


# Impact of Holism Based Blended Learning Model on Medical Immunology Among Traditional Chinese Medicine Students: A Comparative Survey Study

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**Objective:** Due the concept of medical immunology is abstract and difficult to align with the “holism and balance of Yin and Yang” in traditional Chinese medicine (TCM), students feel intimidated and have weak identification with it. This study has constructed a “holism-based blended teaching model” and verified its promoting effect on knowledge, grades, and professional identification.

**Methods:** A cross-sectional study design was adopted. A blended teaching method based on the Zhihuishu platform was used to survey 201 students majoring in TCM. The data were collected through the Wenjuanxing scale and analyzed using descriptive statistical methods. Additionally, an independent *t*-test was used to compare the academic performance of the blended learning group (Grades 2019–2022) and the traditional learning group (Grades 2018).

**Results:** More than 85% of the students were able to integrate knowledge such as T cell dual signals and complement modulation within the framework of balance between Yin and Yang. In the experimental group, 16.29% scored above 90 points, 41.63% scored between 80 and 89 points, which were significantly better than those of the control group (3.57% and 20.41%). Moreover, 92.04% approved of the model, and 76.61% believed it enhanced professional qualities. 76.6% deepened their understanding of the overall perspective, and 82.4% were willing to adopt a combination of traditional and modern medicine thinking.

**Conclusion:** The research results indicate that this blended teaching method helps students better integrate the holism of TCM to understand immunology knowledge. Moreover, the students' self-study abilities and academic performance have also significantly improved. These findings enable the basic knowledge of immunology to better serve the training of professionals in TCM.

**Keywords:** traditional Chinese medicine, medical immunology, blended learning, holism

## Introduction

The rapid development of medical immunology is closely associated with the protection of human health, national health governance, and the inheritance and innovation of Traditional Chinese Medicine (TCM).<sup>1,2</sup> However, many students and medical practitioners, including those specializing in TCM, commonly perceive immunology as a challenging subject to master.<sup>3,4</sup> First, medical immunology features comprehensive content and a highly systematic structure, involving numerous abstract concepts and complex mechanisms that students often find difficult to grasp and internalize.<sup>5,6</sup> Second, the traditional teaching method, which predominantly relies on instructor-centered lectures, fails to effectively engage students or stimulate their enthusiasm for learning.<sup>7,8</sup> Consequently, students tend to passively absorb knowledge in classroom settings, with limited opportunities for active participation and critical thinking, ultimately resulting in suboptimal learning outcomes. Evidence suggests the superior efficacy of concise online lectures over traditional coursework in enhancing student self-study capabilities.<sup>9,10</sup> The blended learning approach that combines online and

offline methods, which amalgamates digital and face-to-face instruction, therefore constitutes an innovative response to the challenges posed by traditional teaching methodologies.

Medical immunology serves as a core discipline for students majoring in TCM. This field explains the development, structure, and functions of the human immune system, as well as the cellular and molecular mechanisms involved in immune responses.<sup>7,11</sup> It highlights the dynamic interactions, including mutual promotion and regulation, among various components of the immune system during their functional processes, thereby maintaining immune homeostasis within the body. TCM is grounded in the concept of “holism”, which emphasizes that the human body functions as a unified whole, with all internal organs, meridians, qi, blood, Yin, and Yang interconnected and working in concert to maintain physiological balance.<sup>12</sup> Among them, qi is an intrinsic energy within the human body and is of vital importance to health. The Yin-Yang philosophy, an ancient Chinese form of dialectical thinking, represents a state in which contradiction and harmony coexist. It reflects the intricate balance between immune response and immune tolerance in immunology.<sup>13</sup> As a result, TCM and modern immunology share significant similarities in their foundational theories and conceptual frameworks.

Although the integration of TCM and Western medicine has been explored in various educational contexts,<sup>1,2</sup> systematic attempts to specifically merge TCM’s holistic principles with immunology teaching using a blended learning approach remain limited. Most existing studies focus on theoretical discussions or isolated case studies, lacking a structured, replicable framework. Our research integrates the holistic perspective of traditional Chinese medicine with medical immunology, enabling students to understand and master the concepts of medical immunology from a Chinese medicine perspective, thereby enhancing their learning outcomes and comprehensive abilities, and providing a novel teaching framework for the cultivation of talents in the field of traditional Chinese medicine.

## Materials and Methods

### Objectives

Students from the 2019–2022 cohorts specializing in TCM were selected as the experimental group, in which a blended teaching model of medical immunology was implemented, emphasizing a holistic conceptual framework. Each class received the intervention measure over a half-year period (approximately 8 weeks). Students from the 2018 cohort in the same program (non-blended teaching) were selected as the control group. The inclusion criteria for this study were students in the second year studying traditional Chinese medicine. Exclusion criteria included students who had previously taken medical immunology courses or had incomplete data records. Baseline consistency was evaluated by comparing the demographic data (age, gender) and previous academic performance (GPA) of the experimental group and the control group. No significant differences were found at the baseline.

