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Student Perceptions of Traditional, IT-Based, and Blended Teaching Methods in Pharmaceutical Botany: A Questionnaire-Based Study

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Abstract

This study investigates the current status and reform pathways of teaching in Pharmaceutical Botany, a core discipline for Chinese Materia Medica majors that integrates theoretical knowledge with practical identification. An online questionnaire surveyed 81 undergraduates at a Guizhou medical university, assessing initial interest, prior experience, perceptions of traditional and IT-based formats, and comparative advantages. Results indicate that 71 students (87.65%) expressed initial interest in the course, and 72 students (88.89%) had prior field or cultivation experience. Traditional hands-on sessions, including specimen observation, microscopy, and field internships, received endorsement from over 90% of respondents but faced temporal, spatial, and resource constraints. IT-based methods were valued for flexibility and rich information yet criticized for lacking authentic sensory experiences and causing cognitive overload. Most respondents (61 students, 75.31%) preferred a deep integration of both. Based on these findings, the study proposes a student-centered blended framework synergistically combining virtual and real elements, advocating strengthened offline practice with strategic digital integration to enhance comprehension, practical competence, and autonomous motivation.

Keywords: Pharmaceutical Botany; teaching approach reform; blended teaching; traditional teaching; modern information technology

1. Introduction

Pharmaceutical Botany constitutes a foundational and indispensable course within the Chinese Materia Medica undergraduate curriculum. It encompasses the morphological characterization, anatomical structure, taxonomic classification, and medicinal value of plant

species, thereby bridging fundamental botanical science with clinical pharmacy applications. The content scope of the course is relatively broad and inherently interdisciplinary, covering plant cell biology, tissue organization, organ morphology, systematic taxonomy, phytochemistry, and ethnopharmacological uses. This knowledge base is not only theoretically dense but also highly practice-oriented, requiring students to develop both conceptual understanding and operational proficiency in plant identification and quality evaluation.

At the undergraduate level, students typically enroll in this course during their sophomore year, having recently transitioned from the predominantly receptive learning models of secondary education. While they may possess rudimentary knowledge of plant biology—such as basic cell structure, tissue types, and organ functions—this prior knowledge often proves inadequate for the integrated and systematic demands of Pharmaceutical Botany. The subject matter is inherently abstract, involving microscopic anatomical features and complex taxonomic terminology, and its successful mastery depends on the learner's ability to synthesize information from multiple sub-disciplines.

To date, pedagogical approaches in Pharmaceutical Botany have predominantly relied on a combination of teacher-centered lectures, laboratory demonstrations, and field practicums. Commonly reported methods include theory-practice integration (Sun et al., 2018), object-based or specimen-based teaching (Peng & Wang, 2010), extended course material sharing, questioning-based instruction (Sun et al., 2018), and discussion-oriented seminars (Wang et al., 2025). Despite the diversity of these techniques, the overall instructional paradigm remains largely teacher-dominated, wherein the instructor acts as the primary transmitter of knowledge while students assume a relatively passive role. This traditional model has been increasingly scrutinized

for its limited effectiveness in cultivating critical thinking, problem-solving skills, and long-term knowledge retention.

A growing body of educational research has critiqued the conventional lecture-based approach for failing to engage students as active participants in their own learning. Jony (2016) observed that teacher-centered instruction often marginalizes students' subjective agency, rendering them passive recipients of information and hindering their capacity for deep cognitive engagement. Similarly, Tsui (2008) suggested that rote memorization and one-way transmission of knowledge impede the formation of interconnected mental schemas, thereby preventing learners from grasping the intrinsic relationships among disparate concepts and ultimately fostering superficial, mechanistic reasoning. Moreover, recent studies have highlighted persistent inadequacies in both the content delivery and practical training components of Pharmaceutical Botany curricula, suggesting that piecemeal reforms are insufficient and that a more systemic reconceptualization of teaching approaches is urgently needed (Meng et al., 2026).

