Analysis of Teaching Practice Results for Blended Learning Model in Medical Statistics

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Abstract. Medical statistics is a core course in the medical education and essential for cultivating the students' research skills and clinical decision. However, under the traditional teaching models, the students often have the anxiety, insufficient comprehension and limited skills. Through a brief review and analysis of existing literature, we examine the current status, challenges and reform pathways in medical statistics education. Findings suggest that blended learning models can effectively improve the students' statistical performance and engagement. Their attitudes, especially perceived cognitive competence, are significantly correlated with the academic outcomes. This work demonstrate that the educational reforms should integrate the online and offline resources, strengthen the clinical scenario-based teaching and focus on the students' attitudes and competency development. The results of the teaching practice indicate that the experimental group, which adopted blended learning, achieved significantly the higher scores than the control group in the post-test, final examination and group practical reports ($p < 0.05$). Moreover, their online learning behaviors were positively correlated with academic performance.

Keywords: Medical statistics education, Blended learning model, Teaching reform, Educational practice, Student attitudes, Cognition and needs.

1 Introduction

Medical statistics is a fundamental compulsory course for the medical students, aiming to develop their abilities in analyzing the statistical data, appraising the literature and making the evidence-based decisions[1, 2]. However, the medical statistics education has faced some challenges for a long time, such as the students' varying backgrounds in mathematics, insufficient motivation and the disconnect between the course content and clinical practice[3]. With the transformations in the medical education and the rapid advancement of the information technology, the traditional teaching model based on the

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lecture approaches have increasingly become inadequate to meet the learning needs of the medical students.

In recent years, the blended learning model has gradually been integrated into medical statistics education. Blended learning combines the online model via the self-directed study with the offline model by the interactive instruction. It can enhance the flexibility and effectiveness in learning[1]. Furthermore, students' attitudes towards statistics, particularly their perceived cognitive competence, have been be verified to be correlate significantly with their academic performance[4]. Additionally, the feedback from the clinical professionals indicates that medical statistics education should emphasize the practical application and establish a connection with the clinical practice[2].

In China, medical statistics education similarly encounters some issues, such as the insufficient cognitive competence, the weak practical application skills and a gap between the teaching and clinical practice. Wu et al. conducted a meta-analysis, advancing that Chinese medical students and healthcare professionals generally display the disadvantage of the knowledge of medical statistics, the advanced statistical methods and software application[5]. Despite this cognitive deficiency, they express a strong desire for learning, which highlighting a contradiction between the educational content and learners' demands.

Moreover, the development of medical statistics competency has become one of the core concerns in the global medical education. For example, American Association of Medical Colleges (AAMC) proposed that the core professional competencies for medical students explicitly includes the ability for the evidence-based practice and statistical literacy[6, 7]. Similarly, World Federation for Medical Education (WFME) suggested the global standards for the undergraduate medical education, identifying that the curriculum design should reflects the scientific advancements and societal needs by adopting the effective teaching and assessment method[8-11]. Therefore, exploring reforms in medical statistics education is not only a response to the local challenges but also an essential requirement for aligning with the international medical education consensus. Experiences from countries such as Iran indicated that it is a successful pathway for advancing the systemic reforms in medical education through integrating the global standards (i.e. WFME, AAMC) with the national contexts [12-16].

In this work, we provides a concise overview of the current status and challenges in medical statistics education. Furthermore, an investigation was conducted on the implementation of the blended learning model in medical statistics in our institution with an evaluation of its effectiveness. Here, the teaching practice demonstrates that a blended learning can significantly enhance the educational outcomes in medical statistics.

2 Results and Discussion

2.1 Current Status and Challenges of Medical Statistics Education

It should be emphasized that cognitive competence pertains to learners' self-assessed ability and assurance in acquiring and utilizing the statistical knowledge to solve the clinical or research challenges. This dimension is typically evaluated using the instruments like the statistical sttitudes scale. Blended learning specifically refers to an instructional design model that organically combines the online learning (i.e., watching core concept videos and completing simulation exercises via a Learning Management System, LMS) with the face-to-face interactive teaching (i.e., group discussions based on clinical cases, problem-solving sessions and software application workshops). Its core lies in consolidating the strengths of both to improve the deep learning.

