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Smart *medical* English pedagogy on a smart teaching platform

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Abstract: The widespread adoption of smart mobile devices has sparked significant innovations in China's smart education landscape in recent years. Smart teaching platforms play a pivotal role in shaping the dynamics of smart teaching. This study aimed to enhance medical *English* pedagogy by implementing smart teaching on the smart teaching platform (Xuexitong). The researchers divided their 178 nursing-majored students into two control classes and two experimental classes to evaluate the effectiveness of smart teaching. Traditional classroom instruction was adopted in the control classes while smart pedagogy was applied in the experimental classes. After a semester-long teaching experiment, two assessments were conducted: a comparison of exam scores and a course feedback survey. The findings revealed that students in the experimental classes significantly outperformed the control group in these two assessments. This highlights the substantial effectiveness of smart medical English pedagogy demonstrating its ability to enhance students' language proficiency and comprehension in medical contexts far beyond traditional teaching methods. The study concluded that smart teaching can significantly improve teaching outcomes and facilitate pedagogical innovations among new technological advancements. These insights offer valuable guidance for future research to enhance the integration of smart mobile technologies with smart language pedagogy.

Keywords: *Course feedback survey, Exam score comparison, Medical English, Smart pedagogy, Smart teaching platform, Teaching effectiveness.*

1. Introduction

The rapid emergence and extensive adoption of mobile technologies have empowered individuals to participate in learning anytime and anywhere through their mobile devices. The rise of mobile devices such as smartphones and tablets has instigated a transformative shift in the realm of mobile learning [1]. In this context, the term "mobile pedagogy" has been coined to outline effective approaches to teaching and learning using mobile technologies [2]. Mobile pedagogy poses significant challenges to current educational practices, requiring sustained development in the design, assessment, and implementation of the instructional process [3] recognized as an indispensable element in the evolution of higher education systems [4]. Mobile pedagogy acknowledged as a vital component in the transformation of higher education systems [3] introduces significant challenges to traditional educational practices. It demands continuous development in the design, assessment and implementation of instructional processes [4].

In the past few years, the rapid advancement of mobile technology has led to notable changes in the educational landscape. Educational methods have had to adapt to make the most of these new tools as mobile devices have evolved with smarter capabilities. This shift has given rise to a concept known as smart pedagogy where teachers use technology to create more interactive and personalized learning experiences. Smart pedagogical approaches can challenge traditional education concepts and redefine

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the boundaries of formal education by embracing the diverse learning opportunities these smart mobile devices provide.

Language pedagogy has seamlessly integrated with smart technologies and kept pace with the broader trend of "going smart". As language learning devices and resources have become more technologically smart, language teaching has evolved to incorporate these innovations. This includes the use of language learning apps, smart learning platforms and interactive digital materials that allow learners to practice and improve their skills in more engaging ways. Language teachers are now embracing technology to create immersive experiences such as virtual reality language lessons and AI-powered language tutors which make learning a new language more interactive and accessible for students everywhere. The effectiveness of smart language pedagogy relies not only on the intelligence level of mobile devices and smart teaching platforms but also on the smartness of both learners and teachers.

Chinese tertiary institutions have extensively adopted English for Specific Purposes (ESP) education aligning with the smart education trend by integrating smart teaching approaches. *Medical English*, a subset of English for Specific Purposes (ESP) is also known as English for medical purposes. It focuses on instructing English tailored for healthcare professionals such as doctors and nurses. Its primary aim is to facilitate the practical use of English in the medical field with the clear objective of enhancing job performance or optimizing the effectiveness of medical training [4].

The main goal of this study was to validate the effectiveness of smart medical *English* pedagogy after a six-month implementation on the smart teaching platform (Xuexitong). Accordingly, the research questions for this study are as follows:

RQ1: How to implement smart *medical English* pedagogy on Xuexitong?

RQ2: How to validate the effectiveness of the smart medical *English* pedagogy on Xuexitong?

A thorough examination of these research questions is crucial as it not only enhances our understanding of implementing smart teaching but also illuminates the optimal ways to use smart teaching platforms. Furthermore, this exploration provides deeper insights into validating smart language pedagogy.

2. Literature Review

2.1. Smart Pedagogy

Smart advancements are sweeping across all sectors and industries with the rapid development of information technology and the remarkable progress in mobile technologies. In education, this trend is exemplified by the emergence of smart pedagogy. Smart pedagogy involves creating a highly flexible school learning environment both in terms of time and space. It promotes students' learning autonomy, fosters collaboration between students and teachers and incorporates multiple uses of digital technologies [5].

The smartness of smart pedagogy is reflected in its adoption of smart technology and its smart pedagogical functionality.

Smart technology serves as the technological backbone of smart pedagogy making it its most defining characteristics. Smart technology is the broad range of advanced systems and devices that integrate computing power, connectivity and intelligent functionalities [6]. Educational smart technologies are adopted to enhance efficiency, convenience and decision-making processes across various pedagogical settings. Currently, the most widely used smart technology in smart teaching is mobile. Consequently, smart pedagogy is also often referred to as smart mobile pedagogy [1]. Besides mobile technology, emerging smart technologies such as big data and artificial intelligence are increasingly being integrated into smart pedagogy.

