

Comparative Effectiveness of Blended Teaching Models with Micro-Teaching Assistants in Clinical Pharmacokinetics Education

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ABSTRACT

Objective: This study aimed to evaluate the effectiveness of micro-teaching assistants within a hybrid online-offline teaching framework in the context of clinical pharmacokinetics education.

Material and Methods: A total of 320 clinical pharmacy students participated, with 143 students from earlier cohorts forming the control group and 177 students from the 2019 and 2020 batches comprising of the observation group. Traditional teaching methodologies instructed the control group, while the observation group benefited from a novel, blended teaching approach incorporating micro-teaching assistants. The evaluation criteria encompassed theoretical knowledge acquisition, practical skill development, pass rates, and score distribution.

Results: This investigation into clinical pharmacokinetics education demonstrates the superiority of a blended teaching model, enhanced by micro-teaching assistants, over traditional methodologies. The observation group, utilizing this approach, displayed a significant 15% increase in theoretical knowledge scores, maintained high practical skill levels, alongside achieving a 94.9% pass rate, markedly surpassing the control group's 91.6%. Feedback from students corroborated the model's effectiveness, with satisfaction scores exceeding 4.8 out of 5; despite potential respondent bias. Notably, the application of micro-teaching assistants was most pronounced in Pharmacology, highlighting its value in teaching complex theoretical content, and advocating for expanded use in medical education.

Conclusion: This study concludes that the integration of micro-teaching assistants into blended teaching strategies for clinical pharmacokinetics significantly improves educational outcomes. This approach not only facilitates a more effective learning environment but also underscores the potential of innovative pedagogical tools in enhancing student performance, and comprehension in complex subjects.

Keywords: blended teaching; clinical pharmacokinetics; educational effectiveness; micro-teaching assistants; student outcomes

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INTRODUCTION

Clinical pharmacokinetics occupies a foundational role in the clinical pharmacy curriculum, not only serving as a cornerstone for further academic pursuits within the discipline but also attracting interest from students across health-related majors, such as pharmacy and clinical medicine¹. The rapid evolution of societal and technological landscapes has rendered traditional educational paradigms increasingly inadequate in meeting the growing demand for innovative teaching methods and the development of new talent. This challenge has been magnified by the global health crises, highlighting the urgent need for pedagogical innovation and compelling educational institutions to reevaluate and reform their teaching strategies².

The advent of the digital era has made the integration of technology into educational practices not merely advantageous but imperative. Among the innovations in this field, WeChat and its micro-teaching functionalities stand out, offering a flexible and interactive platform that transcends the geographical and physical limitations of traditional classroom settings. This investigation delves into the potential benefits and transformative impacts of employing a blended online-offline teaching model, anchored by WeChat-based micro-teaching, within the domain of clinical pharmacokinetics education at medical colleges. Although the findings indicate positive outcomes for this particular subject area, their generalizability to other disciplines or broader educational contexts requires further exploration.

The traditional face-to-face teaching model, characterized by its direct educator-student interactions, has been instrumental in the systematic dissemination of knowledge. However, this model often lacks effective mechanisms for personalizing learning experiences and fostering innovation, which is crucial for accommodating the diverse needs of a heterogeneous student population³. In contrast, the emergence of the blended online-offline teaching model, epitomized by micro-teaching

through platforms like WeChat, represents a significant advancement. This model merges the accessibility and engagement offered by digital technologies with the depth of traditional educational methods, addressing some of the key limitations associated with solely face-to-face or online teaching approaches⁴.

This study specifically targets the clinical pharmacy student population from the academic years 2016 to 2020, comparing the educational outcomes between those that experienced traditional teaching methods and those exposed to the WeChat-enhanced micro-teaching approach. While the feedback from students has been predominantly positive, it is acknowledged that the reliance on subjective assessments may introduce biases. Furthermore, the research primarily focuses on immediate academic performance, with a longitudinal evaluation of knowledge retention and application over time suggesting a potential area for future research. Through this investigation, the aim is to contribute to the ongoing discourse on educational reform, advocating for a broader acceptance of technology-enhanced learning methods that prepare students to navigate and succeed in a rapidly changing global environment.