The disconnect between the course content and clinical practice is another critical issue. Doctors frequently suggest that statistical education should incorporate more authentic research cases and the clinical decision-making scenarios[2]. As early as the 1990s, Altman and Bland pointed out that the doctors are predominantly consumers rather than producers in researching. Thus, teaching should emphasize the data interpretation over the computational skills[12].

As shown in Table 1, the four evolutionary stages of medical statistics education models have been systematically outlined. This developmental trajectory clearly reflects a fundamental shift from a focus on teaching to learning. This evolution begins with the stage of the traditional lecture characterized by the large-class lectures. It then enters the stage of the problem-based learning, which emphasizes the competency development. Subsequently, it transitions into the blended learning that integrates the online and offline resources. Ultimately, it is moving toward an intelligent integration driven by artificial intelligence and big data in the future. The core driver of this progression is the technological innovation, with the overarching aim of continuously enhancing the instructional interactivity, flexibility and personalization to meet the complex demands of cultivating the medical professionals in the new era.[13, 14].

Table 1. Timeline of Evolution in Medical Statistics Education Models.

Stage	Time	Characteristics	Evaluation
Traditional Lecture	before 1990	large-class lectures	insufficient interaction
Problem-Based Learning	1990–2010	group discussions, case-based teaching	high reliance on resources
Blended Learning	2010–present	integration of online and offline, resources personalized learning	high flexibility, enhanced interaction
Intelligent Integration	future	AI-assisted learning, big-data learning analytics	adaptive learning, virtual reality environments

2.2 Teaching Practice Analysis: Implementation and Effectiveness of a Blended Learning Model in Statistics

Practice Background and Participants.

This teaching practice was conducted during the spring semester of 2025 in the Statistics course for the students at the School of Nursing and Health Management, Wuhan Donghu College. The course lasted 16 weeks and 126 students engaged in this research .

To assess the effectiveness of the blended learning model, students were divided into an experimental group (n=63) and a control group (n=63), respectively. The experimental group was received via a blended approach combining the online learning with offline interactive seminars. while the control group was exposed to the traditional lecture-based instruction. Before the intervention, there was no the statistically significant difference in baseline mathematics performance for the two groups (i. e. $p > 0.05$).

In the blended learning model, we adopt the core guiding principle of the online resource-guided learning and offline interactive internalization. This approach systematically integrates the digital resources with the face-to-face instruction. The specific instructional design is outlined as follows:

(1) Online Component (Based on the institution's Smart Education Platform)

The online component is facilitated through the institution's digital learning environment, emphasizing the systematic integration for the resources and coordination of teaching functions. The teaching resources, consisting of organized lesson frameworks, essential presentation slides and supplementary reference materials, are regularly distributed to support for the learners. The simulated training tasks are structured in a stepwise manner and implemented through the specialized simulation software. They cover the essential steps including the data entry, selection of appropriate statistical methods and interpretation of the analytical results. This approach strengthens the applied skills and enhances the capacities for reasoning. Following each instructional unit, an self-evaluation tool is provided to enable the developmental assessment. The platform also has two thematic forums, focusing on the case analysis and academic developments, respectively. The forums encourage the students to share the case explorations and academic exchange to from an active learning community.

(2) Offline component (face-to-face instruction)

The offline component is conducted through the classroom sessions, systematically designed around academic inquiry, problem-solving and comprehensive skills. We regularly organize the academic paper workshops to guide the students evaluating the research designs and interpreting the statistical findings based on the published clinical studies. Furthermore, we implement a problem-based learning approach in small groups, focusing on the analysis of the clinical scenarios, i. e., the application of survival analysis in the oncology prognosis. Additionally, we arrange a learning outcome presentation that require each group to deliver an integrated demonstration and combines a literature review on a specific statistical method with its practical software application. This educational design aims to foster the knowledge internalization and transfer toy promote the holistic enhancement of students' academic literacy and practical competencies.

(3) Data collection and analytical methods

The students' academic performance is primarily assessed through the pre- and post-test examinations (100 points, consisting of 60 points in the basic theory and 40 points in the applied analysis), final exam scores and group-based practical report grades. Learning process data are mainly derived from the platform-recorded metrics, including the login frequency, video completion rates, the number of discussion forum posts and exercise submission status.