Given the multifaceted and experiential nature of botanical study, we contend that the optimal starting point for pedagogical reform lies not in top-down institutional mandates but in a bottom-up understanding of student perspectives. Learners, as the primary agents of the educational process, possess unique insights into which instructional methods resonate with their cognitive styles, motivational drivers, and practical needs. Therefore, the present study adopts a student-centered methodological stance, seeking to elicit and analyze students' authentic evaluations of existing teaching approaches, their preferences for alternative formats, and their perceptions of the relative merits and drawbacks of traditional versus modern IT-based pedagogy. By grounding the reform agenda in empirical evidence derived from the student body, we aim to offer actionable

recommendations that are both theoretically informed and practically feasible.

To this end, we conducted a comprehensive online survey among 81 undergraduates enrolled in Pharmaceutical Botany at a regional medical university in Guizhou Province. The survey instrument was designed to capture multiple dimensions: initial students' initial interest, prior practical exposure, experiential assessments of specific teaching forms, comparative advantage/disadvantage rankings, and overall preference for future instructional models. The resulting dataset provides a valuable preliminary empirical evidence for diagnosing current pedagogical challenges and charting a nuanced path toward blended, student-responsive teaching that harmonizes the strengths of traditional hands-on methods with the affordances of digital technologies.

2. Methods

2.1 Survey Context and Participants

The survey was conducted at a medical university situated in Guizhou Province, southwestern China, which is characterized by rich biodiversity and a long-standing tradition of medicinal plant utilization. The participants were undergraduate students enrolled in the Chinese Materia Medica program, all of whom were required to complete the Pharmaceutical Botany course as a core component of their professional training. A total of 81 students voluntarily participated in the survey, comprising 2 freshmen, 61 sophomores, and 18 juniors. The distribution reflects the typical cohort structure, with the majority of students at the sophomore stage when the course is normally offered. All participants had previously received basic instruction in general botany and had some exposure to plant identification through their pre-university education or extracurricular

activities.

2.2 Survey Instrument and Procedure

The survey was administered online using a widely accessible mobile platform, allowing students to complete the questionnaire at their convenience and ensuring anonymity to encourage candid responses. The instrument was structured into three distinct sections, each designed to probe a specific domain of inquiry.

Part I collected demographic and baseline information, including academic year, prior field internship or cultivation experience related to medicinal plants, and self-reported level of interest in Pharmaceutical Botany prior to course commencement. This section comprised four single-choice items.

Part II focused on students' experience and preference regarding specific teaching approaches. It included six multiple-choice items that presented both traditional (e.g., teacher-led lecturing, specimen observation, microscopic examination, field internships, taxonomic key usage) and modern IT-based formats (e.g., online courses/micro-lectures, digital herbaria/databases, digital slides, virtual simulation experiments, interactive smart classrooms). For each format, participants rated their level of favorability on a five-point Likert-type scale ranging from "very unfavorable" to "very favorable."

Part III addressed comparative evaluations and open-ended suggestions. This section contained four items, three of which were single-choice (overall preference between traditional, modern, or blended models; optimal combination within blended teaching; and perceived learning outcomes enhanced by blended teaching) and one open-ended item soliciting additional comments

or alternative proposals.

2.3 Data Processing and Analytical Approach

For single-choice items, percentages were computed as the proportion of respondents selecting a particular option relative to the total number of respondents. For multiple-choice items, percentages were calculated as the number of times an option was selected divided by the total number of respondents, allowing for multiple selections per participant. All percentage values were rounded to two decimal places to maintain precision while avoiding unnecessary granularity.

To facilitate interpretability and comparative analysis, responses from the five-point preference scales (Part II, items 5 and 8) were collapsed into three aggregated categories: "popular" (combining "somewhat favorable" and "very favorable"), "indifferent" (neutral), and "unpopular" (combining "very unfavorable" and "somewhat unfavorable"). This trichotomous classification simplifies cross-form comparisons while preserving the directional valence of student attitudes. All survey responses were voluntary, and the raw data were recorded in a de-identified format to protect participant privacy. Descriptive statistics and frequency distributions were generated using standard spreadsheet software, with no inferential statistical tests applied, as the study's primary aim was to map prevailing perceptions rather than to test causal hypotheses.