### Student Profiling

The medical immunology course was delivered during the fourth semester. Students enrolled in five-year TCM programs had previously completed foundational Western medical science courses, including human anatomy, histology and embryology, and pathology. Additionally, they had undertaken core TCM subjects such as basic theories of TCM, diagnostics in TCM, pharmacology of Chinese medicine, formula science, and *Synopsis of the Golden Chamber (Jin Kui Yao Lue)*. They had acquired essential TCM knowledge, including the unity of heaven and humanity and the theory of five elements. In terms of learning competencies, students had prior experience with online learning environments, thereby fulfilling the prerequisites for participation in the blended teaching reform.

### Development of the Online Course on the Zhihuishu Platform

An online medical immunology course was designed and deployed on the Zhihuishu platform (<https://coursehome.zhihuishu.com/courseHome/2062117>). The course content consisted of the following components:

- (1) video Lectures and PPT Courseware: During the recording process, key and complex topics were modularized according to the teaching syllabus. Considering attention span dynamics, 91 short instructional videos, each

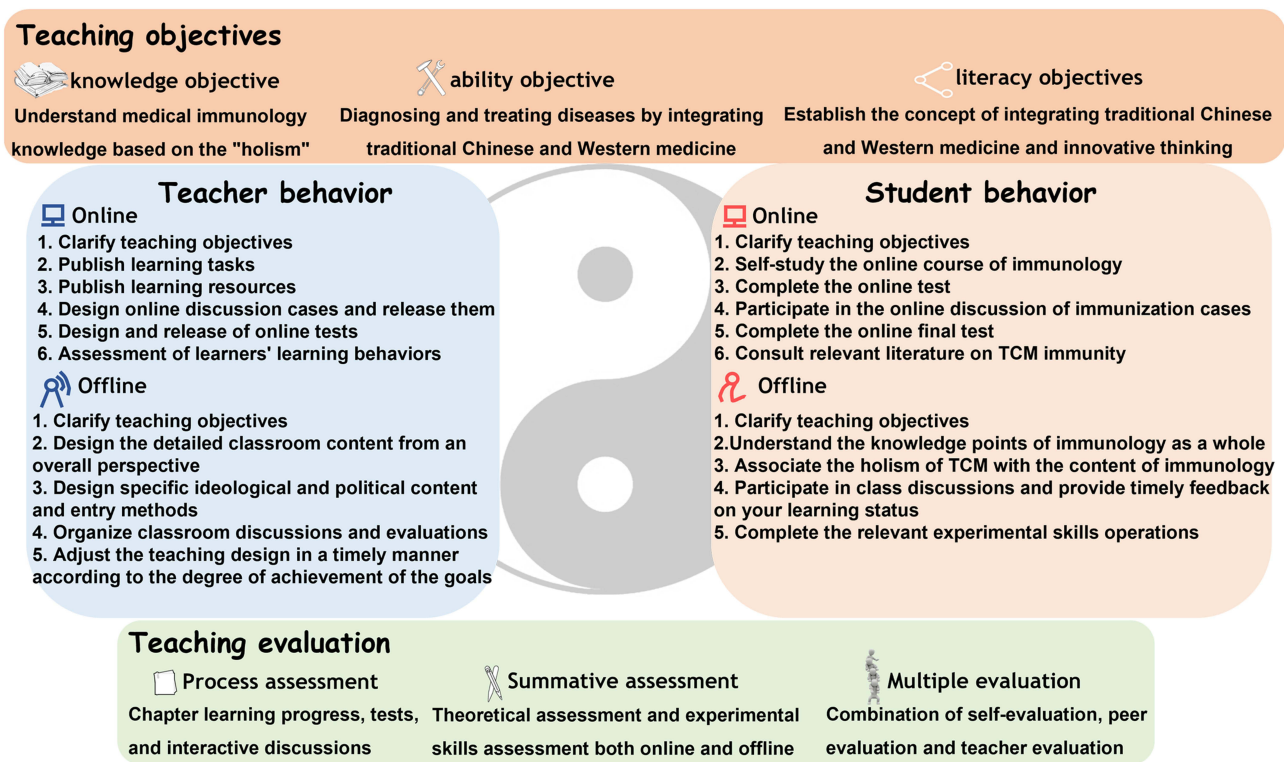
lasting between 5–15 minutes, were produced. The content was structured to progress from foundational to advanced concepts. For instance, the module commenced with “What Do You Know About Immunity?” to introduce the historical development of immunology, immune system functions, immune organs and tissues, immune cells, and immune molecules, culminating in an exploration of the interactions among immune cells and molecules in antigen elimination and immune homeostasis maintenance. The functional characteristics of immune system components and their coordinated and regulatory roles during immune responses were emphasized, reinforcing the holistic perspective of the immune system. This approach facilitated students’ understanding of internal conceptual connections from a TCM holistic viewpoint, particularly regarding antigen recognition, response mechanisms, timely response termination, and immune homeostasis.