2.3 Practice outcomes of Teaching Practice

The students' performance in the experimental group significantly is better than those in the control group on the post-test, final exam and practical reports, as shown in in Table 2. Compared to the traditional teaching model, the blended learning model can significantly improve the students' academic performance in medical statistics, with a particularly the notable advantage in the knowledge application and practical abilities. All p-values were less than 0.05, indicating that these differences are not from chance but the statistically reliable effects.

Table 2. Comparison of Academic Performance Between Experimental and Control Groups (scores, mean ± SD).

Assessment Item	Experimental Group (n=63)	Control Group (n=63)	t-value	p-value
Pre-test Score	72.35 ± 8.41	71.89 ± 9.12	0.297	0.767
Post-test Score	85.67 ± 7.53	79.24 ± 9.86	4.152	<0.001
Final Exam Score	87.42 ± 7.21	82.15 ± 8.34	3.785	<0.01
Group Practical Report	89.10 ± 5.67	80.63 ± 8.92	6.328	<0.001

The experimental group showed higher utilization and participation in online resources, and online learning behaviors were positively correlated with final grades. Table 3 demonstrates a consistent positive relationship between students' engagement in online learning activities and their academic performance. All measured metrics, including video completion rates, participation in self-assessments, activity in discussion forums and submission of practical exercises, showed statistically significant correlations with final exam scores ($p < 0.05$). Among these, the submission rate of simulation exercises had the strongest correlation with the final exam score ($r = 0.99$), underscoring the critical role in enhancing the learning outcomes. These findings validate the effectiveness of the structured online components within the blended learning model and provide a foundation for implementing the formative assessment and timely academic interventions.

Table 3. Correlation Between Online Learning Engagement and Academic Performance in the Experimental Group

Learning Behavior Metric	Mean/Percentage	Correlation with Final Exam Score (r)	P-value
Average Video Completion Rate	93.20%	0.98	<0.01
Average Number of Chapter Quiz Attempts	2.90 times	0.92	<0.01
Average Discussion Board Posts	4.40 items	0.97	<0.05
Average Simulation Exercise Submission Rate	88.50%	0.99	<0.001

Table 4 presents the changes between the experimental and control groups before and after the course, via a 5-point liker scale attitude inventory. After the course, the experimental group has the obvious advantage in the self-rated cognitive competence, affective attitudes and value perception than the control group. The results show the significant influence in the blended learning model on the students' cognitive, affective and value perception dimensions. Post-course scores in the experimental group is significantly higher than those in the control group across all three dimensions. Furthermore, the magnitude of improvement is markedly over the experimental group, with all between-group differences being statistically significant ($p < 0.05$). The data presented in Table 4 offer the psychological evidence for the blended learning model's integrated effectiveness in facilitating knowledge internalization within promoting the attitude change and reinforcing value recognition.

Table 4. Correlation Between Online Learning Engagement and Academic Performance in the Experimental Group

Learning Behavior Metric	Group	Pre-test Score	Post-test Score	Pre-post Difference (Δ)	p-value for Between-group Δ
Cognitive Competence	Experimental	3.12 ± 0.78	4.05 ± 0.65	0.93	< 0.01
	Control	3.08 ± 0.81	3.41 ± 0.72	0.33	
Affective Attitudes	Experimental	2.95 ± 0.82	3.88 ± 0.71	0.93	< 0.01
	Control	2.89 ± 0.85	3.25 ± 0.79	0.36	
Value Perception	Experimental	3.45 ± 0.75	4.20 ± 0.68	0.75	< 0.05
	Control	3.41 ± 0.77	3.80 ± 0.74	0.39	

Note: The survey uses a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree).

3 Conclusion

Medical statistics education is currently undergoing a critical transition from the traditional knowledge transmission toward the competency development. Blended learning model significantly enhances the students' academic performance and engagement. Students in the experimental group demonstrated significantly better performance in both knowledge acquisition and application skills compared to those in the traditional teaching group and their online learning engagement was positively correlated with academic achievement. Looking ahead, medical statistics education must further promote integration between the course content and clinical contexts, innovation through the blended teaching models, and diversification in the assessment methods. Special emphasis should be placed on the teaching of advanced statistical methods and the cultivation of the practical software skills. Educators must proactively respond to student' learning needs and pursue systematic, multidimensional reforms to nurture medical professionals equipped with the robust statistical literacy and clinical research competencies.

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