3. Results

3.1 students' initial interest and Prior Experience

Among the 81 respondents, 72 students (88.89%) reported having prior field internship or cultivation experience related to medicinal plants (Figure 1B), indicating that students enter the

course with a tangible connection to the subject matter. Only 9 students (11.11%) had no such background (Figure 1B). In terms of interest level, 18 students(22.22%) indicated they were "very interested" in Pharmaceutical Botany before instruction began, while 53 students (65.43%) were "somewhat interested," 9 students (11.11%) were neutral, and a mere 1 student (1.23%) was "not very interested", No student selected "very uninterested" (Figure 1A). These data indicate that overall students' initial interest is relatively high (87.65% combining "very" and "somewhat interested"), and that the vast majority of students already possess a foundational practical exposure that can be leveraged to enhance learning engagement.

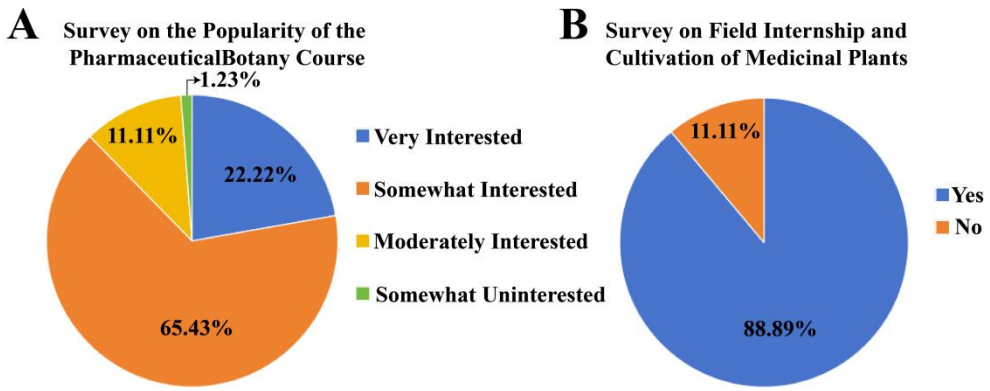


Figure.1. Survey on students' pre-course interest and prior experience before instruction. (A) Analysis of students' students' pre-course interest; (B) Analysis of prior field or cultivation experience.

3.2 Experience and Preference for Teaching Approaches

Students' experiential evaluations of teaching approaches are critical indicators of instructional effectiveness, as positive learning experiences have been shown to enhance motivation and sustained engagement, while preference patterns directly influence course interest and academic perseverance (Petrescu & Benta, 2023). In this study, we systematically assessed both traditional

and modern IT-based teaching formats, each comprising five representative forms.

Traditional teaching formats included: (a) teacher-led systematic lecturing; (b) observation of physical specimens; (c) microscopic observation of plant tissue sections; (d) field internships and specimen collection; and (e) plant identification using taxonomic keys (Song et al., 2015; Ji et al., 2012; Zhang et al., 2007). Modern IT-based formats encompassed: (a) online courses and micro-lecture videos (Huang et al., 2018); (b) digital herbarium and online databases (Liu et al., 2021); (c) digital slides (Wang et al., 2021); (d) virtual simulation experiments or simulated field internships (Yan et al., 2021); and (e) interactive smart classrooms (Song & Guo, 2024).

As presented in Table 1, the favorability rates (combined "somewhat favorable" and "very favorable") for traditional approaches were uniformly high: teacher-led lecturing reached 60 students (74.07%); specimen observation achieved 74 students (91.36%); microscopic section observation stood at 76 students (93.83%); field internships and specimen collection peaked at 77 students (95.06%); and taxonomic key identification recorded 63 students (77.77%). Notably, the three practical hands-on formats (specimen observation, microscopy, and field internships) all exceeded 90% favorability, underscoring the substantial student appreciation for authentic, tactile learning experiences. The neutral ("indifferent") proportions ranged from 9 students (11.11%) to 25 students (30.86%), while unpopular responses were minimal, never exceeding 6 students (7.4%).

