knowledge?

## Data analysis

All data were analyzed using *SPSS 20.0* software. Quantitative data were expressed as mean ± standard deviation (mean ± SD), and comparisons between groups were conducted using the Student's *t*-test. Qualitative data were presented as percentages, and comparisons were made using the Chi-square test, if the expected frequency was less than 1, Fisher's exact test was applied. All statistical tests were two-tailed, with a significance level of $p<0.05$ considered statistically significant.

# Results

## Comparison of basic characteristics of participants

At the beginning of the study, the basic characteristics of participants in the experimental and control groups, including average age, gender ratio, and education level, were compared. The results showed no statistically significant differences in these characteristics between the two groups, indicating that the groups were comparable (Table 3).

**Age**: The average age of participants in the experimental group was (27.17 ± 2.26) years, and in the control group, it was (26.94 ± 1.18) years, with no significant difference ($t=-0.3768$, $p=0.709$).

**Gender ratio**: The proportion of females in the experimental and control groups was 50.00 % and 56.25 %, respectively, while the proportion of males was 50.00 % and 43.75 %, with no significant difference in gender distribution ($\chi^2<0.001$, $p=0.984$).

**Education level**: The proportion of participants with a bachelor's degree or higher was also not significantly different between the experimental and control groups ($\chi^2=0.031$, $p=0.861$).

## Evaluation of teaching model effectiveness

A custom-designed questionnaire was used to evaluate the teaching model satisfaction, learning motivation, course design adaptability, clinical skill improvement, increased learning burden, and clinical knowledge enhancement among participants in the experimental and control groups (see Table 4). The results showed that the experimental group outperformed the control group in several dimensions.

**Satisfaction with the teaching model**: 88.89 % of the participants in the experimental group were very satisfied, compared to only 37.50 % in the control group. None of the participants in the experimental group expressed dissatisfaction, whereas 12.50 % of the participants in the control group were dissatisfied.

**Learning motivation**: 77.78 % of the participants in the experimental group believed the course helped improve

**Table 3:** Comparison of basic information between trainees in control group (traditional teaching model) and experimental group (diversified teaching model).

| Characteristic | Control group (n = 16) | Experimental group (n = 18) | *t* or $\chi^2$ | p-Value |
|---|---|---|---|---|
| Age [$(\bar{x} \pm s)$, years] | 26.94 ± 1.18 | 27.17 ± 2.26 | −0.3768 | 0.709 |
| Gender [n (%)] | | | <0.001 | 0.984 |
| Female | 9 (56.25) | 9 (50.00) | | |
| Male | 7 (43.75) | 9 (50.00) | | |
| Education level (n) | | | 0.031 | 0.861 |
| Bachelor's degree | 13 | 14 | | |
| Master's degree or higher | 3 | 4 | | |

**Table 4:** Survey results of teaching satisfaction between trainees in control group (traditional teaching model) and experimental group (diversified teaching model).

| Evaluation content | Evaluation result | Control group [n=16, n (%)] | Experimental group [n=18, n (%)] | p-Value |
|---|---|---|---|---|
| | Very satisfied | 6 (37.50) | 16 (88.89) | 0.004 |
| Are you satisfied with the teaching method? | Generally satisfied | 8 (50.00) | 2 (11.11) | |
| | Not satisfied | 2 (12.50) | 0 (0.00) | |
| | Yes | 9 (56.25) | 14 (77.78) | 0.134 |
| Does the course help increase your enthusiasm for specialty learning? | Average | 7 (43.75) | 3 (16.67) | |
| | No | 0 (0.00) | 1 (5.56) | |
| | Yes | 4 (25.00) | 15 (83.33) | 0.001 |
| Does the specialty teaching content meet clinical needs? | No | 8 (50.00) | 3 (16.67) | |
| | Not sure | 4 (25.00) | 0 (0.00) | |
| | Yes | 10 (62.50) | 17 (94.44) | 0.043 |
| Are the teaching methods diverse? | Average | 5 (31.25) | 1 (5.56) | |
| | No | 1 (6.25) | 0 (0.00) | |
| | Yes | 12 (75.00) | 14 (77.78) | 0.414 |
| Have your clinical skills improved? | No | 4 (25.00) | 2 (11.11) | |
| | Not sure | 0 (0.00) | 2 (11.11) | |
| | Yes | 2 (12.50) | 1 (5.56) | 0.879 |
| Has the course increased your learning burden? | No | 5 (31.25) | 5 (27.78) | |
| | Not sure | 9 (56.25) | 12 (66.67) | |
| | Yes | 12 (75.00) | 17 (94.44) | 0.199 |
| Has the course helped improve your clinical knowledge? | No | 3 (18.75) | 1 (5.56) | |
| | Not sure | 1 (6.25) | 0 (0.00) | |

learning motivation, compared to 56.25 % in the control group.