A broad range of smart pedagogical functionalities enabled by smart technology have become defining characteristics of smart pedagogy. These smart pedagogical functionalities include seamless learning, digital play, student agency, autonomy, gamification, customization, authentic environments, simulation, context-awareness, data sharing, co-construction, reflection, real-world tools, co-design for mobile learning, intergenerational learning, bridging and community-based approaches [7, 8].

Smart pedagogy primarily involves two key human elements as a pedagogical approach enabled by smart technologies. The first key human element is the teacher who is tasked with involving students in cognitive activities, facilitating their participation in knowledge creation and nurturing their skills in critical thinking, research, and environmental exploration. A study shows that smart education is increasingly viewed as the solution to educational challenges and in this context, smart teachers have no choice but to be adaptive to survive today's dynamic educational environment [9]. The second key human element is the students who actively gather information and independently construct knowledge within carefully designed teaching scenarios [5]. A smart student is a student who learns in the real world using smart technology to provide personalized learning services and empower them [10]. According to this perspective, smart teaching and smart learning are the two essential procedural parts of smart pedagogy that correspond to those two essential human characteristics. The core of smart teaching involves breaking the traditional teaching scene and integrating all aspects of the teaching process to achieve interaction between teachers and students in the current teaching environment [11]. In contrast, smart learning takes a student-centered approach to education diverging from traditional didactic instructional models where the teacher centrally controls the educational process and the students have limited opportunities to exert their agency [7]. Smart learning emphasizes scenarios where technological possibilities are integrated into the learning environment to support students' learning [12].

Smart pedagogy also comprises two fundamental material elements: smart devices and smart learning environments.

Smart devices are computing media that combine the functionalities of mobile phones, computers, wireless internet, digital cameras, music players and various software applications with examples including smartphones and tablets [13]. Learning devices are considered smart if they are small, portable, and affordable, support and engage learners at any time and place and enhance learning often in playful contexts [14]. Smart mobile devices, especially smartphones and tablets are becoming increasingly prevalent among tertiary teachers and students. The importance of smart mobile devices in enhancing smart pedagogy is immeasurable given that the fundamental basis of smart pedagogy lies in the use of these smart devices [8, 15]. However, smart devices present a challenge to established classroom frameworks sparking thoughtful inquiries about the continued significance and fundamental essence of traditional classrooms due to their growing ubiquity and extensive utilization [16]. Smart learning environments are spaces that incorporate technology to enhance student learning outcomes [17]. A dynamic intelligent learning environment functions as a versatile space or activity area capable of identifying diverse learning scenarios, understanding individual learner characteristics, providing appropriate learning materials and intuitive interactive tools, autonomously monitoring the learning journey and assessing outcomes with the ultimate goal of enhancing the overall effectiveness of the learning experience [18]. Key attributes defining a smart learning environment as outlined by Thomas et al. [17] include support for knowledge tasks, sensitivity to learners, awareness of context, and the incorporation of reflection and feedback mechanisms. Moreover, according to Spector [12] a smart learning environment should promote four key elements: meaningful discussions among students, reflective exercises for self-evaluation, support for creativity and the development of self-organization. In the realm of smart pedagogy, the significance of smart learning environments is paramount because the essence of smart education lies in establishing intelligent environments through smart technologies [19].

This study aimed to investigate the effectiveness of smart medical *English* pedagogy at Taizhou University, China in addition to reviewing the previously mentioned knowledge of smart pedagogy. This study also explores the research and practical status of smart pedagogy in China.

Smart pedagogy garners considerable attention from various levels of government and the education sector in China. It signifies a vital and inexorable trend in the digitization and development of education in China providing an innovative response to the challenges encountered in the progress of China's education [19]. During the World Digital Education Conference on February 13th, co-hosted by China's Ministry of Education and the United Nations Educational, Scientific and Cultural Organization (UNESCO), the China National Institute of Education Sciences revealed the *China Smart Education Bluebook*[1] to a global audience. The *Bluebook* encapsulates the core of smart education by delineating 16 specific characteristics distributed across four dimensions. Additionally, it puts forth an evaluation system designed to measure the developmental stage of smart education comprising four primary dimensions and 12 secondary dimensions. The *Bluebook* holds substantial reference value for the worldwide advancement of intelligent education.

Therefore, the following will review one of the most popular smart teaching platforms in Chinese universities:

2.2. Xuexitong as a Smart Teaching Platform

Smart pedagogy requires more than just smart teachers, smart learners and smart devices. It also necessitates a smart teaching platform which serves as the cornerstone of a smart learning environment. This is easily comprehensible considering that the essence of successful smart pedagogy relies on establishing a smart learning environment, typically centered on a robust smart teaching and learning platform. In the contemporary educational context, it has become essential for universities to integrate a smart platform to guarantee a high standard of intelligent education [20].Chinese homemade smart teaching platforms gained popularity in 2016 and they peaked in 2020 after COVID-19 broke out. Subsequently, several smart teaching platforms have been extensively implemented in schools at all levels as a result of the widespread adoption of online learning. The most prevalent smart teaching platforms in Chinese universities include Xuexitong, Rain Classroom and Tsinghua Educational Online among many others.

The smart medical English pedagogy in this research was implemented through the Xuexitong platform. As a result, further exploration of the characteristics of Xuexitong and its current adoption status in China was deemed necessary. Since the COVID-19 outbreak, Xuexitong, one of the most widely used smart teaching platforms in Chinese tertiary institutions has become even more well-known [21].