Table 1.Evaluation of Student Experience and Preferences for Traditional Teaching Approaches.

Teaching Approach	Very Unfavorable	Somewhat Unfavorable	Neutral	Somewhat Favorable	Very Favorable

Teacher-led systematic lecturing	1.23%(1)	1.23%(1)	30.86%(25)	54.32%(44)	19.75%(16)
Observation of physical specimens	2.47%(2)	0.00%(0)	12.35%(10)	45.68%(37)	45.68%(37)
Microscopic observation of plant tissue sections	1.23%(1)	0.00%(0)	11.11%(9)	51.85%(42)	41.98%(34)
Field internship and specimen collection	1.23%(1)	0.00%(0)	12.35%(10)	44.44%(36)	50.62%(41)
Plant identification via taxonomic keys	1.23%(1)	6.17%(5)	23.46%(19)	44.44%(36)	33.33%(27)

Note: The numbers in parentheses in the table indicate the number of students who selected this option.

For modern IT-based approaches (Table 2), favorability ratess were also substantial: online courses/micro-lectures garnered 51 students (62.97%); digital herbaria/databases reached 64 students (79.01%); digital slides achieved 64 students (79.02%); virtual simulation field internships were favored by 68 students (83.95%); and interactive smart classrooms obtained 57 student (70.37%). Across all modern formats, the popular proportion consistently exceeded the neutral and unpopular categories, though the neutral share was noticeably higher than in traditional practical formats, particularly for online courses, where 27 students (33.33%) were neutral. This suggests that while students generally appreciate the affordances of digital technologies, a notable minority segment remains ambivalent or uncertain about their effectiveness.

Table 2.Evaluation of Student Experience and Preferences for Modern Information -Technology-Based Teaching Approaches.

Teaching Approach	Very Unfavorable	Somewhat Unfavorable	Neutral	Somewhat Favorable	Very Favorable

Online courses / micro- lecture videos	2.47%(2)	6.17%(5)	33.33%(27)	41.98%(34)	20.99%(17)
Digital herbarium / online databases	1.23%(1)	0.00%(0)	25.93%(21)	45.68%(37)	33.33%(27)
Digital slides	1.23%(1)	0.00%(0)	23.46%(19)	50.62%(41)	28.40%(23)
Virtual simulation experiments or field internships	1.23%(1)	1.23%(1)	17.28%(14)	40.74%(33)	43.21%(35)
Interactive smart classrooms	1.23%(1)	3.70%(3)	30.86%(25)	46.91%(38)	23.46%(19)

Note: The numbers in parentheses in the table indicate the number of students who selected this option.

3.3 Perceived Advantages and Disadvantages of Traditional vs. Modern Approaches

To gain a deeper understanding of the underlying reasons for students' preferences, we asked participants to identify the main advantages and disadvantages of both teaching paradigms. For traditional teaching, students were presented with a list of potential strengths and limitations and asked to select all that applied.

As displayed in Table 3, the most highly endorsed advantage of traditional teaching was its intuitive and authentic nature (e.g., touching specimens, conducting fieldwork), selected by 65 students (80.25%) of respondents. The second most cited strength was the systematic knowledge framework and clear logic (59 students, 72.84%), followed by direct teacher-student interaction and an active classroom atmosphere (47 students, 58.02%), and the cultivation of solid foundational skills and hands-on ability (37 students, 45.68%). No other advantages were mentioned.

Table 3.Advantages of Traditional Teaching Methods.