- (2) Chapter Tests: Each chapter included 5–10 post-lecture assessment questions aligned with the syllabus to reinforce learning.
- (3) Online Discussion Forum: Instructors provided comprehensive and thought-provoking questions based on the course content, such as “What immune cells are you familiar with, and what are their functions?” and “Which immune cells and molecules are involved in the primary immune response to bacterial infection?” This approach encouraged students to develop critical thinking and analytical skills.
- (4) Final Examination: Upon course completion, a final examination paper was administered, based on the syllabus and key or challenging topics from each chapter. All assessment components contributed to the final grade according to a pre-established weighting system.

## Blended Teaching Design

The blended teaching approach integrated both instructional and learning strategies, aiming to achieve educational objectives through meaningful teacher-student interaction. Specifically:

- (1) Instructors systematically organized and categorized the course content based on topic difficulty and Bloom’s taxonomy of educational objectives, classifying learning outcomes into three domains: knowledge recall, comprehension, and comprehensive application. Foundational immunological concepts requiring memorization were assigned for self-directed online study, while complex or challenging topics, such as immunological mechanisms that students typically struggle to grasp independently, were addressed in depth during face-to-face classroom sessions. Instructors guided students progressively from basic to advanced concepts, gradually expanding their understanding of immunology while emphasizing the interconnectedness and systemic nature of the discipline. For example, the relationships among antigens, antigen-presenting cells, MHC molecules, T-cell activation, and differentiation were explicitly highlighted.
- (2) The design incorporated TCM-specific perspectives. For instance, when discussing immune system functions, students were guided to explore the relationship between the “immune defense” function of the body and the TCM concept of *zheng qi* (vital energy). Similarly, when addressing T-cell activation, the modulatory roles of co-stimulatory and co-inhibitory signals were linked to the TCM principle of Yin-Yang balance. This integration facilitated a deeper understanding of the interconnected and systemic nature of immunological phenomena from a TCM-oriented perspective.
- (3) Teaching strategies were dynamically adjusted based on the achievement of learning objectives and student engagement levels.
- (4) Students were required to complete online learning modules and assessments, actively participate in both online and offline discussions, articulate their understanding of immunological concepts from a professional standpoint, and demonstrate comprehension through diagrammatic representation or other illustrative methods.
- (5) Throughout the instructional process, ideological and political elements relevant to both immunology and TCM were integrated through case-based learning, thematic embedding, and implicit pedagogical strategies. Particular emphasis was placed on cultivating students’ independent thinking and innovation capabilities, guiding them to appreciate the significance of immunology’s development in the context of TCM inheritance and modernization (Figure 1).



**Figure 1** Hybrid teaching design framework. The framework integrates Traditional Chinese Medicine (TCM) holism with Medical Immunology through a blended online-offline teaching model. Online, instructors guide learning and evaluate progress, while students' study independently and engage in case discussions. Offline, teaching is case-focused, promoting holistic understanding and integration of TCM with immunology. Evaluation combines process and summative assessments with multi-source feedback.

- (6) Development of a Dynamic Multi-Element Assessment Framework. In contrast to conventional teaching approaches that rely exclusively on final examination scores to determine student grades, blended instruction employs a dynamic and multifaceted evaluation system. Continuous assessment scores consist of both offline and online components. Online performance constitutes 24% of the overall grade and encompasses metrics such as video completion progress, chapter test results, final exam outcomes, and engagement in interactive discussions. Related data can be exported and systematically compiled from the learning platform. Offline assessment accounts for 76% of the total grade and includes in-class participation and the final examination score. In-class performance reflects students' comprehension of the roles played by various cells and molecules in the immune system's response to antigens, assessed through activities such as question-and-answer sessions and thematic discussions. This approach facilitates students' understanding of interconnections between chapter topics, ultimately integrating previously isolated immunology concepts into a unified framework.
- (7) Evaluation of Teaching Model Satisfaction. A satisfaction survey was administered to 201 students enrolled in the 2022 TCM program using the Wenjuanxing platform. The survey instrument assessed various dimensions of satisfaction with the blended teaching approach, including its influence on self-regulation, time management, collaborative skills, and academic motivation. Their responses were recorded and analyzed anonymously in Wenjuanxing platform.