Xuexitong optimizes the technological advantages provided by smart mobile devices such as smartphones and tablets. It demonstrates strong capabilities in fulfilling the features of a smart learning environment, including location-awareness, context awareness, social awareness, interoperability, seamless connection, adaptability, ubiquitousness, whole record (of learning path data), natural (multimodal) interaction and high engagement [22]. Xuexitong widely used both inside and outside the classroom can effectively harness its capabilities as a smart teaching platform by integrating common teaching strategies for smart pedagogy proposed by Uskov, et al. [23]. These strategies include inquiry-based learning, learning-by-doing, personal crossover learning, collaborative learning, gamification of learning, context-based learning, robotics-based learning, flipped classroom, learning analytics, formative analytics, adaptive teaching, and the "bring your own device" strategy.

In particular, Xuexitong functionally excels in the following three aspects:

(1) Diverse pedagogical approaches to cater to personalized learning.

The Xuexitong platform facilitates a range of effective strategies in teaching and learning to realize personalized education for students. Teachers have the flexibility to design their instruction by incorporating Massive Open Online Course (MOOC) videos, live and recorded lectures and online materials into classroom instruction. This allows them to customize learning content to meet the unique needs of each student. Similarly, students can leverage teacher-recommended teaching slides, videos, an online library and additional materials tailored to their learning circumstances, thereby fulfilling their personalized learning requirements.

[1] http://www.moe.gov.cn/jyb_xwfb/gzdt_gzdt/s5987/202302/t20230213_1044284.html

(2) Multiple and timely interactions.

Xuexitong seamlessly integrates a diverse array of features including course delivery and management, content repository and sharing, real-time chat, online forums, group and private chats, fostering timely interactions between teachers and students. This interaction is achieved through various forms such as text, voice and video either online or offline.

(3) Strong data analysis ability.

Xuexitong can digitally process a substantial volume of learning-related information. It is designed to conduct comprehensive online tests, evaluate learning outcomes, administer online surveys and collect and analyze data related to learning. After a lecture is delivered on Xuexitong, data on students' pre-class, in-class and post-class learning activities is automatically tracked, recorded, analyzed, and stored online for easy access by both teachers and students.

This system allows teachers to monitor students' learning progress in real-time, evaluate their teaching methods based on immediate feedback and adjust their strategies to enhance teaching efficiency. Meanwhile, students benefit from detailed feedback on their learning thanks to the real-time data monitoring and analysis.

In this study, medical *English* teaching places a high emphasis on the importance of the smart pedagogical approach seamlessly integrating smart teaching of medical *English* with the smart teaching platform. With its multiple functions, Xuexitong skillfully connects pre-class, in-class and post-class activities meeting the requirements of smart pedagogy for a teaching platform.

Based on the above literature review of smart pedagogy and the Xuexitong platform, research gaps can be identified in studies related to these closely connected topics. Previous research has extensively explored the theoretical components and practical applications of smart pedagogy. There is limited study on its use and results in ESP educational settings, such as *medical English* education. Moreover, smart pedagogy is widely adopted and its benefits are recognized. Empirical studies on actual smart pedagogical practices on smart teaching platforms are sparse. Finally, there are few quantitative comparisons between smart teaching and traditional teaching methods. This research addresses these gaps by comparatively exploring the effectiveness of smart medical *English* pedagogy implemented at Xuexitong at Taizhou University, China.

3. Methods

3.1. Overview of Research Methods

This study primarily used a quantitative research approach complemented by a descriptive research method. The study relied on a quantitative analysis of a teaching experiment conducted over one semester. Participants were divided into a control group and an experimental group. The control group employed traditional "Microsoft PowerPoint Presentation (PPT) and whiteboard" methods for teaching medical *English* emphasizing conventional teacher-led classroom instruction. Conversely, the experimental group used the smart teaching approach based on the Xuexitong.

Following a semester-long teaching experiment, both groups underwent a final exam using identical test papers. Examination results were compared by assessing the scoring rates for each test item, average scores, pass rates and excellence rates between the control and experimental groups. Subsequently, a t-test was conducted to compare the above-mentioned data related to scores between the control and experimental groups. Additionally, a 7-point Likert scale assessment was employed to analyze the experimental group's acceptance of smart pedagogy on Xuexitong.

This study integrated a descriptive research component as a supplementary method to provide a procedural depiction of the smart pedagogy implemented in the experimental group (see Figure 1). This descriptive research method aimed to narrate and elucidate the procedural aspects of smart teaching offering insights into the implementation of smart pedagogy within an experimental setting.

3.2. Setting and Participants

In the post-pandemic era, Chinese universities continued to prioritize smart pedagogy. Teachers across various disciplines had been actively encouraged to use smart devices and platforms for smart pedagogical activities both inside and outside the classroom.

This study specifically focused on four nursing classes from the School of Medicine at Taizhou University in Zhejiang Province, China. The student cohort comprised 144 women (81%) and 34 men (19%) enrolled in a 4-year bachelor's degree program in nursing. They were organized into 4 teaching classes (nursing 1, 2, 3 and 4). Notably, nursing 1 and 2 served as the control classes whereas nursing 3 and 4 operated as experimental classes. It was crucial to highlight that the course content and learning resources remained uniform across all classes. The differentiation primarily stemmed from variances in teaching approaches, methods of resource sharing and channels for teacher-student interactions.