Options	Percentage
Intuitive and authentic, leaving a strong impression (e.g., touching specimens, field work)	80.25%(65)
Systematic knowledge framework, clear logic	72.84%(59)
Direct teacher-student interaction, clear and active atmosphere	58.02%(47)
Helps to cultivate solid basic skills and hands-on ability	45.68%(37)
Others	0.00%(0)

Note: The numbers in parentheses in the table indicate the number of students who selected this option.

Conversely, the main disadvantages of traditional teaching (Table 4) were dominated by severe constraints of time, space, and weather, particularly for field-based activities (63 students, 77.78%). Limited teaching resources, such as insufficient specimen availability (52 students, 64.20%), and relatively fixed content that lacks vividness (36 students, 44.44%) were also prominent. 30 students (37.04%) reported difficulty in re-watching or re-experiencing the learning process, especially for demonstrations and blackboard work.

Table 4.Disadvantages of Traditional Teaching Methods.

Options	Percentage
Severe constraints by time, space, and weather (e.g., field internships)	77.78%(63)
Limited teaching resources (e.g., specimens)	64.20%(52)

Content relatively fixed and not vivid enough	44.44%(36)
Difficulty in re-watching/re-experiencing (e.g., teacher's blackboard writing, operational demonstrations)	37.04%(30)
Others	0.00%(0)

Note: The numbers in parentheses in the table indicate the number of students who selected this option.

For modern IT-based teaching, the perceived advantages (Table 5) were largely associated with flexibility and resource richness. The most frequently cited advantage was rich resources and large information volume, including access to databases (74 students, 91.36%), followed by flexible learning time and location with repeatability (70 students, 86.42%). Novel and attractive forms (58 students, 71.60%) and strong interactivity with timely feedback (22 students, 27.16%) were also acknowledged, though the latter was less widely endorsed.

Table 5.Advantages of Modern Information-Technology-Based Teaching Approaches.

Options	Percentage
Flexible learning time and location, repeatable learning	86.42%(70)
Rich resources and large information volume (e.g., databases)	91.36%(74)
Novel forms, vivid and interesting, highly attractive	71.60%(58)
Strong interactivity and timely feedback (e.g., classroom polling)	27.16%(22)
Others	0.00%(0)

Note: The numbers in parentheses in the table indicate the number of students who selected this

option.

However, the disadvantages of modern IT-based approaches (Table 6) were also clearly articulated. The most serious drawback was the lack of authentic sensory experiences—tactile, olfactory, and other somatic perceptions—cited by 58 students (71.60%). Information overload and easy distraction followed closely at 52 students (64.20%), while over-reliance on devices and networks was noted by 41 students (50.62%). Additionally, 33 students (40.74%) expressed concern about potential reduction in face-to-face emotional communication between teachers and students. A small proportion (2 students, 2.47%) mentioned other disadvantages, such as technical glitches or eye strain.

Table 6.Disadvantages of Modern Information-Technology-Based Teaching Approaches.

Options	Percentage
Over-reliance on devices and networks	50.62%(41)
Lack of authentic tactile, olfactory, and other sensory experiences	71.60%(58)
Information overload, easily distracted	64.20%(52)
Potential reduction in face-to-face emotional communication between teachers and students	40.74%(33)
Others	2.47%(2)

Note: The numbers in parentheses in the table indicate the number of students who selected this option.

Collectively, these comparative data reveal that traditional and modern approaches possess complementary strengths and weaknesses. Traditional teaching excels in providing authentic, systematic, and interactive learning experiences, whereas modern IT-based teaching offers

flexibility, rich information, and repeatability. Their respective advantages effectively compensate for the other's deficiencies: for instance, digital tools can overcome spatial and temporal limitations of field trips, while hands-on activities can restore the sensory authenticity that virtual environments lack.

3.4 Overall Preference and Optimal Blended Model in the Pharmaceutical Botany Course

After evaluating individual teaching formats and their pros and cons, we asked students to declare their overall preference among three broad instructional models: (a) mainly traditional, (b) mainly modern IT-based, or (c) deep integration of both (i.e., blended online-offline teaching). As shown in Table 7, 61 students (75.31%) chose the integrated blended model, while only 12 students (14.81%) preferred traditional methods alone and 8 students (9.88%) favored IT-based methods exclusively. This substantial majority indicates a notable student consensus in favor of pedagogical hybridization.