MATERIAL AND METHODS

Teaching Methods

Control Group (Traditional Teaching Model)

Within the control group, a traditional teaching paradigm was adopted, comprising a systematic educational methodology. Initially, participants undertook a pre-class exploration of clinical pharmacokinetics via textbooks, examining core principles, such as drug absorption, distribution, metabolism and excretion. This was succeeded by in-class sessions, wherein pre-designed multimedia courseware facilitated enhanced learning, promoting interactive dialogues to ensure a uniform grasp of the subject matter irrespective of students' initial knowledge levels. The instructional sequence culminated in a post-

class phase, with educators addressing inquiries, allocating homework, and offering feedback to solidify educational gains. Nonetheless, this conventional method sometimes fell short in fully meeting the varied learning needs of a diverse student demographic⁵.

Observation Group (Blended Online-Offline Model Using Micro-Teaching)

In the observation group, a blended teaching model incorporating micro-teaching techniques significantly enhanced the learning experience. Pre-class activities involved distributing digital courseware and micro-videos through an online platform facilitating self-directed study and feedback, which informed timely pedagogical adjustments. In-class, the micro-teaching platform's mobile sign-in feature streamlined attendance while leveraging pre-class insights through quizzes and polls to ensure active engagement and immediate feedback. This approach fostered a dynamic educational environment. Post-class, the use of micro-teaching analytics enabled instructors to provide targeted feedback, with assignments and online assessments offering an objective measure of student comprehension and progress. This comprehensive strategy ensured a robust evaluation of the educational outcomes, demonstrating the effectiveness of integrating digital tools in enhancing teaching and learning processes⁶.

Observation Indicators and Methods

This study utilized a detailed framework of observation indicators and methods to assess the effectiveness of teaching methodologies, covering both formative and summative learning aspects. Formative assessments included process scores for attendance (10%), homework (20%), quizzes (20%), discussions (20%), and practical experiments (30%), each on a 0–100 scale, enabling an in-depth evaluation of student engagement. Summative assessments involved theoretical and practical mastery through post-course exams, scored up to 100

points, to measure overall knowledge acquisition. Further analysis included passing rates and grade distribution, categorized as <60 (fail), 60–69 (pass), 70–79 (good), 80–89 (very good), and 90–100 (excellent), reflecting the instructional effectiveness. Additionally, feedback on WeChat's integration into the curriculum, rated on a 5-point scale with most scores above 4.8, indicated high student satisfaction. The use of micro-teaching assistants across medical disciplines was evaluated to gauge the adaptability and impact of digital tools on educational quality. This comprehensive approach not only facilitated a thorough assessment of teaching methods but also highlighted opportunities for pedagogical enhancement and innovation.

Statistical Methods

Data analysis was conducted using SPSS (version 20.0), with continuous variables described by mean values ($\bar{X}$) and standard deviations (S.D.); elucidating the dataset's central tendencies and variabilities. Group disparities were evaluated using independent samples t-tests for continuous variables, revealing mean differences between the control and observation groups. Chi-square tests assessed categorical variables to discern distribution variances, enriching the analysis with insights into categorical data variability. For data not adhering to normal distribution or for ordinal variables, rank-sum tests were utilized, comparing group medians to ensure a thorough examination across all data spectrums. A predefined alpha level (α) of 0.05 marked the threshold for statistical significance with p-values at or below this criterion signifying substantial differences or correlations, thereby ensuring that the analysis robustly identified significant outcomes within the research parameters.

Ethical Approval

This study was meticulously aligned with the ethical guidelines stipulated in the Declaration of Helsinki, ensuring the protection and respect of all participants.

The Institutional Review Board (IRB) of Kunming Medical University granted ethical endorsement (approval number 202300079), underscoring the study's commitment to ethical research practices. Prior to their inclusion in the study, informed consent was obtained from all participants.