3.3. Data Collection and Analysis

The research data for the smart teaching experiment were collected through 2 methods: exam score comparison and a course feedback survey. Exam score comparison involved evaluating the final exam results of the control and experimental groups. The objective was to ascertain whether a significant relationship existed between the adopted teaching methods and students' final exam scores. The statistical tools employed for comparing exam scores included percentage comparison and the t-test function in SPSS.

The course feedback questionnaire (see Appendix A) was exclusively administered to the experimental group through an online survey. The questionnaire consisted of 2 sections: the first part conducted a demographic background survey while the second part focused on evaluating students' acceptance of smart teaching. Respondents were asked to rate their level of agreement with the 25 survey items using a 7-point Likert scale (with 1= very little and 7= very much). SPSS was used to compute the mean and standard deviation for each item aiming to measure the extent of students' acceptance of smart pedagogy on Xuexitong.

4. Process and Results

4.1. Implementation Process of Smart Pedagogy

Medical English stands as a mandatory course for nursing majors. Spanning 16 weeks, the course entails a total of 32 class hours. In this study, the control group (nursing 1 and 2) used the traditional teaching mode of "PPT and whiteboard" whereas the experimental group (nursing 3 and 4) adopted a smart pedagogical approach based on Xuexitong.

Before formally implementing smart pedagogy in the experimental classes, the teacher distributed QR codes to 90 students across 2 control classes (nursing 3 and 4) to facilitate their enrollment in the respective virtual classes on Xuexitong. As delineated in Figure 1, the implementation of smart pedagogy unfolded across three key phases: pre-class, in-class and post-class.

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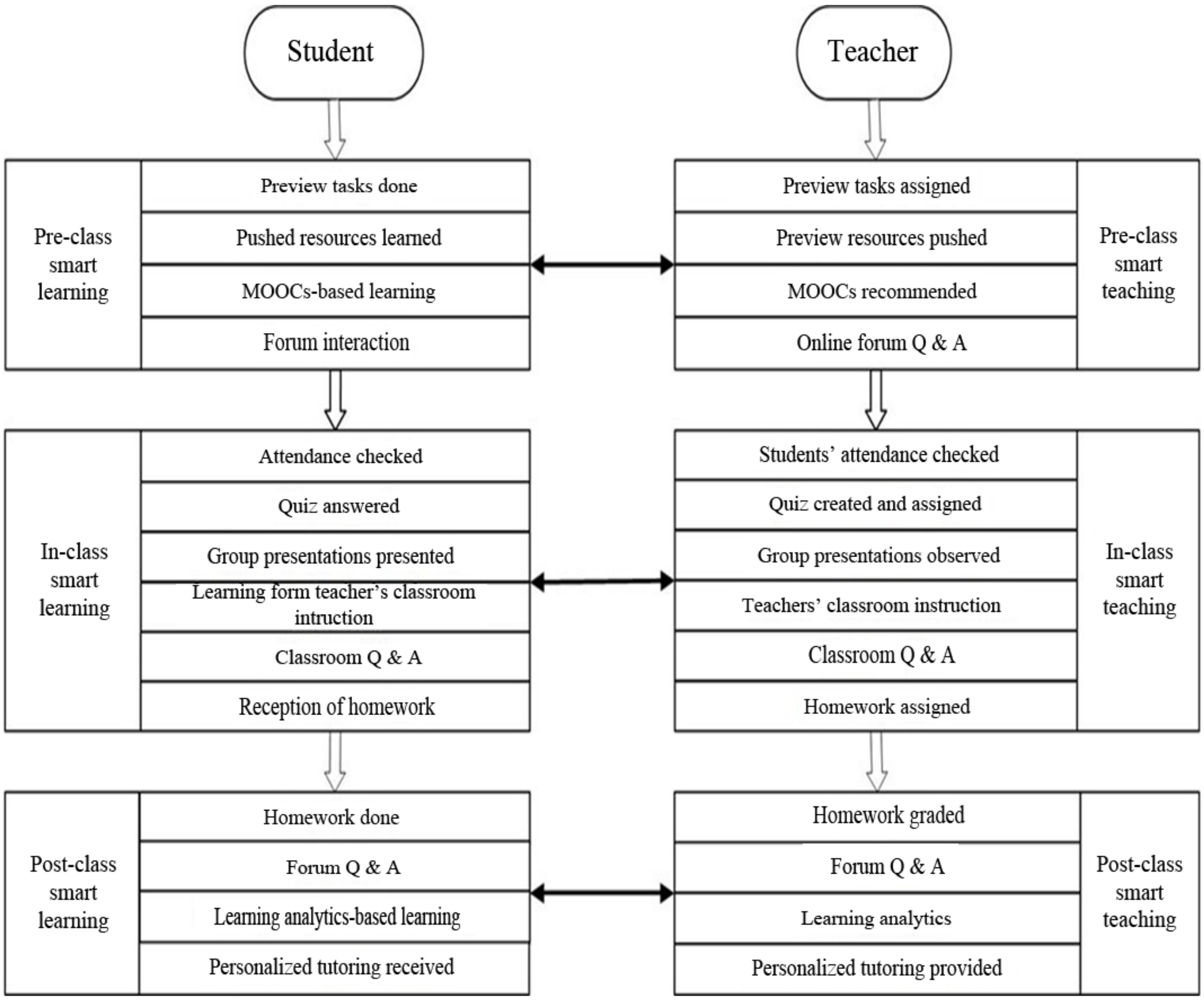

Figure 1.
The implementation process of smart pedagogy based on Xuexitong.