## Statistical Analyses

All statistical analyses were performed using GraphPad Prism 9.0. The collected survey data were analyzed by means of descriptive percentage calculations to summarize participant responses for each survey item. The chi-square test was employed to compare the statistical significance of academic performance between traditional and blended teaching methods, with a *P*-value less than 0.05 indicating a significant difference.

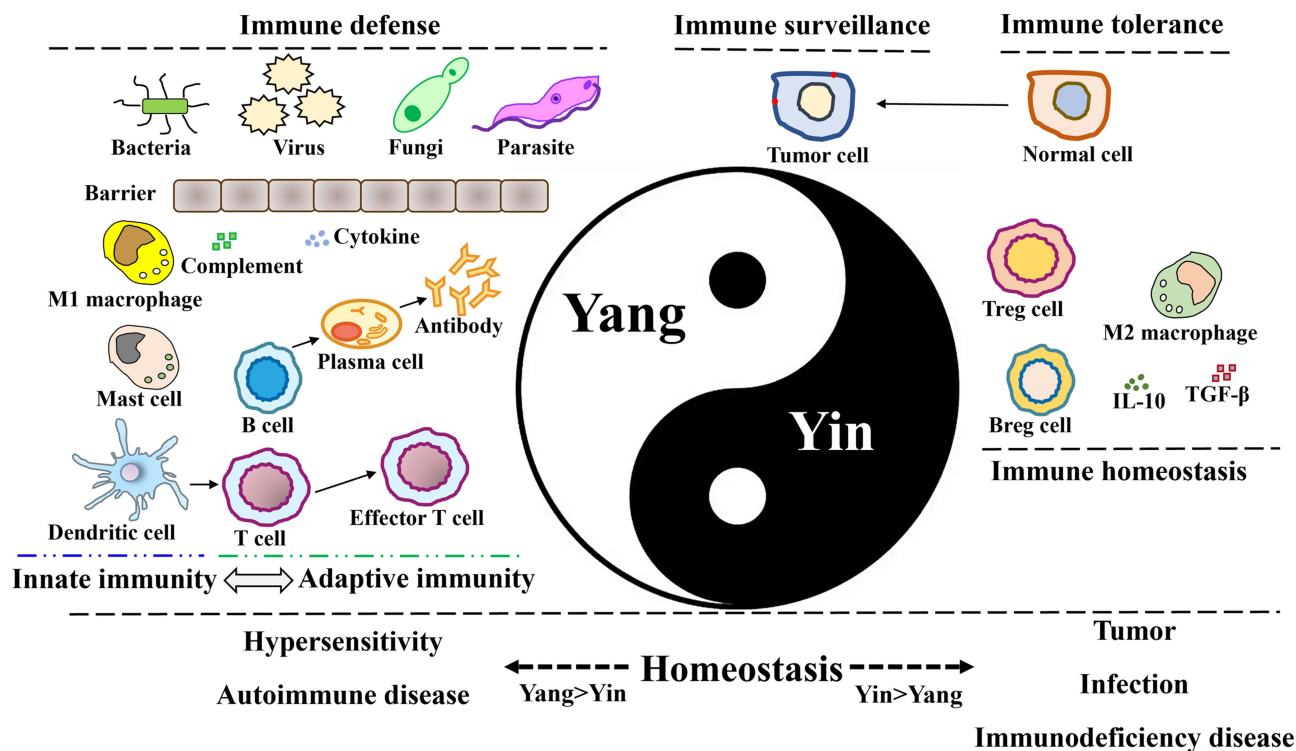
## Results

### Students' Capacity to Comprehend the Knowledge Framework

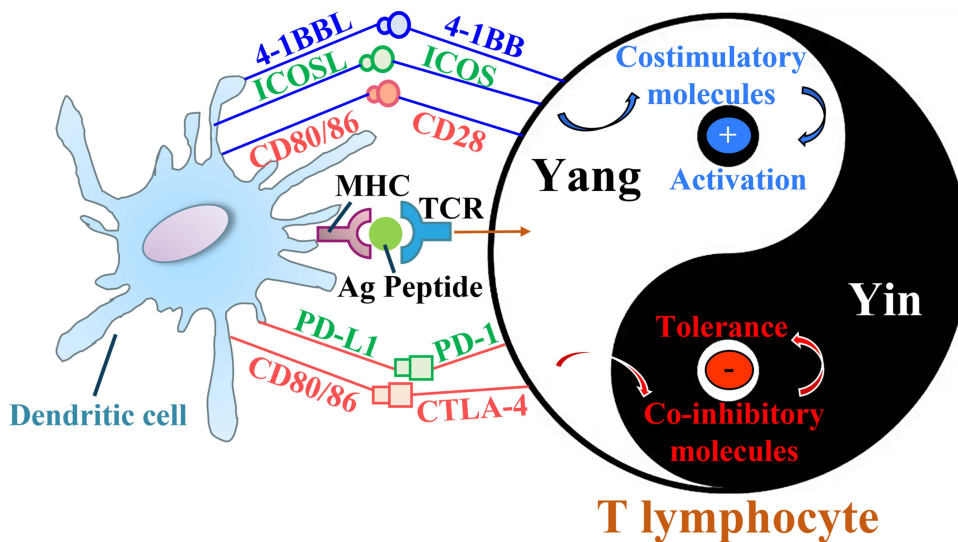
Students exhibited a systematic understanding of the subject matter through their presentations on both online and offline discussion topics, as well as through illustrative drawings that reflected their comprehension of key concepts. This demonstrates that students are capable of thoroughly grasping the role of the immune system's three primary functions in maintaining normal physiological processes, viewed through the holistic framework of TCM—specifically the unity of heaven and humanity and the balance of Yin and Yang (Figure 2). Additionally, they displayed an understanding of how T cell activation is modulated by the interplay between co-stimulatory and co-inhibitory signals, interpreted from the holistic perspective of Yin-Yang equilibrium (Figure 3). Moreover, students effectively synthesized and integrated knowledge from various chapters into a unified whole (Figures 4 and 5), thereby showcasing a comprehensive and professionally grounded understanding of core immunological principles.