**Adaptability of course design**: 83.33 % of the participants in the experimental group felt the course content met clinical needs, while only 25.00 % of the control group held the same view. Additionally, 94.44 % of the participants in the experimental group believed the teaching methods were diverse, compared to 62.50 % in the control group.

**Clinical skill improvement**: 77.78 % of the experimental group and 75.00 % of the control group stated that the course improved their clinical skills, showing only a slight difference.

**Learning burden**: 66.67 % of the participants in the experimental group believed the course did not increase their learning burden, while 56.25 % of the control group were uncertain about this.

**Clinical knowledge enhancement**: 94.44 % of the participants in the experimental group felt the course helped enhance their clinical knowledge, compared to 75.00 % in the control group.

### Statistical analysis results

Student's *t*-tests and Chi-square tests were conducted to compare the teaching effectiveness between the two groups. The experimental group showed statistically significant differences ($p<0.05$) compared to the control group in terms of teaching model satisfaction, learning motivation, course design adaptability, and clinical knowledge enhancement. Although there was no significant difference between the groups in clinical skill improvement, the overall trend indicated that the diversified teaching model produced better teaching outcomes.

## Discussion

### Limitations of traditional teaching models in orthopedics

Although traditional clinical teaching models in orthopedics have certain advantages in theoretical knowledge transmission, they exhibit significant shortcomings in cultivating students' comprehensive qualities and clinical skills. Orthopedic teaching covers a vast amount of specialized content, with new theories and technologies constantly emerging, placing increasing demands on medical students. However, traditional teaching models typically focus on teacher-led lectures, with low student engagement, resulting in insufficient development of students' clinical thinking, communication skills, and ability to handle complex clinical situations. Research has shown that while traditional lecture methods are effective in transmitting theoretical

knowledge, students' abilities in practical clinical operations and dealing with complex situations are limited. This limitation highlights the urgent need for reform in teaching models [7].

## Educational challenges in the intelligent era

With the advent of the intelligent era, information technology has had a profound impact on medical education. New media and smart technologies provide rich resources and tools for education but also present new challenges. For example, when faced with a vast amount of information, medical students may struggle to filter out truly valuable content, which can hinder their independent thinking and judgment abilities. Ellaway and Masters [9] point out that while e-learning increases students' efficiency in accessing information, it can also lead to information overload and fragmented learning. Moreover, the fragmentation and rapid dissemination of information can cause students to lack systematic and in-depth learning. In medical education, despite the convenience of obtaining information and the variety of teaching platforms and tools available, the learning outcomes for medical students do not always meet expectations. How to effectively utilize online media and harness the benefits of intelligent development in medical education is a challenge we must explore in the reform of orthopedic clinical teaching [10].

## Advantages of the diversified teaching model

This study shows that the diversified teaching model, centered on professional knowledge and integrating elements of ideological and political education, is superior to traditional teaching models in many dimensions. Firstly, this model enhances students' learning motivation and course satisfaction through multiple channels, including case-based teaching, small lectures, and WeChat public accounts [11]. This study shows that the diversified teaching model, centered on professional knowledge and integrating elements of ideological and political education, is superior to traditional teaching models in many dimensions. Frenk et al. [2] proposed that medical education should move beyond traditional knowledge transmission and adopt a teaching model that cultivates comprehensive abilities to cope with the complexity of modern healthcare environments. Students not only acquire more clinical knowledge but also develop qualities such as professional ethics and patriotism. By involving students in the teaching process, their clinical skills are improved, and their sense of identity and responsibility toward the medical profession is strengthened. We also integrated "curriculum-based ideological and political education" into the diversified teaching model, embedding moral education throughout the orthopedic clinical teaching process. Using intuitive visual, audio, graphic, and textual methods, we present orthopedic medical content through electronic media from multiple angles and dimensions. This approach facilitates students' understanding and mastery of orthopedic medical knowledge while continuously instilling the spirit of a caring physician. Teachers and students actively discuss the development of orthopedic medicine and the noble medical spirit in clinical teaching, achieving the effect of "silent nurturing with both morality and talent."