Table 7.Survey on Students' Preferences for Teaching Methods.

Options	Percentage
Mainly rely on traditional teaching methods	14.81%(12)
Mainly rely on modern information technology teaching methods	9.88%(8)
Deep integration of both (online and offline blended teaching)	75.31%(61)

Note: The numbers in parentheses in the table indicate the number of students who selected this option.

Furthermore, when asked to specify the ideal combination within a blended framework

(Table 8), the most popular choice was "offline classroom delivery of core knowledge, with online platform used for extended resources, submitting assignments and quizzes," selected by 47 students (58.02%) of respondents. The alternative model—"online learning of theoretical knowledge (videos, materials), with offline classroom discussions, Q&A, and experimental operations"—received 32 students (39.51%) support, while a mere 2 students (2.47%) proposed other combinations. These results suggest that students favor a structure where foundational concepts are introduced in person, while supplementary materials and formative assessments are delivered digitally, rather than fully flipping the classroom.

Table 8.Survey on the Optimal Combination for Blended (Online-Offline) Teaching Mode.

Options	Percentage
Online learning of theoretical knowledge (videos, materials), with offline classroom discussions, Q&A, and experimental operations	39.51%(32)
Offline classroom teaching of core knowledge, with online platform used for extended resources, submitting assignments and quizzes	58.02%(47)
Other combination suggestions (please briefly explain)	2.47%(2)

Note: The numbers in parentheses in the table indicate the number of students who selected this option.

Finally, we queried students about which specific learning outcomes they believed would be most enhanced by adopting a blended teaching approach (Table 9). The highest proportion (27 students, 33.33%) pointed to memorization and understanding of theoretical knowledge, followed by learning interest and initiative (23 students, 28.40%) and practical operation and appraisal skills

(20 students, 24.69%). Comprehensive problem-solving ability and teamwork/communication skills were less frequently mentioned (10 students, 12.35% and 1 student, 1.23%, respectively). This pattern implies that students perceive blended teaching primarily as a tool for consolidating theoretical content and boosting motivation, rather than as a direct solution for higher-order competencies—though they do not dismiss its potential for the latter.

Table 9.Survey on the Learning Outcomes Enhanced by Adopting a Blended (Online-Offline) Teaching Mode.

Options	Percentage
Memorization and understanding of theoretical knowledge	33.33%(27)
Practical operation and appraisal skills	24.69%(20)
Learning interest and initiative	28.40%(23)
Comprehensive ability to solve complex problems	12.35%(10)
Teamwork and communication skills	1.23%(1)

Note: The numbers in parentheses in the table indicate the number of students who selected this option.

4.Discussion

The present study, through a comprehensive survey of 81 undergraduates, has systematically studied the current student perceptions, experiences, and preferences regarding the teaching approaches employed in Pharmaceutical Botany. The findings not only confirm the enduring appeal of hands-on, experiential learning but also illuminate the emerging demand for technology-enhanced flexibility. In this section, we interpret the results in light of existing literature,

discuss their pedagogical implications, and propose a coherent framework for reforming the course.

4.1 High students' initial interest and the Advantage of Prior Experience

A notable finding is the relatively high level of student interest in Pharmaceutical Botany prior to formal instruction, with 71 students (87.65%) expressing positive interest (Figure 1A). The elevated interest may be attributed to the inherently tangible and aesthetically appealing nature of plants, as well as the cultural and economic significance of medicinal herbs in the Chinese context. Moreover, the fact that 72 students (88.89%) had prior field or cultivation experience suggests (Figure 1B) that informal exposure—through family traditions or school gardens—has already cultivated a degree of familiarity and curiosity. This finding has important implications for instructional design: educators can leverage students‘ existing knowledge and personal connections to the subject matter to channel their initial enthusiasm into systematic learning.