### Significant Enhancement in Student Academic Achievement

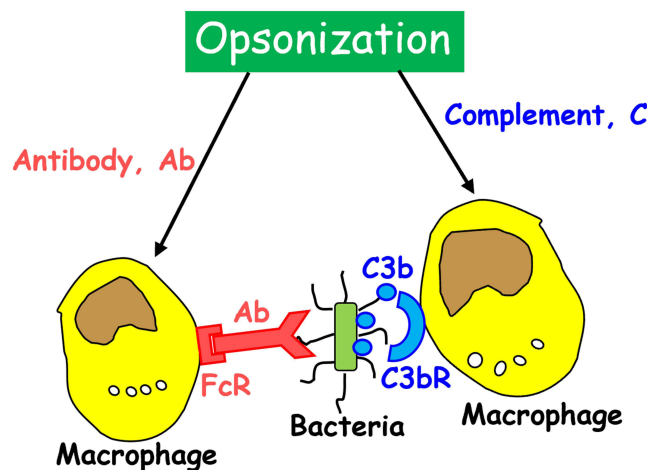
The academic outcomes of students who engaged in the innovative teaching model demonstrated a statistically significant improvement compared to those who did not participate. Data analysis revealed that, across the 2019–2022 cohorts, there was a marked increase in the number of students achieving scores above 90, as well as those obtaining scores within the 80–90 range (Figure 6A). The rate of academic excellence (scores above 90) exhibited statistically significant differences when compared to the 2018 cohort ( $\chi^2=21.61$ ,  $P<0.001$ ), which did not undergo blended instruction (Figure 6B). These findings suggest that the implementation of blended teaching methodologies has a positive and measurable impact on student performance.



**Figure 2** Students' overall understanding of the composition and function of the immune system based on the theory of Yin-Yang balance. This diagram illustrates the correspondence between Medical Immunology and TCM's Yin-Yang theory, linking immune components and functions to the balance of Yin and Yang. It further associates Yin-Yang imbalance with various diseases, visually integrating TCM's holistic view with immunology.