(1) Pre-Class Teaching Activities

Pre-class activities are conducted online. The teacher carefully selects extra-curricular reading materials and audio or video clips that closely align with the classroom content uploading them onto Xuexitong. Students are then required to study the materials. Additionally, the teacher chooses suitable MOOC courses offered by Fanya[2] a large-scale comprehensive website affiliated with the same company as Xuexitong which provides access to millions of e-books, 5 million academic papers and premium video lectures by more than 10,000 distinguished teachers. Within the online forum on the smart learning platform, the teacher and students engage in real-time discussions to address any questions encountered during pre-class learning activities. The teacher may also pose questions related to the pre-class learning tasks for students to refer to or respond to. Finally, the teacher assigns pre-class homework with a primary focus on assigning presentations given by students during the class. These learning tasks are labeled as "task points" on Xuexitong and the platform automatically records the time spent and completion status of each task point.

(2) In- class teaching activities

[2]http://fanya.chaoxing.com/portal/

At the beginning of the class, the teacher employs an intelligent attendance system to check students' attendance. Subsequently, the teacher uses the learning platform's online testing module to quiz students on their pre-class tasks. During the quiz, Xuexitong monitors and records the number of times students leave the exam screen to prevent them from using mobile devices to search for quiz answers. After the automatic grading of the quiz, the teacher provides feedback on some quiz questions. Next, group representatives give presentations followed by a "question and answer" (Q&A) session involving the presenters, the teacher and the students. After the presentations, the teacher provides feedback on them and subsequently gives classroom instructions. The teacher then poses questions on the learning platform related to the key and challenging points of the lecture encouraging student responses. Finally, at the end of the class, the teacher announces the homework assigned for the day.

(3) Post-class teaching activities.

The teacher uses a computer or laptop installed with the Xuexitong application to grade student assignments. The teacher interacts with students in the online forum providing answers to questions to reinforce the key points of the learning contents. Additionally, the learning platform equipped with big data functionality not only fully records students' learning trajectories and activities but also conducts statistical analysis on students' participation in learning activities, resource usage, quiz scores and class attendance. The teacher commends and actively inspires students to exhibit exceptional performance drawing upon extensive big data learning analysis. Simultaneously, the teacher offers timely personalized guidance and support to students who may benefit from improvement.

The teaching process outlined in Figure 1 endeavors to adhere to the extensively referenced principles of smart pedagogy presented by Spector [12]: seamless learning, digital play, student agency, autonomy, gamification, customization, authentic environment, simulation, context-awareness, data sharing, artifact construction, co-construction, reflection, real-world processes, real-world tools, role-play, peer review, codesign for mobile learning, intergenerational learning, bridging and community-based approaches.

This section of the paper successfully answers RQ1 which is: How to implement smart medical English pedagogy on Xuexitong? Sections 4.2 and 4.3 of the paper are dedicated to addressing RQ2, which is: How can the effectiveness of smart medical English pedagogy are validated on Xuexitong?

4.2. Exam Score Comparison

The effectiveness of the smart pedagogy was validated through a comprehensive statistical analysis of seven score values (see Figure 2) comparing exam results between the control and experimental groups. The initial 4 score values reflect the average scoring rates of examinees across the first 4 exam items, which included multiple choice (MC), fill in the blanks (FB), term translation (TT) and reading comprehension (RC), constituting 30%, 14%, 16% and 40% of the total scores, respectively. Notably, the first three test items directly aligned with textbook content collectively contribute to 60% of the total scores. These exam items predominantly evaluated students' comprehension and proficiency regarding common diseases and their nursing measures, as emphasized in the curriculum. In contrast, the reading comprehension (RC) section was unrelated to textbook content and centered on assessing students' aptitude for understanding medical passages unrelated to the textbook.

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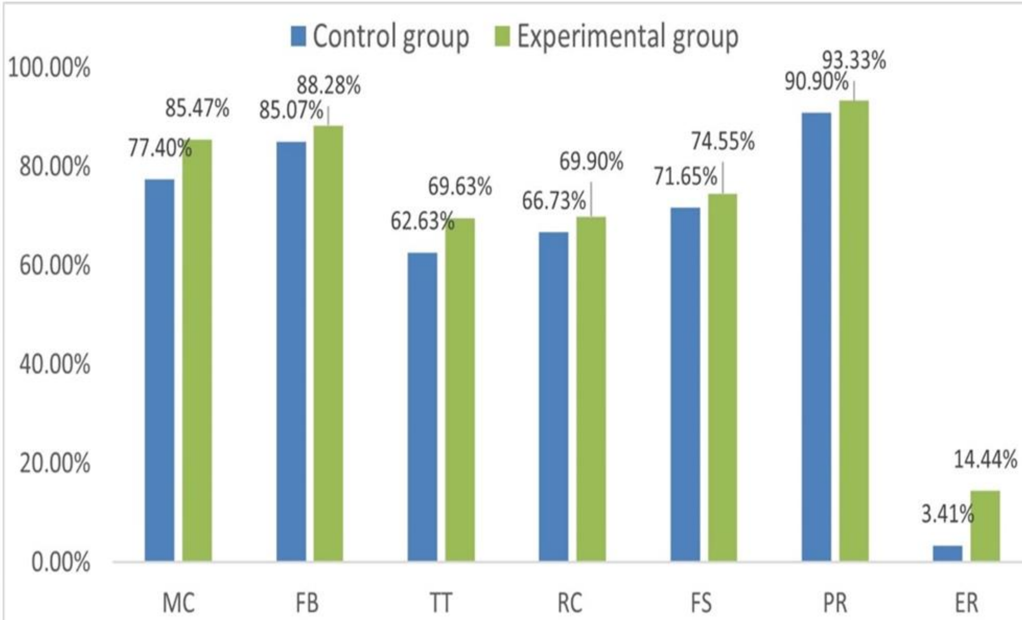

Figure 2.
Comparison chart of score-related data for the control and experimental groups.