RESULTS

Comparative Efficacy of Blended and Traditional Teaching Methods on Student Learning Outcomes

The bar chart elucidates the differential impact of blended versus traditional teaching on students' theoretical and experimental competencies. Represented in blue, the average theoretical knowledge scores under blended

teaching (79.06 ± 3.95) contrast significantly with those from traditional teaching (69.68 ± 3.48), denoting a marked improvement with the former approach. In contrast, experimental operations scores, shown in orange, maintain consistency across both methods (95.73 ± 4.79 for blended and 95.25 ± 4.76 for traditional). This visual representation, as supplemented by Table 1 and Figure 1, suggests that while practical skills acquisition remains stable, the assimilation of theoretical knowledge is enhanced by blended instructional strategies. Further analysis considering larger datasets and additional variables would be instrumental in substantiating these findings.

Table 1 Comparison of theoretical knowledge and experimental skills between the two groups

Group	Number of people	Average score of theoretical knowledge	P	Average score of experimental operations	P
Observe (2019+2020)	177	79.06*	0.001	95.73	0.073
Compare (2016+2017)	143	69.68		95.25	

p-value<0.05, *indicates a statistically significant difference between the observation group and the control group

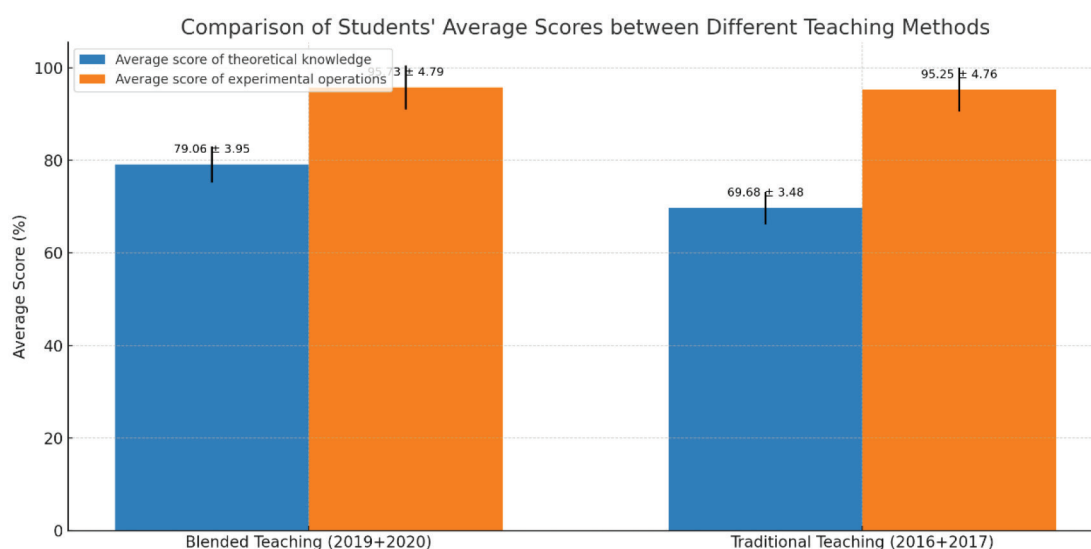


Figure 1 Comparison of passing rates between traditional and blended teaching groups

Statistical Significance in Passing Rates: Blended vs. Traditional Teaching

The bar chart compares passing rates between traditional teaching (2016–2017) and blended teaching groups (2019–2020), demonstrating a notable enhancement with the latter. The traditional group exhibited a pass rate of 91.6%, whereas the blended approach resulted in a higher rate of 94.9%. Statistical analysis indicates a significant

difference, with a p -value of 0.002, substantiating the effectiveness of the blended teaching method over the traditional one. These outcomes, further detailed in Table 2 and illustrated in Figure 2, suggest that blended teaching strategies better facilitate student achievement in passing examinations. This evidence advocates for reconsidering pedagogical approaches in educational practices to optimize student success rates.