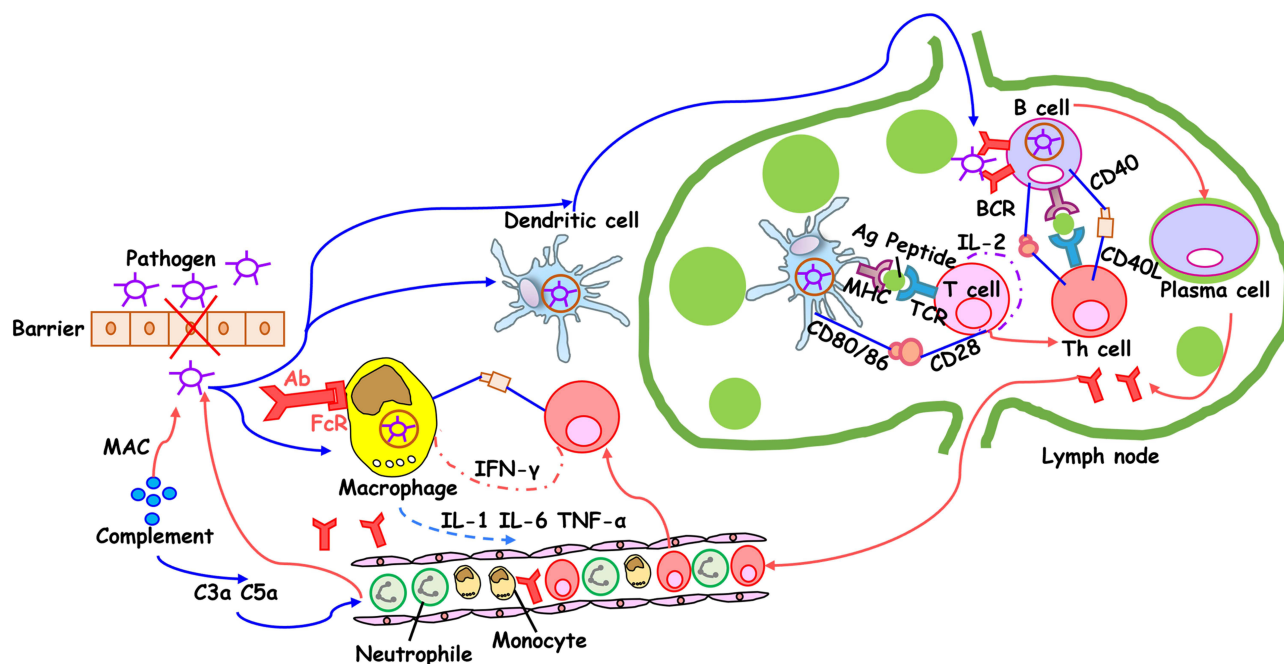
**Figure 3** Students' understanding of "dual signals of T cell activation" based on Yin-Yang balance theory. This diagram illustrates the regulation of T cell activation and tolerance by costimulatory (Yang) and co-inhibitory (Yin) molecules, depicting an immune equilibrium analogous to Yin-Yang balance within the TCM theoretical framework.



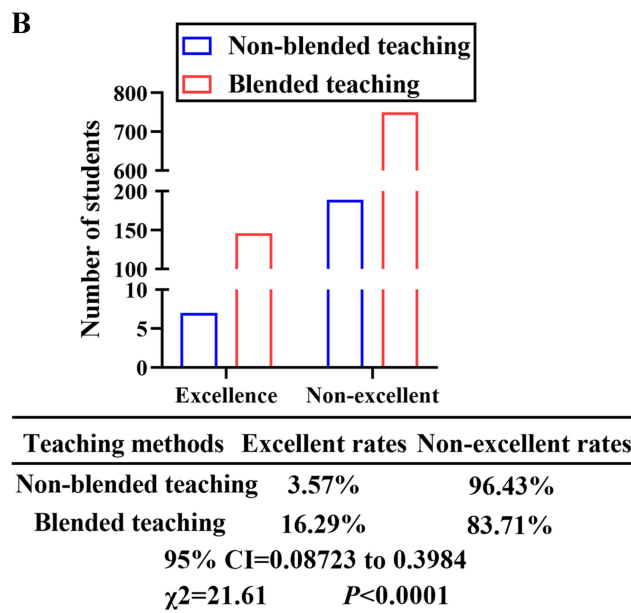
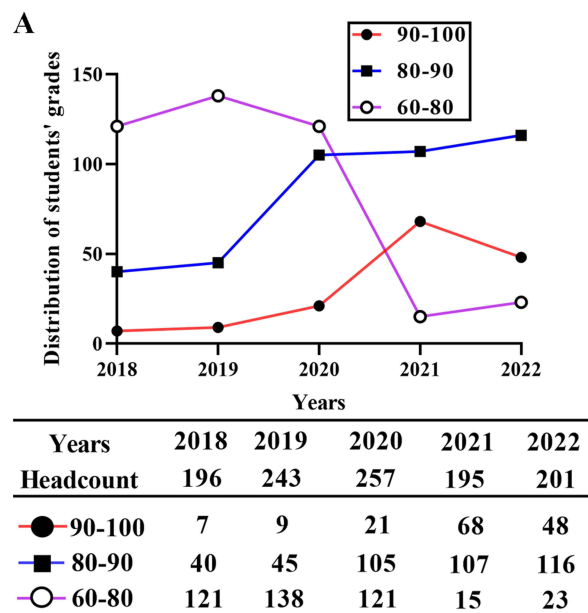
**Figure 4** Students' induction of "Opsonization" in different chapters. Whether it is antibody or complement, they can promote the phagocytosis of pathogenic bacteria by macrophages through the opsonization process.

