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A Scoping Review of the Rain Classroom:
An intelligent pedagogical tool for nursing education

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Abstract
This scoping review explores the use of Rain Classroom, an interactive platform integrated with WeChat, within nursing education by analyzing its uses, benefits, and challenges. Out of 1,726 studies screened between 2016 and 2025, 27 empirical studies highlighted key strengths such as increased interactivity, real-time feedback, and adaptability. Nonetheless, notable obstacles persist, including technological demands on faculty, challenges with student self-discipline, and infrastructure limitations. While Rain Classroom presents significant potential, its effective implementation requires addressing both technical and educational hurdles, indicating a need for further research into its long-term effects and best practices for integration.

Keywords: Rain Classroom; nursing education; technology-enhanced learning; scoping review

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1.0 Introduction
The rapid advancement of information technology has catalyzed significant transformations in nursing education methodologies. The systematic integration of digital tools into conventional teaching frameworks has substantially accelerated the adoption of online learning platforms (Mendez et al., 2020; Rutledge et al., 2021). This transition experienced unprecedented growth during the COVID-19 pandemic (Chang et al., 2022), stimulating the development of diverse digital tools that effectively align with various instructional designs. These platforms provide engaging educational experiences supported by timely personalized feedback mechanisms (Xue et al., 2023; Ghafouri et al., 2024). The Rain Classroom was collaboratively developed by Tsinghua University and Xuetang X back in 2016 (Zhu, 2021). It seamlessly integrates with WeChat, one of the most widely used communication software applications in the world. This unique integration sets it apart from other online tools and ensures easy accessibility. Furthermore, Rain Classroom has been successfully

implemented and validated across various educational fields (Feng et al., 2022; Han & Lu, 2020; Li et al., 2021). Within nursing education, where educators maintain a steadfast commitment to optimizing professional training for future healthcare practitioners, the strategic adoption of evidence-based digital tools has become increasingly imperative. Nevertheless, to the best of our knowledge, no scoping review has systematically investigated the effectiveness of Rain Classroom specifically within nursing education contexts. This study aims to address this critical knowledge gap by comprehensively examining the platform's educational impacts, identifying salient benefits and implementation challenges, and proposing strategic recommendations for future integration. Through this systematic scoping review, we additionally seek to identify significant research gaps and suggest productive avenues for scholarly inquiry. We anticipate that our findings will provide valuable insights for both educational researchers and nursing education practitioners.

2.0 Literature review

2.1 Technological Advantages of Rain Classroom in Nursing Education
Rain Classroom, a blended learning platform that integrates WeChat and PowerPoint, offers several distinct advantages for nursing education. Its robust data analytics functionality enables personalized instruction by allowing educators to monitor individual student progress and adjust teaching strategies in real time (Gong, 2021). Performance dashboards within the system support the early identification of at-risk students, facilitating timely interventions critical in competency-based nursing training (Fang, 2024). Moreover, the platform's offline synchronization capability ensures uninterrupted learning during clinical rotations, overcoming common connectivity challenges in hospital settings (Ying & Liang, 2022). This feature effectively bridges online and offline learning modes, enabling flexible review of course materials while sustaining instructor-student interaction a vital resource for students managing concurrent theoretical and clinical responsibilities. Recent research further confirms the platform's reliability and adaptability across diverse educational contexts, including institutions with limited resources (Liu et al., 2024).

2.2 Educational Challenges and Implementation Barriers
Despite growing evidence linking Rain Classroom to enhanced student engagement and academic performance (Zhu, 2021; Feng et al., 2022; Lin et al., 2023), its widespread adoption continues to encounter significant barriers. A primary obstacle is faculty resistance, frequently stemming from the platform's technological complexity and the substantial time investment required to redesign course materials (Guo et al., 2020). This challenge is further exacerbated by the platform's reliance on students' self-directed learning abilities, potentially disadvantaging learners with limited self-regulation skills. Additionally, as Han and Lu (2020) note, Rain Classroom demands higher levels of instructional design competence from instructors, requiring more advanced pedagogical strategies to fully realize its potential. Collectively, these challenges underscore that successful implementation depends not only on robust technological infrastructure but also on systematic faculty training and sustained institutional support.

2.3 Linking Statement
Although the existing literature highlights both the benefits and challenges associated with Rain Classroom, the evidence is scattered and lacks coherence across nursing education settings. To bridge the gap between technological potential and practical implementation, a systematic synthesis of current research is critically needed. This scoping review seeks to map the available evidence comprehensively, identify recurring themes and persistent knowledge gaps, and provide actionable recommendations for the effective integration of Rain Classroom in nursing education.