Table 2 Comparison of passing rates between the two groups

Group	Number of people	Number of pass	Pass rate	P
Observe (2019+2020)	177	168*	94.9%*	0.002
Compare (2016+2017)	143	131	91.6%	

p -value<0.05, *indicates a statistically significant difference between the observation group and the control group

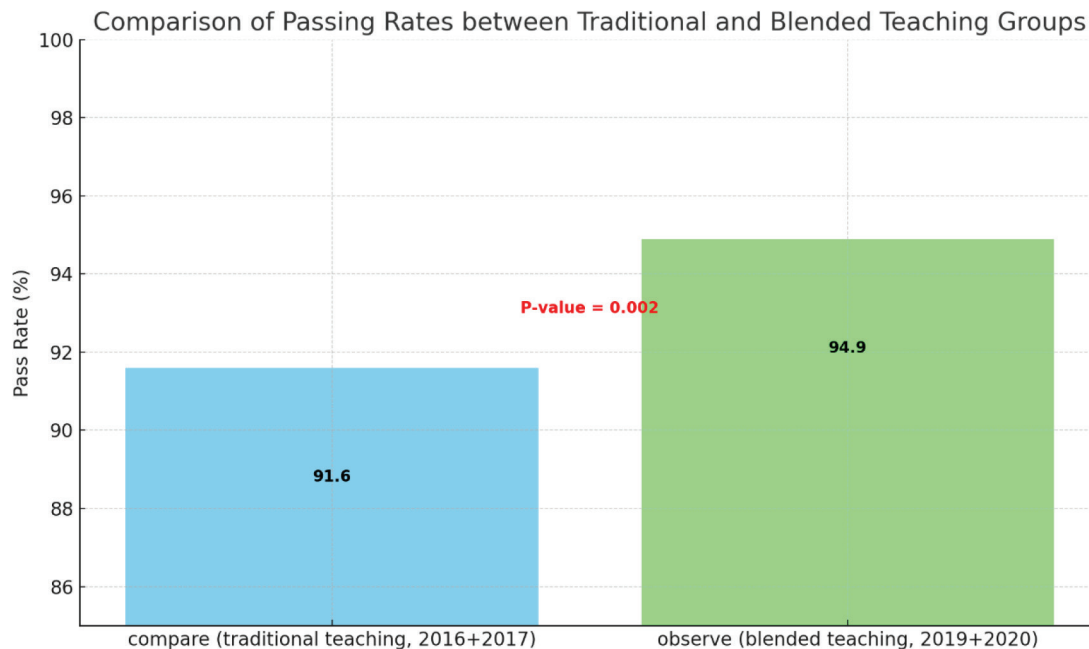


Figure 2 Comparison of passing rates between traditional and blended teaching groups

Enhanced Academic Performance with WeChat Study-aided Blended Teaching

The histogram comparing score distributions between the control and observation groups delineates a distinct academic advantage in the latter. The observation group utilized the WeChat Study for a blended online–offline educational approach, which is mirrored in their superior performance. A considerable proportion of this group's students scored above the 80–point mark, a stark contrast to the control group, where only 14 students reached this level. This divergence not only emphasizes the efficacy of the WeChat Study as a pedagogical tool but also highlights the benefits of innovative teaching methodologies in elevating students' academic proficiency. These outcomes are visually and statistically represented in Figure 3, providing clear evidence of the enhanced learning experience offered by the integration of technology with traditional teaching practices

Student Feedback on WeChat Study's Role in Clinical Pharmacokinetics Education

Incorporating the WeChat Study into the clinical pharmacokinetics curriculum, feedback from the 2019 and 2020 cohorts reflects a favorable reception of this hybrid teaching model. Students' evaluations, averaging above 4.8 on a 5–point scale across various pedagogical facets, indicate high satisfaction. Categories, such as theoretical knowledge, practical skills, teaching materials, design, multimedia use, teaching aids, concept explanation, and cutting–edge insights, all received commendable ratings, with particularly high acclaim for multimedia integration and the clear articulation of intricate concepts. The data depicted in Figure 4, while overwhelmingly positive, stems from a homogenous group lacking diversity in age, prior knowledge, and socioeconomic status. Such uniformity could introduce bias, suggesting the need for more diverse and structured feedback mechanisms. Nonetheless, the feedback highlights the course's thoroughness, instructor readiness, and the exhaustive nature of resources provided, alongside the appreciated inclusion of advanced topics and relevant professional applications.