### Student Satisfaction Survey

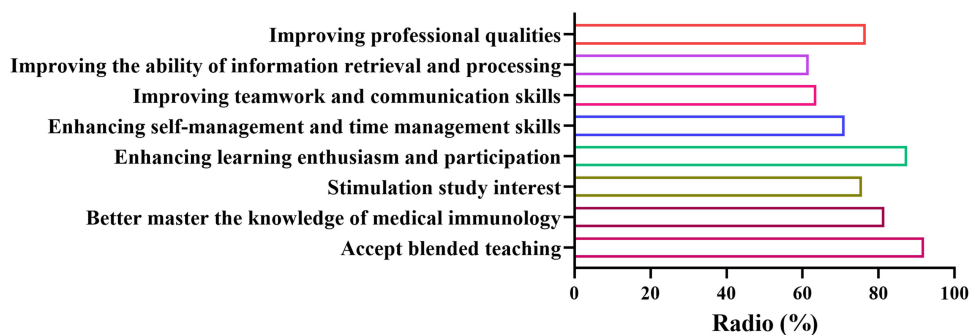
A total of 201 questionnaires were distributed to assess student satisfaction, with all 201 successfully retrieved, resulting in a 100% response rate. The findings indicated that 92.04% of students accepted the blended teaching approach; 75.62% reported that it enhanced their interest in learning; 81.59% perceived an improvement in their ability to grasp knowledge effectively; 87.56% believed it increased their learning enthusiasm and participation; 71.14% indicated that it strengthened their self-management and time management skills; 63.68% felt it improved their teamwork and communication abilities; 61.69% reported enhanced skills in information searching and processing; and 76.61% considered it significantly enhanced their professional competence (Figure 7). These results further confirm that students have provided positive feedback regarding the implementation of this comprehensive blended immunology teaching model.



**Figure 5** Students' overall understanding of the processes involved in the immune response triggered by pathogens. Upon breaching the body's barriers, pathogens are recognized by macrophages and dendritic cells, triggering cytokine release and complement activation to recruit innate immune cells. Dendritic cells then migrate to lymph nodes, where they present antigens to naive T cells, activating T helper (Th) cells. These activated Th cells facilitate the differentiation of B cells into antibody-producing plasma cells, establishing humoral immunity. This process demonstrates the coordinated effort between innate and adaptive immune components to effectively combat pathogenic invasion.



**Figure 6** Examination scores distribution and comparison of excellent performance rate of traditional Chinese medicine students. (A). Examination scores distribution of traditional Chinese medicine students in the experimental (2019–2022) and control (2018) groups. (B). Comparison of excellent performance rate (scores  $\geq 90$ ) between the groups of traditional Chinese medicine students. The chi-square test indicates a statistically significant difference ( $\chi^2=21.61$ ,  $P<0.001$ ), suggesting that the blended learning model was associated with higher academic achievement.



**Figure 7** Satisfaction survey of traditional Chinese medicine student with blended teaching model.

## Discussion

TCM has entered a favorable stage of development, marked by opportune timing, conducive environmental conditions, and collaborative human effort. Talent continues to serve as the foundational pillar of this developmental path.<sup>14,15</sup> Therefore, it is critically important to strengthen students' professional commitment and bolster their confidence in the discipline while they study fundamental Western medical courses within the existing educational framework. This approach is essential for nurturing high-caliber TCM practitioners. Medical immunology refers to the biological mechanisms by which the immune system effectively identifies, promptly responds to, and timely terminates specific antigens. This process encompasses complex interactions between innate and adaptive immunity, as well as the coordinated yet regulated functions of immune cells and molecules. Furthermore, the immune system operates in conjunction with other physiological systems, such as the nervous and endocrine systems, to maintain systemic homeostasis.<sup>16</sup> Consequently, the central concept of immunology—holistic harmony and stability—is inherently consistent with the core principles of TCM.

Over the past four years, the implementation of a blended teaching model for Medical Immunology within TCM programs, based on a holistic perspective, has yielded promising results. Students' understanding has progressed from basic recognition of knowledge points to increasingly logical and inductive reasoning, culminating in comprehensive, discipline-oriented critical thinking. Notably, by the end of the course, students were able to interpret key immunological concepts—such as the initiation and timely termination of immune responses and the maintenance of immune tolerance—through the TCM framework of Yin-Yang equilibrium. Data from questionnaires and comparative pedagogical effectiveness analyses indicate that this teaching model is both feasible and effective in immunology education. It promotes students' self-regulated learning and independent study abilities while enhancing their engagement with immunological content. The integration of immunology with TCM-specific knowledge has also reduced the perceived complexity of the subject.