The fifth score value (FS) delineated the scoring rates of both the control and experimental groups. The sixth and seventh score values represent the pass rates (PR) and excellent rates (ER) with the passing threshold set at 60 points and the excellence threshold at 85 points.

According to the bar chart presented in Figure 2, the control and experimental groups show notable discrepancies in the scoring rates for the initial three question types—MC, FB, and TT. In contrast, within the RC category, the scoring rates demonstrated a comparatively minor difference. Similarly, the passing rates for the control and experimental groups stood at 90.90% and 93.33%, respectively indicating a relatively modest disparity. However, in stark contrast, the excellent rates for the control and experimental groups were 3.41% and 14.44%, respectively, revealing a pronounced discrepancy.

Subsequently, the study incorporated a t-test analysis of examination scores (see Table 1). In this investigation, a t-test was employed to determine the potential influence of smart pedagogy on medical *English* course learning. The analysis specifically focused on the 5 items that may exhibit significant differences. These 5 items correspondingly represented the mean scores of MC, FB, TT, RC, and FS respectively of the control and experimental groups.

Table 1.
T-test results for score comparison between the control and experimental groups.

	Item mean scores (M ± SD)		***t***	***p***
	Control classes (*n*=88)	**Experimental classes (*n*=90)**		
MC	23.22±3.99	25.64±2.93	-4.624	0.000***
FB	10.91±2.01	12.36±1.55	-2.656	0.009***
TT	10.02±2.51	11.14±2.57	-2.941	0.004***
RC	26.69±4.94	27.96±4.75	-1.739	0.084*
FS	71.65±9.25	74.55±9.13	-3.814	0.000***

Note: * p<0.1 *** p<0.01 In the t-test, * p<0.1 () means p < 0.1 (Weak significance), (Moderate significance), and *** means p < 0.01 (Strong significance).

According to Table 1, students in the control group achieved mean scores of 23.22 (SD = 3.99), 11.91 (SD = 2.01), 10.02 (SD = 2.51), 26.69 (SD = 4.94) and 71.63 (SD = 9.25) for MC, FB, TT, RC, and FS, respectively. Meanwhile, students in the experimental group obtained scores of 25.64 (SD = 2.93), 12.36 (SD = 1.55), 11.14 (SD = 2.57), 27.96 (SD = 4.75) and 76.88 (SD = 9.13) for MC, FB, TT, RC and FS. The corresponding p-values for MC, FB, TT, RC, and FS were 0.000, 0.100, 0.004, 0.084, and 0.000, respectively.

4.3. Course Feedback Survey in Experimental Classes

We conducted a course feedback survey on 2 experimental classes to obtain a more precise understanding of students' acceptance of the smart pedagogy. The survey employed a 7-point Likert scaling assessment and the 25 survey items were crafted by drawing upon existing research including works by Hao et al. [24], Botero et al. [25] and Li and Chu [26]. These 25 questionnaire items were distributed across 5 subscales: perceived usefulness (PU), perceived ease of use (PE), facilitating conditions (FC), motivation of use (MU), and smart self-efficacy (SS).

Table 2.
Students' Likert scale feedback survey of smart pedagogy on Xuexitong.

Items	**Mean**	**SD**	**Subscale reliability coefficient**
Subscale 1: Perceived usefulness (PU)			0.820
1. I think smart teaching can increase the effectiveness of classroom instruction.	5.477	0.991	
2. I think smart teaching can assist my course learning.	5.709	1.016	
3. I think the adoption of smart mobile devices can enhance my performance in my course learning.	5.384	1.2	
4. I think Xuexitong is very useful and helpful in my course learning.	5.383	0.948	
5. I think smart mobile devices make classroom instruction more effective.	5.663	0.978	
Subscale 2: Perceived ease of use (PE)			0.918
6. I would find MALL on Xuexitong easy to use in my course learning.	5.488	0.991	
7. My interaction with Xuexitong would be clear and understandable.	5.628	1.03	
8. I would find my smart phone a convenient tool for my course learning.	5.628	0.959	
9. It would be easy for me to become skilled at using smart teaching platforms.	5.581	1.057	
10. The teacher's use of Xuexitong in class is convenient for both teachers and students.	5.587	1.079	
Subscale 3: Facilitating condition (FC)			0.877
11. I have the resources necessary to be engaged in smart mobile learning.	5.791	0.984	
12. I can have easy and regular access to the wireless connection on my smart phone or iPad.	5.814	0.988	
13. I can seek assistance from specialized personnel when facing technical difficulties in my mobile learning.	5.721	0.99	
14. In general, the university has supported us in the course of smart mobile pedagogy.	5.709	1.016	