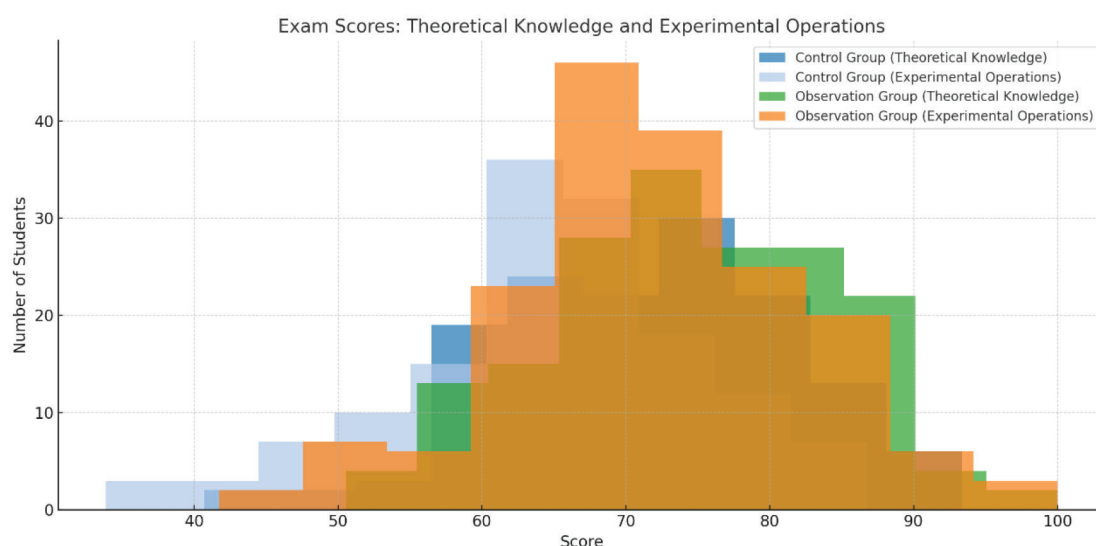


Figure 3 Score distribution of the observation group (2019+2020) and the control group (2016+2017)

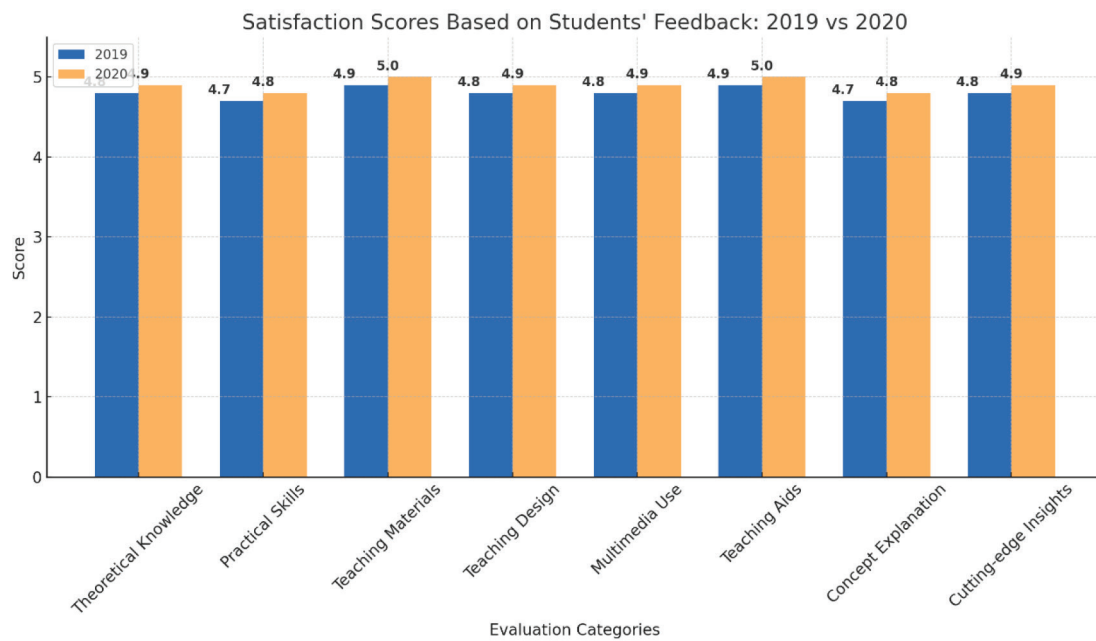


Figure 4 Comparative student satisfaction scores for 2019 and 2020 across evaluation categories