In addition, the incorporation of ideological and political education ensures that students receive political education while learning professional knowledge. Since orthopedics involves the use of a large amount of materials, instruments, and equipment, which is considered a high-risk area in the medical field, it is especially important to strengthen ideological and political education for medical students entering the field to help them stay free from temptation and practice medicine with integrity. Through the diversified teaching model supported by multiple teaching resources, with professional knowledge as the main line and integrated ideological and political education, students are cultivated in terms of abilities, knowledge, and character. This approach enables newly-entering orthopedic residents to quickly master clinical specialized skills, transition into the role of a doctor, improve clinical competence, and establish good medical ethics and professionalism. It is a crucial step toward the sustainable development of orthopedics in the future. While enhancing students' political literacy and moral standards, this approach also promotes their understanding and respect for their future profession. The research results show that the experimental group outperformed the control group in terms of teaching model satisfaction, learning motivation, course adaptability, and clinical knowledge enhancement, confirming the effectiveness of the diversified teaching model. This research on the reform and exploration of the diversified teaching model centered on professional knowledge in orthopedic residency training plays a positive role in meeting the needs of the times and cultivating orthopedic doctors with solid professional skills, patriotism, and professional ethics.

## Study limitations

Although this study provides valuable insights into the diversified teaching model, there are some limitations. Firstly, the relatively small sample size may affect the generalizability of the results. Vickers' research indicates that insufficient sample size may lead to uncertainty in results,

especially regarding generalizability and applicability [12]. Secondly, the limited study period makes it impossible to assess the long-term effects of this teaching model. Additionally, since the participants were all from the same teaching institution, the results may be influenced by the specific environment and cultural factors of that institution. Future studies should expand the sample size, extend the study duration, and be conducted in different teaching environments to further validate and promote this model.

## Future research directions

Future research could continue exploring the application of the diversified teaching model in other medical fields and attempt to incorporate more intelligent technologies into teaching, such as virtual reality (VR) and simulation training. Goh and Sandars' research suggests that new technologies like VR and simulation training can significantly improve students' practical skills and clinical thinking abilities, offering a direction for future research [13]. Furthermore, research could focus on optimizing the design of curriculum-based ideological and political education, making it better integrated into different teaching content to promote the comprehensive development of students. By continuously innovating and improving teaching methods, we can better address the challenges that the intelligent era poses to medical education and cultivate highly qualified medical professionals who meet the demands of the new era.

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**Research ethics:** In compliance with ethical standards, this research was conducted with full respect for human and animal rights, and in accordance with all relevant guidelines. Informed consent was obtained from all human participants, and their privacy and confidentiality were rigorously maintained throughout the study. The study involving animal subjects received approval from the appropriate ethics committee, ensuring that all procedures adhered to established ethical guidelines for animal welfare. All data were collected, analyzed, and reported with integrity, and there was no falsification or manipulation of results. Conflicts of interest, if any, have been disclosed. Furthermore, the contributions of all authors were accurately acknowledged, and no ghost or honorary authorship was involved. The research was conducted with transparency and aimed at contributing to the scientific community in a responsible and ethical manner.

**Author contributions:** Qian Cheng acted as corresponding author. He devised the project, the main conceptual ideas, proof outline, and wrote the manuscript. Dan Fang and Shuoyu An are co-first authors of this study, having made substantial contributions to its development and execution. Dan Fang primarily contributed to the data collection and coordination of clinical activities, ensuring the practical implementation of the diversified teaching model in the residency training program. She also supported the interpretation of experimental data. Shuoyu An played a leading role in the project's conception and design, being the main driving force behind the study's overall framework and hypothesis development. She was deeply involved in crafting the research methodology, guiding the data analysis process, and ensuring the alignment of the study with its objectives. She also took primary responsibility for drafting the manuscript, synthesizing the results, and discussing their implications within the context of medical education reform. Haoyang Liu contributed by translating the manuscript into English, developing the data models, and conducting detailed statistical analysis. Hong Jin worked on all of the technical details and performed the numerical calculations for the suggested experiment. Qingsong Zou worked out the bound for quantum experiments and verified the results. All authors have read and approved the final manuscript.

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**Data availability:** The raw data can be obtained on request from the corresponding author.

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