3.0 Methodology

3.1. Study Design
This scoping review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) guidelines (Tricco et al., 2018), employing Arksey and O'Malley's (2005) methodological framework (Fig.1). The methodology comprised the following stages: (1) identifying the research question, (2) searching for relevant studies, (3) study selection, (4) data charting, and (5) collating, summarizing, and reporting the results.
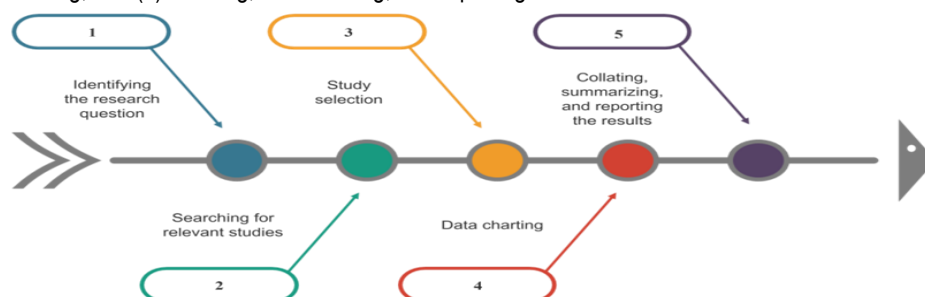

Figure 1. Methodological framework *(Arksey and O' Malley, 2005)*

3.2. Identifying the Research Question

This study is guided by the following primary research questions:

RQ 1: In what ways can Rain Classroom enhance nursing education? This question is broken down into the following sub-questions:

RQ 1: Which teaching models have been integrated with Rain Classroom in nursing education? RQ 2: What are the most commonly used evaluation tools for measuring their effectiveness? RQ 3: What are the key benefits of implementing Rain Classroom in nursing education?

RQ 2: What implementation challenges and practical limitations have been encountered when adopting Rain Classroom in nursing education settings?

3.3. Searching For Relevant Studies

A comprehensive literature search was conducted across seven databases: PubMed, Web of Science, Scopus, CINAHL (Cumulative Index to Nursing and Allied Health Literature), Wanfang, VIP, and CNKI. The search encompassed publications from April 2016 to February 2025 to ensure the inclusion of recent and relevant studies while maintaining a sufficient sample size for analysis.

Search terms were systematically developed based on the titles, abstracts, and keywords of previously identified relevant articles. Boolean operators were employed to refine the search strategy: "OR" was used to combine related terms within each conceptual group, while "AND" was applied to link different search sets. The complete list of English and Chinese search terms is presented in Table 1.

Table 1. Search terms.

Mesh	English search terms	Chinese search terms
Population: Nursing students	Students, Nursing OR Nurses OR Intern OR Trainee	护生实习 OR 护生学习 OR 护生临床实习 OR 护生教学 OR 实习护生 OR 护理实习生 OR 护士
Concept: Rain Classroom	Rain Classroom OR Learning Management System OR Educational Technology OR Education, Distance OR Blended learning OR Mixed study OR Active learning	雨课堂教学 OR 雨课堂平台 OR 雨课堂 OR 雨课堂智慧教学 OR 雨课堂软件
Context: Nursing Education	Education, Nursing OR Nursing education research OR Nursing teaching OR Nursing OR Teaching Rounds	护理教育 OR 护理学教育 OR 护理教学 OR 护理带教 OR 护理学教学