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Items	Mean	SD	Subscale reliability coefficient
15. I have a smart phone or a tablet.	5.779	0.938	
Subscale 4: Motivation of use (MU)			0.896
16. I like learning collaboratively or independently on Xuexitong.	5.86	0.842	
17. I prefer smart mobile teaching on Xuexitong compared with traditional classroom instruction.	5.663	0.941	
18. I want to spend more time on course learning due to the convenience brought by smart mobile devices.	5.953	0.919	
19. Smart mobile pedagogy increased my interest in learning.	5.907	1.002	
20. I feel motivated to actively participate in discussions and activities facilitated through smart mobile devices.	5.581	1.079	
Subscale 5: Smart self-efficacy (SS)			0.912
21. I felt confident in using the smart mobile platform and devices for course learning and instruction.	5.698	0.869	
22. I feel confident in my ability to effectively use smart mobile devices for educational purposes.	5.581	1.09	
23. I am confident in my ability to troubleshoot technical issues on my smart phone related to educational apps.	5.791	0.922	
24. I can independently navigate and explore various educational resources on my smart mobile devices.	5.756	0.945	
25. I feel capable of managing my time efficiently when engaging in smart mobile learning activities.	5.849	0.901	

The reliability of the course feedback survey was confirmed through the evaluation of the subscale reliability coefficient of the Likert scale survey statements. The high subscale reliability coefficients validated the strong internal consistency among the 25 subscale items. The subscale reliability coefficients for the five dimensions (PU, PE, FC, MU, and SS) were 0.820, 0.918, 0.877, 0.896 and 0.912, respectively (Table 2). These findings supported robust internal consistency among the survey items with Cronbach's alpha reliability values ranging from 0.820 to 0.896 ($0.90 > \alpha > 0.80$) and 0.912 to 0.918 ($\alpha > 0.90$) indicative of levels of reliability respectively classified as "good" and "excellent" [27].

Furthermore, respondents consistently rated the Likert scale assessment statements above the mean value (m=4) indicating a high level of acceptance for smart pedagogy. The minimum Likert scale value provided by the respondents surpassed the mean significantly. Drawing upon the elevated Likert scale ratings from the 10 assessment statements within subscales 1 and 2, the respondents recognized smart pedagogy as a beneficial pedagogical approach (PU) and perceived it as easy to implement (PE). Then, respondents believed that five facilitating conditions (FC), including the availability of wireless connections, assistance from specialized personnel, university administrative support and access to smart learning devices contributed to the successful implementation of smart pedagogy. Finally, the respondents' elevated Likert scale scores on the assessment items related to motivation of use (MU) and smart efficacy (SS) conveyed their strong motivation and ample confidence in smart pedagogy. This emphasizes their heightened preparedness to adopt a smart pedagogical approach to learning medical *English*.

5. Discussion

We investigated the efficacy of the smart pedagogical approach by comparing the exam scores of both the control and the experimental groups. The results of this examination score comparison were

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visually depicted in Figure 2 as a bar graph. As depicted in Figure 2, the experimental group excelled over the control group in all compared score-related data. Specifically, within the domains of multiple choice (MC), term translation (TT) and excellence rate (ER), the experimental group exhibited significantly higher values compared to the control group. The passing rates were slightly lower in the control group (90.90%) compared to the experimental group (93.33%), a difference of less than 3 percentage points (see Figure 2). This subtle variation in PR could be attributed to the fact that both the traditional and smart pedagogical teaching approaches were effective enough to ensure the students passed the exam. In stark contrast, among the seven comparison items, ER exhibited the most pronounced differences. This significant difference in ER ($S \geq 85$) suggested that the smart pedagogical approach played a role in deepening students' mastery and understanding of crucial course content, contributing to their excellence in the exam. This aligns with Phoong et al.'s [28] study which confirms that smart classrooms greatly improve students' academic performance compared to conventional classrooms. Meng et al. [29] also confirm that smart pedagogy significantly promotes learning outcomes in students by integrating situated learning, mastery learning, adaptive learning, reflective learning and thinking tools. T-tests were employed to examine and confirm potential significant differences within data related to scores. There was only 1 item out of the 5 that did not show significant changes (see Table 1). The item that did not exhibit significant differences was reading comprehension (RC). As shown in Table 1, both the control group (26.69 ± 4.94) and the experimental group (27.96 ± 4.75) displayed close mean and standard deviation values in RC. The increased p-value (0.084) derived from the t-test implied a lack of significant difference in RC between the control and experimental groups where the non-significant threshold was established at $p>0.05$. RC constituted the largest portion (40%) of the exam scores among all exam items. It assessed students' reading proficiency in medical-related passages unrelated to course book contents and classroom instruction. The non-significant difference in RC might be attributed to the test's emphasis on language proficiency rather than on course content. Moreover, a single semester of teaching experimentation might not have been sufficient to impact the overall language proficiency of the experimental group students.

On the other hand, 4 out of the 5 compared items showed significant differences. Significant differences ($p<0.05$) were observed in FB, MC, TT and FS between the control and experimental groups. FB, MC, and TT, closely connected to course book contents and classroom instruction demonstrated higher average scores in the experimental group indicating the effectiveness of smart pedagogy in medical *English* instruction.

Among the 4 comparison items with significant differences, FS was particularly noteworthy. A significant difference in FS was identified between the control and experimental groups ($t=-3.814$, $p=0.000$). Notably, the average score in the control class (71.62) was significantly lower than that in the experimental class (76.88) indicating that smart pedagogy substantially enhanced students' performance in the exam.