4.2 The Irreplaceable Role of Traditional Hands-On Methods

The practical components of traditional teaching were recognized by the majority of students—with specimen observation, microscopy, and field internships all exceeding 90% favorability (Table 1)—underscores a fundamental principle of botanical pedagogy: authentic sensory engagement is widely considered irreplaceable. The tactile experience of handling plant specimens, the visual scrutiny of cellular details under a microscope, and the immersive context of field exploration together create rich cognitive and affective impressions that digital simulations, however sophisticated, cannot fully replicate. Students' own articulation of the main advantage of traditional teaching as "intuitive and authentic" (65 students, 80.25%) reinforces this interpretation (Table 3).

Nevertheless, students were equally articulate about the limitations of traditional methods. The constraints of time, space, weather, and limited teaching resources are practical barriers that have long plagued field-based education. In an era of expanding class sizes and shrinking contact hours, relying solely on conventional fieldwork can hardly meet the teaching needs. The fact that 52 students (64.20%) cited "limited teaching resources" suggests that even within traditional settings, resource inadequacy (Table 4)—such as insufficient specimen or outdated microscope slides— diminishes the learning experience. Thus, while traditional approaches are valued, they are also recognized as having certain limitations when used alone.

4.3 The Affordances and Pitfalls of Modern IT-Based Teaching

Modern IT-based teaching approaches were generally well received, particularly for their flexibility and informational abundance. The high endorsement of "rich resources and large information volume" (74 students, 91.36%) and "flexible time and location, repeatable learning" (70 students, 86.42%) (Table 5) indicates that students appreciate the ability to access learning materials on demand and revisit difficult concepts at their own pace. Digital herbaria and online databases, in particular, provide a favorable platform for accessing rare or geographically distant specimens, thereby making knowledge of pharmaceutical botany more accessible.

However, the significant criticisms leveled at IT-based teaching—notably the lack of authentic sensory experiences (58 students, 71.60%) and information overload leading to distraction (52 students, 64.20%) (Table 6)—highlight the inherent trade-offs of digitization. The absence of tactile, olfactory, and even auditory cues that accompany real plants can reduce the richness of perceptual learning, which is critical for accurate identification and classification. Furthermore, the

sheer volume of online content can overwhelm students, leading to superficial browsing rather than deep processing. Moreover, 33 students (40.74%) who worried about diminished emotional communication (Table 6) between teachers and students point to the relational dimension of teaching—a dimension that is often undervalued in technology-centric reform discourses.

4.4 The High Endorsement for Blended Teaching

A notable outcome of this survey is 61 students (75.31%) preference for a deep integration of traditional and modern approaches (Table 7). What is particularly informative is the specificity of students' preferences: they favor a model where core knowledge is delivered offline, while online platforms serve as repositories for supplementary resources, assignments, and quizzes (Table 8). This suggests that students prefer to enhance the classroom experience rather than replace it entirely.

This preference also implies that traditional teaching methods and modern IT-based approaches each have their own strengths. A deep integration of the two can help preserve the role of the instructor as a facilitator and mentor, while empowering students to take greater ownership of their learning process. The fact that 47 students (58.02%) chose this combination, compared to 32 students (39.51%) for the flipped alternative (Table 8), suggests that students are cautious about placing too much cognitive load on self-directed online study, especially for a subject as visually and conceptually complex as botany.

4.5 Implications for Teaching Reform

Based on these findings, we propose a multi-pronged reform strategy for Pharmaceutical Botany that is student-centered, evidence-informed, and context-sensitive.

First, theoretical knowledge that is highly repetitive or rule-based—such as plant cell structure, tissue types, and systematic terminology—can be effectively digitized into short micro-lectures, animated diagrams, and interactive quizzes. These resources should be made available online for students to access before or after class, thereby freeing classroom time for more interactive and applied activities.