This blended teaching approach involves pre-class online preparation, during which students engage with digital resources prior to attending face-to-face sessions.<sup>8,17,18</sup> In these sessions, instructors contextualize immunological concepts within TCM principles, guiding students to understand immunology through a holistic framework. Post-class reinforcement is achieved through the review of online video lectures. Throughout its historical evolution, TCM has developed a distinct theoretical system, with the holistic concept as one of its defining features. This concept emphasizes the regulation of qi and blood via meridians, guided by the philosophical principles of the unity of heaven and humanity and the Five Elements theory, to maintain internal equilibrium and systemic coherence. Incorporating this holistic philosophy into immunology instruction enhances students' understanding of the interconnections between immunological theories and TCM's "holism" and "balanced regulation". This integration not only deepens conceptual comprehension but also reinforces professional identity. Additionally, embedding TCM-related ideological and political elements into various chapters enhances students' sense of professional belonging. The inclusion of online learning duration and assessment scores in the final evaluation further motivates academic engagement. While our study focuses on integrating TCM principles with immunology, similar blended learning approaches in other medical education contexts have shown

comparable benefits in student engagement and performance.<sup>8,17</sup> These studies highlight the broader applicability of blended learning models in enhancing educational outcomes.

Survey results indicated that over 90% of students expressed favorable opinions regarding the blended teaching approach, highlighting multiple benefits. Students have successfully adopted a holistic approach to synthesize fragmented knowledge. In contrast to traditional teaching methods, where topics such as antigens, antibodies, complements, cytokines, major histocompatibility complexes, and immune cells were taught in isolation, many students previously struggled to integrate these elements when discussing immune responses, resulting in confusion and diminished learning outcomes. Within the holistic blended teaching model, educators use immune responses as a central theme, posing relevant questions in both online and offline settings to comprehensively explain how the immune system identifies antigens, responds promptly, and terminates reactions in a timely manner. Each chapter's content is systematically contextualized within this overarching framework, enabling students to develop a coherent understanding of immunology. Some students have already applied this integrative learning approach to other disciplines, demonstrating that the model equips learners with transferable skills for future academic pursuits.

According to survey findings, 71.14% of students reported that the blended teaching model positively influenced their self-management abilities. In this instructional approach, online modules require students to complete assigned video lectures and chapter assessments within specified timeframes, with performance scores reflecting their learning progress. This structure necessitates effective time management and cultivates self-discipline, moving away from traditional rote memorization and last-minute cramming. Moreover, the model enhances independent learning capabilities, as students must engage in self-directed study, synthesizing and analyzing information to link prior knowledge with new content. Some students incorporated TCM elements into their mind maps to deepen comprehension, while others extended their learning by consulting additional literature, thereby transitioning from passive recipients to active, self-directed learners and enhancing intrinsic motivation.

Examination analyses revealed that students exposed to the new teaching model demonstrated significant improvements in both pass rates and excellence rates. While teaching and learning should inherently be interdependent, traditional methods often created a disconnect between the two. The holistic blended teaching model effectively addresses this limitation. Given that the instructional design centers on the holistic perspective, linking TCM's concept of Yin-Yang balance with the functional integration of the immune system, educators with foundational TCM knowledge must strategically structure online and offline teaching content, discussion topics, and assignments based on the interrelationships among immunological concepts. Prior to student-led summarization, instructors present key knowledge points using mind maps. Once students grasp the material, they actively explore and internalize new knowledge, integrating it through a professional, holistic lens. Furthermore, constructive feedback from students on teaching content and methods has contributed to continuous pedagogical improvement, fostering mutual growth in both teaching and learning and ultimately enhancing overall educational effectiveness.

## Limitations and Recommendation

To our knowledge, the integration of cultural and disciplinary philosophies into biomedical teaching, as demonstrated in our study, can enhance student understanding and engagement, suggesting potential applications in other educational contexts. The study design is quasi-experimental, with historical controls and non-randomized cohorts. This limits our ability to establish causal relationships between the blended learning model and the observed outcomes.

## Conclusions

Within the framework of a single-center, historically-controlled study, the holism-based blended immunology model was favorably received by students and correlated with immediate improvements in test scores and self-reported learner satisfaction. However, whether these benefits lead to sustained competence or enhanced clinical performance remains to be confirmed through multicenter, randomized trials. Subsequent efforts will concentrate on optimizing the integration of immunology content with TCM professional courses, in order to further explore its educational potential.

## Ethics Approval and Consent to Participate

All data are publicly available on the Zhihuishu platform (<https://coursehome.zhihuishu.com/courseHome/2062117>). This study was exempt from the Ethics Committee of Binzhou Medical University (Ethics No. 2022-121). This work was carried out in accordance with the Helsinki Declaration. The consent to participate was obtained through an online questionnaire. As the data were anonymized before analysis, individual informed consent was waived by the same committee. The reasons for exemption were: (1) the project constitutes a secondary analysis of de-identified data originally collected for educational purposes; (2) no personal identifiers were retained, making re-identification impossible; (3) no intervention or additional data collection was performed; (4) the risk to participants was deemed no greater than minimal.

## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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## Disclosure

All authors declare that there is no conflict of interest.

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