The course feedback survey conducted among the experimental group students confirmed the high acceptance of smart pedagogy among the students. The results are clearly presented in Table 2. Mean values represented respondents' average Likert scale assessments with a higher mean indicating a more positive attitude. The standard deviation gauged overall variation with lower values indicating greater consistency. The survey confirmed that respondents provided a positive evaluation of the 25 subscale items acknowledging smart pedagogy as a beneficial methodology.

The feedback survey results further support many studies concerning learners' acceptance of smart teaching and learning. Lall et al. [30] discovered that students warmly embrace the smart classroom concept due to the use of smart technologies, like 3D animated modules or videos in teaching which help cultivate higher-level thinking and improve reading skills. Uskov et al. [31] gathered student feedback confirming a keen interest among students in smart pedagogy.

6. Conclusion

The introduction of smart pedagogy provides a new teaching method and perspective for the teaching of medical *English*. The smart teaching in this study integrated the advantages of smart mobile devices and the Xuexitong platform making the classroom instruction of medical *English* lively and effectively addressing the issues of personalized needs of the students. The smartphones or tablets owned by every student and teacher have evolved into effective tools for smart learning and teaching. This study also confirmed that the integration of mobile education technology and the concept of smart teaching known as smart pedagogy were the direction and solution for education to move towards informatization, intelligence and personalization.

This study is subject to several limitations. First, the sample size was relatively small with a total of 178 nursing majors divided into four classes which may limit the generalizability of the results. Second, the study focused on a single academic semester which might not be sufficient to capture the long-term impact of smart pedagogy on students' learning outcomes. Third, the study was conducted in a specific geographical location Zhejiang Province, China where the educational context might differ from other regions potentially affecting the transferability of the results.

This study has highlighted a critical recommendation for future research: examining the significance, urgency and approach to enhancing smart teaching competencies among current educators. Smart pedagogy mandates that teachers excel in using smart devices, possess robust skills in collecting, organizing, and processing network resources and excel in producing multimedia courseware. Therefore, the smart teaching mode places increased demands on the professional capabilities and dedication of teachers. As a result, teachers must be trained to enhance their information literacy and foundational skills in smart teaching.

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Institutional Review Board Statement:

The Ethical Committee of the Taizhou University, China has granted approval for this study (Ref. No. 2023-12-01).

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

Competing Interests:

The authors declare that they have no competing interests.

Authors' Contributions:

All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

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Appendix A.

Course feedback survey.

(For experimental class respondents)

This survey has been developed to record your evaluation of your acceptance of the smart pedagogy. The survey is divided into 2 sections, both of which are required

***Required**

Section I: Demographic information

Your gender:

① Male ( ) ② Female ( )

Your years of teaching experience:

① 0-10 years ( ) ② 11-20 years ( ) ③ over 20 years ( )

You are now teaching

① EFL courses for English majors ( ) ② EFL courses for non-English majors ( )

***Required**

Section II: Likert scale assessment

You are invited to participate in a 7-point Likert scale questionnaire. The Likert scales are utilized to measure your acceptance level with the smart pedagogy, ranging from Strongly Disagree (SD/1), Disagree (D/2), Moderately Disagree (MD/3), Neither Disagree nor Agree (NN/4), Moderately Agree (MA/5), Agree (A/6), to Strongly Agree (SA/7). Please mark the relevant blank with a "√".

The extent of your agreement / **Measurement items**	**SD** (1)	**D** (2)	**MD** (3)	**NN** (4)	**MA** (5)	**A** (6)	**SA** (7)
(1) I think smart teaching can increase the effectiveness of the classroom instruction.							
(2) I think smart teaching can assist my course learning.							

(3) I think the adoption of smart mobile devices can enhance my performance in my course learning.							
(4) I think Xuexitong is very useful and helpful in my course learning.							
(5) I think smart mobile devices make the classroom instruction more effective.							
(6) I would find MALL on Xuexitong easy to use in my course learning.							
(7) My interaction with Xuexitong would be clear and understandable.							
(8) I would find my smart phone a convenient tool in my course learning.							
(9) It would be easy for me to become skillful at using smart teaching platform.							
(10) Teacher's use of Xuexitong in class is convenient for both teacher and students.							
(11) I have the resource necessary to be engaged in smart mobile learning.							
(12) I can have easy and regular access to the wireless connection on my smart phone or iPad.							
(13) I can seek assistance from specialized personnel when facing technical difficulties in my mobile learning.							
(14) In general, the university has supported us in the course of smart mobile pedagogy.							
(15) I have a smart phone or a tablet.							
(16) I like learning collaboratively or independently on Xuexitong.							
(17) Compared with the traditional classroom instruction, I prefer smart mobile teaching on Xuexitong.							
(18) I want to spend more time on course learning due to the convenience brought by smart mobile devices.							
(19) Smart mobile pedagogy increased my interest in learning.							
(20) I feel motivated to actively participate in discussions and activities facilitated through smart							

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mobile devices.							
(21) I felt assured in utilizing the smart mobile platform and devices for course learning and instruction.							
(22) I feel confident in my ability to effectively use smart mobile devices for educational purposes.							
(23) I am confident in my ability to troubleshoot technical issues on my smart phone related to educational apps.							
(24) I believe I can independently navigate and explore various educational resources on my smart mobile devices.							
(25) I feel capable of managing my time efficiently when engaging in smart mobile learning activities.							
Thank you for participating in this survey!							

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