3.4. Study Selection

Figure 2.0 shows the PRISMA guidelines followed to report on the article selection process.
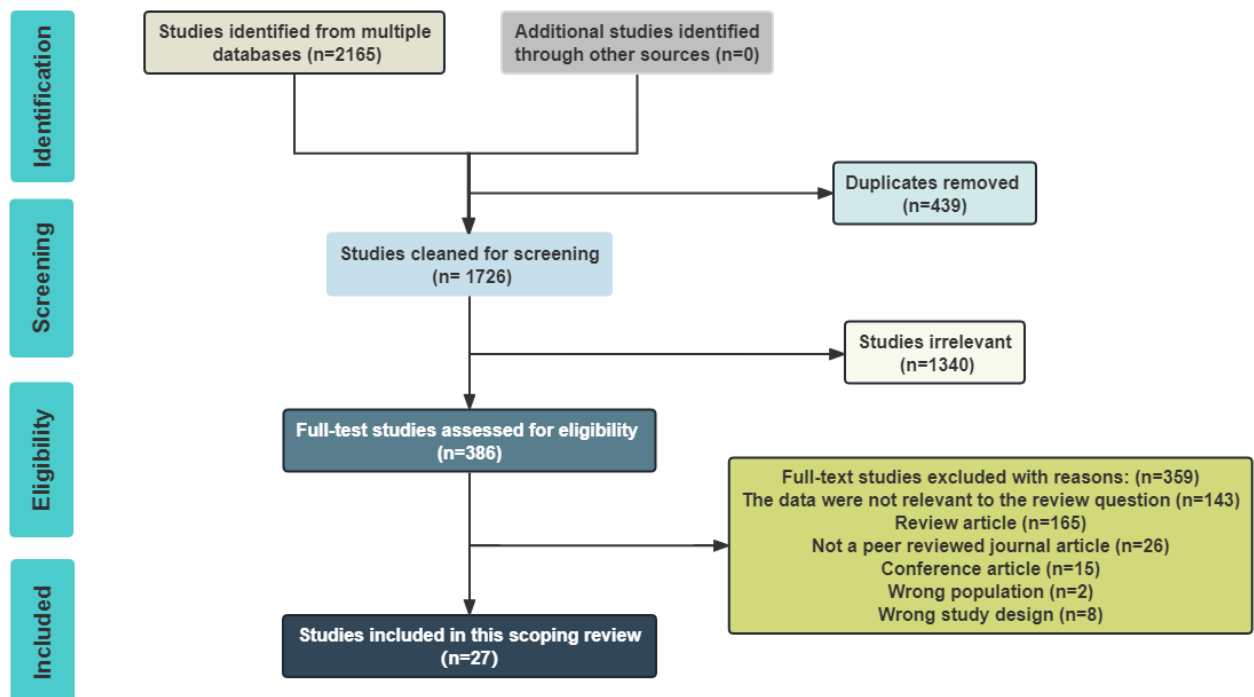

Figure 2. PRISMA flow diagram for paper selection.

All citations were imported into EndNote, and duplicates were removed. The review included peer-reviewed primary studies in English or Chinese on the use of Rain Classroom in nursing education, published since its introduction in 2016. Eligible designs were descriptive, cross-sectional, cohort, quasi-experimental, and experimental studies. Grey literature and inaccessible full texts were

excluded. After screening and team consensus on borderline cases, 27 studies were retained from 1,726 identified, with most exclusions due to irrelevance, non–peer-reviewed sources, or conference papers.

3.5. Data Charting
The research team systematically extracted data from each selected article across the following domains: author, year of publication, country of origin, research methods or methodology, assessment tools employed, sample size (N), key findings, and conclusions.

3.6. Collating, Summarizing, and Reporting Results
Two authors (QX and LX) conducted a thorough reading of the full articles. Through structured adjudication sessions, they independently identified categories and subsequently convened to discuss and consolidate these categories into overarching themes. Any discrepancies at this stage were resolved by referring them to a third examiner (HE) for final arbitration. The review findings were systematically collated, summarized, and organized into descriptive narratives in accordance with the methodologies outlined by Pham et al.(2014). Additionally, tables were utilized to complement and enhance the clarity of the narrative presentation.

4.0 Findings
This section presents the results of the analysis of the responses to the research questions defined in Section 3.2. In what ways can Rain Classroom enhance nursing education? RQ 1 : This question is broken down into the following sub-questions:
(RQ 1): Which teaching models have been integrated with Rain Classroom in nursing education?.
From a comprehensive analysis of 27 review studies, the distribution of instructional models is as follows: BOPPS model (Bridge-in, Objective, Pre-assessment, Participatory Learning, Post assessment, Summary): 6 studies; Blended teaching model: 6 studies; PBL (Problem-Based Learning): 2 studies; PAD (Presentation-Assimilation-Discussion): 2 studies; Flipped Classroom: 2 studies; CBL (Case-Based Learning): 4 studies; TBL (Team-Based Learning): 1 study; Standardized Patient model: 1 study; SPOC (Small Private Online Course): 1 study; Scenario Simulation model: 1 study; Flipped Classroom + PAD hybrid model: 1 study. A detailed breakdown of these distributions is provided in Table 2.
  (RQ 2) What are the most commonly used evaluation tools for measuring their effectiveness?
Among the 27 included studies, three primary assessment tools were utilized. Specifically, examination scores were used in all studies (100%), teaching satisfaction questionnaires were employed in 23 studies (85%), and the Self-Rating Scale of Self-Directed Learning was applied in 11 studies (41%). For more detailed results, please refer to Table 2.