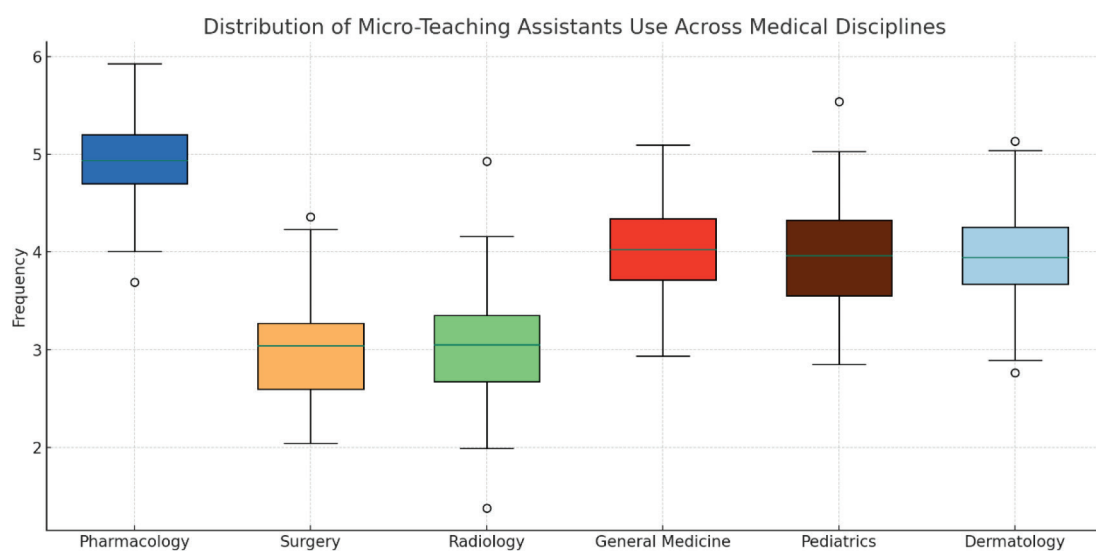


Figure 5 Distribution of micro-teaching assistants' utilization across medical disciplines

Utilization Patterns of Micro-Teaching Assistants in Various Medical Disciplines

The box plot in Figure 5 highlights the disparity in the utilization frequency of micro-teaching assistants across different medical disciplines. Pharmacology emerges as the discipline with the highest median frequency; nearing 5 instances of application. Conversely, Surgery and Radiology present a lower median frequency, both hovering around the 3 times mark. Disciplines like General Medicine, Pediatrics, and Dermatology demonstrate intermediate frequencies, reflecting a variable integration of micro-teaching assistants in medical education. These distributions indicate a pronounced preference for micro-teaching aids in Pharmacology, potentially due to their conceptual and theoretical density.

While short-term academic enhancements are evident within the observation group, encompassing theoretical understanding, skill acquisition, exam success rates, and grade improvements, it is crucial to contextualize these as preliminary findings. The study's scope, centered on immediate academic performance, necessitates further longitudinal research to evaluate the enduring impact of knowledge retention and practical application. A longitudinal approach would yield a more nuanced understanding of the long-term efficacy and challenges inherent in the blended teaching model.

DISCUSSION

Enhancing Student Autonomy via WeChat-Enhanced Micro-Teaching

The transition to WeChat-enhanced Micro-teaching in Clinical Pharmacokinetics education has been pivotal in advancing student autonomy, a critical component in the learning process. According to feedback from the 2019 and 2020 cohorts, this approach has significantly invigorated students' engagement with the subject matter. The proactive access to course materials and interactive discussions facilitated by WeChat has fostered a sense of ownership

and accountability in the learning process. It has shifted the focus from a teacher-led model to a more student-centric paradigm, wherein learners are empowered to explore complex pharmacokinetic concepts actively. Despite the positive outcomes, the feedback indicates potential biases due to a lack of diversity in the demographic sample. Future investigations should strive to include a broader spectrum of students to ensure the generalizability of these findings and to understand the full scope of WeChat-Enhanced Micro-Teaching's impact⁷.