Second, the core practical components—specimen observation, microscopic identification, and field internships—should be preserved and even strengthened in the offline curriculum. Rather than reducing these sessions, institutions should invest in maintaining specimen collections, upgrading microscopy facilities, and securing field sites. The authenticity of these experiences is the unique value proposition that cannot be outsourced to digital alternatives.

Third, digital tools should be strategically deployed to address the limitations of traditional methods. For instance, digital herbaria and virtual simulation experiments can serve as preparatory activities before field trips or as remedial tools for students who miss fieldwork due to illness or weather cancellations. They can also provide supplementary visualizations—such as 3D reconstructions of plant anatomy—that enhance comprehension of complex structures.

Fourth, interactive smart classroom technologies—such as real-time polling, collaborative annotation, and discussion bulletins—can be introduced to boost participation and foster a more dialogic learning environment. These tools are particularly valuable for large classes where individual students may hesitate to speak up.

Fifth, assessment and feedback mechanisms should be redesigned to align with the blended model. Online quizzes and peer-evaluation platforms can provide immediate formative feedback,

while offline practical examinations can assess hands-on proficiency. The combination allows for continuous, low-stakes assessment that reduces examination anxiety and promotes sustained engagement.

4.6 Limitations and Future Research

While this study provides valuable empirical insights, it is not without limitations. The sample is drawn from a single institution in a specific geographic region, which may limit generalizability to other contexts with different student demographics, resource endowments, or curricular structures. Moreover, the survey relied on self-reported perceptions rather than objective measures of learning outcomes; future studies should triangulate these findings with performance data, such as examination scores or practical skill assessments. Additionally, the study is cross-sectional in design; longitudinal research tracking student responses before, during, and after the implementation of blended reforms would offer stronger evidence of causality.

Nonetheless, the current findings offer an evidence base for designing and piloting blended teaching interventions in Pharmaceutical Botany. We encourage educators to adopt an iterative, action-research approach: implement incremental changes, gather student feedback, and refine the model accordingly. By doing so, the course can evolve into a dynamic, responsive educational experience that meets the diverse needs of contemporary learners while preserving the disciplinary rigor and authenticity that define botanical science.

5. Conclusion

This study has empirically examined the perceptions, experiences, and preferences of undergraduate Chinese Materia Medica students regarding traditional and modern IT-based

406 teaching approaches in Pharmaceutical Botany. The results suggest that while students highly value
407 the authenticity and systematicity of traditional hands-on methods, they also recognize and
408 appreciate the flexibility and informational richness of digital technologies. However, neither
409 approach in isolation fully satisfies their learning needs; instead, a substantial majority of students
410 (61 students, 75.31%) explicitly endorse a deep integration of both—a blended online-offline
411 teaching model.

412 The preferred configuration articulated by students—core knowledge delivered offline,
413 supplemented by online platforms for extended resources, assignments, and quizzes—aligns with
414 contemporary blended learning theories. This approach offers a pragmatic pathway that preserves
415 the valuable experiential dimension of botanical education while leveraging the flexibility and
416 informational richness of digital technologies.

417 In practical terms, the teaching strategy for Pharmaceutical Botany should be optimized.
418 Online platforms can be reasonably used for theoretical learning. Practical sessions (specimen
419 observation, microscopy, fieldwork) should be preserved and strengthened. Digital resources can
420 help overcome spatiotemporal constraints. Interactive classroom technologies should be integrated
421 to foster active student participation. Although further research with objective learning outcomes
422 and larger, multi-institutional samples is needed, this study provides preliminary evidence for
423 integrating traditional and IT-based approaches in Pharmaceutical Botany.

424 Ultimately, pedagogical reform in Pharmaceutical Botany should not be framed as a binary
425 choice between tradition and modernity. Rather, it should be conceived as a synergistic
426 integration—a "virtual-reality complementarity"—that places students at the center, respects the

discipline's unique requirements, and responds to the evolving technological landscape. This approach may help educators cultivate not only skilled practitioners of medicinal plant identification but also lifelong learners equipped with critical thinking, practical competence, and enduring curiosity.

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