Improving Experimental Engagement and Safety

WeChat-Enhanced Micro-Teaching has played a substantial role in enhancing engagement and ensuring safety in the pharmacokinetics laboratory. The platform's instructional videos and real-time monitoring capabilities have raised the standard for conducting experiments, crucial in a discipline where precision is paramount. These resources have not only increased safety awareness but have also streamlined the standardization of experimental procedures⁸. The consistent use of the GPS-enabled sign-in system further underscores the commitment to maintaining a disciplined and rigorous experimental environment. While these advancements mark a significant improvement, it is important to recognize that the study's primary focus on one platform may overlook other tools' potential benefits. Hence, a comparative analysis combining alternative teaching aids could provide a broader perspective on the most effective strategies for laboratory teaching⁹.

WeChat-Enhanced Micro-Teaching's Impact on Learning Outcomes

The comparative analysis of assessment results pre- and post-implementation of WeChat-Enhanced Micro-Teaching indicates a notable improvement in the academic performance of Clinical Pharmacokinetics students. This teaching method has not only solidified the theoretical foundations but has also broadened the students'

approach to learning: as evidenced by the improved assessment scores. The innovative use of WeChat as a micro-teaching tool has introduced a dynamic and flexible learning environment, which is particularly beneficial for the intricate and fast-evolving field of pharmacokinetics. However, the implications for long-term knowledge retention and application remain to be seen, suggesting the need for longitudinal studies to assess the sustained impact of this educational innovation¹⁰.

Broader Educational Implications and Future Directions

This study's insights into WeChat-Enhanced Micro-Teaching within Clinical Pharmacokinetics offer a promising perspective on integrating technology in medical education. The observed benefits, in terms of student feedback and academic performance, underscore the potential of this method to enhance learning. However, caution must be exercised when considering the application of these findings to other disciplines or educational contexts. The specificity of the study's setting and the short-term nature of the assessed outcomes necessitate a cautious approach to generalization. Further research is needed to explore the long-term benefits of WeChat-Enhanced Micro-Teaching as well as to compare its effectiveness against other technological tools in education. Such work will contribute to a more comprehensive understanding of the role that innovative teaching methods play in cultivating the next generation of medical professionals¹¹.

CONCLUSION

In evaluating clinical pharmacokinetics instruction, this comparative study delineates WeChat-enhanced Micro-teaching as a potent enhancer of pharmaceutical education over traditional methods. This hybrid model provides a diverse and rich learning milieu, pivotal for nurturing research expertise and practical prowess in pharmacology. However, the study's design, with its limited demographic breadth, signals the necessity

for an inclusive, objective evaluation framework that encompasses a wider range of learner backgrounds. The singular focus on WeChat-enhanced Micro-teaching, while insightful, potentially eclipses the benefits derivable from a spectrum of educational technologies. Prospective research should therefore extend to multiple platforms to assess their collective impact on the sustained assimilation and application of knowledge. Although, current results endorse the efficacy of the WeChat-enhanced approach within Clinical Pharmacokinetics, extrapolation to other academic domains awaits empirical corroboration. This investigation, nevertheless, charts a progressive trajectory in pharmaceutical education's methodological innovation.

Author contributions

The study's conception and design were the brainchild of Yang Jian, who also oversaw the entirety of the research process. Zhang Xiaofang was pivotal in curating the data, carrying out detailed analyses, and playing a significant role in the manuscript's primary composition. Li Ji offered essential resources, adeptly administered the experimental procedures, and provided critical revisions to the manuscript drafts. Zhou Jianyu was instrumental in the meticulous review and editing of the manuscript and adeptly handled the administrative aspects of the project. All authors have meticulously reviewed and consented to the final manuscript as submitted.

Ethical approval

This research adhered strictly to the ethical standards of the Declaration of Helsinki, safeguarding the dignity and rights of all participants. Ethical approval for the study was conferred by the Institutional Review Board of Kunming Medical University, evidenced by approval number 202300079, which reaffirms our adherence to ethical research principles. Prior to their enrollment, informed consent was duly obtained from every participant, ensuring transparency and participant autonomy throughout the study.

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CONFLICT OF INTEREST

The authors declare that they have no competing interests, financial or otherwise, related to this current work.

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