Table 2. Characteristics of included studies

Teaching Model	Leader author(Year)	Nursing Course	Sample Size	Evaluation Tools
BOPPS	Yangbo Tan (2020)	Surgical Nursing	132	A; B
	Lina Zhu (2024)	Thoracic Surgery Nursing	90	A; B; C
	Bowen Zhao (2023)	Operating Room Nursing	119	A; C
	Qiuming Tang (2022)	Radiation Therapy Nursing	112	A; B; C
	Zhouyan Ming (2023)	ICU Nursing	126	A; B; C
	Xiaomin Lin (2023）	Obstetrics and Gynecology Nursing	300	A; B
Blended Teaching	Linlin Liu(2021)	Traditional Chinese Medicine Nursing	196	A; B
	Jinling Tang (2020)	Obstetrics and Gynecology Nursing	210	A; B
	Haijun Liu (2024)	Emergency Clinical Nursing	60	A
	Xuchuan Zhou (2021)	Operating Room Nursing	363	A; B
	Na Song (2024)	Orthopaedics Nursing	210	A; B
	Xiaoli Feng (2022)	Physiology	87	A; B
PBL	Hui Pei (2022)	Obstetrics and Gynecology Nursing	60	A; B
	Min Chen (2022)	Surgical Nursing	64	A; B
PAD	Zhenxiang Wang(2021)	Biochemistry	195	A; B
	Hui Lv （2024）	Surgical Nursing	212	A; B; C
Flipped Classroom	Fei Lv(2018)	Nursing Introduction	106	A; B
	Tian Zhang （2021）	Hemodialysis Center Nursing	114	A; C
CBL	Ya Meng (2023)	Fundamentals of Nursing	135	A; B; C
	Ya Meng (2020)	Fundamentals of Nursing	114	A; B; C
	Xiaorong Chen(2020)	Clinical Nursing in Gastroenterology	101	A; B
	Pingping Fang(2024)	Rehabilitation Nursing	100	A; C
TBL	Ang Liu (2021)	Emergency Clinical Nursing	120	A; B
Standardized Patient	Ju Mu(2019)	Fundamentals of Nursing	72	A; C
SPOC	Mingjin Wu (2022)	Emergency Clinical Nursing	108	A; B; C
Scenario Simulation	Jiang Zhang (2022)	Radiation Therapy Nursing	120	A; B
Flipped Classroom +PAD	Yanxia Guo (2020)	Geriatric Nursing	198	A; B

Note: Assessment tools: A = Examination score; B = Teaching satisfaction questionnaire; C = Self-Rating Scale of Self-Directed Learning

(RQ 3). What are the key benefits of implementing Rain Classroom in nursing education?

A comprehensive review of the literature revealed four primary advantages of Rain Classroom in nursing education: (1) rich and diverse pedagogical experience, (2) real-time data collection and analysis integrated into the instructional process, (3) adaptability to various instructional settings, and (4) flexibility in scheduling instructional time. The detailed findings are summarized in Table 3.

Table 3. Key Benefits of Rain Classroom in Nursing Education Identified in Included Studies (N=27)

Key benefit	Rain Classroom description	Citation references
Rich and diverse pedagogical experience	- Real-time Interaction: In-class bullet comments ("Danmu"), a "Confused" feedback button, instant polling, likes, and quizzes enhance student engagement and enable immediate clarification of doubts. - Multi-format learning materials (video, audio, PPT) accommodate diverse learning styles and promote self-directed learning.	Meng et al., 2023; Wang et al., 2021; Liu et al., 2021; 2020; Zhang et al., 2021; Tang et al., 2020; Fang et al., 2024; Liu et al., 2024; Pei et al., 2022; Ming et al., 2023; Song & Xia, 2024; Lin et al., 2023; Feng et al., 2022;
Real-time data collection and analysis integrated into the instructional process	- Automated Performance Analytics: Embedded quiz analytics, response time tracking, and participation heatmaps quantify comprehension levels and uncover learning patterns. - Post-Class Reinforcement: Automated exercise distribution, learning behavior dashboards, and comparative performance reports monitor longitudinal progress and assess teaching strategies.	Liu et al., 2021; Zhang et al., 2022; Wu et al., 2022; Liu et al., 2024; Ming et al., 2023; Song & Xia, 2024; Lin et al., 2023; Feng et al., 2022
Adaptability to various instructional settings	- Micro-module design combined with integrated pre-class, in-class, and post-class activities supports just-in-time learning while maintaining learning continuity. - Gamified learning journeys enhance cognitive engagement. - The adaptable setting of a hybrid mode supports both online and clinical environments effectively.	Meng et al., 2020; Liu et al., 2021; Mu et al., 2019; Liu et al., 2024; Feng et al., 2022
Flexibility in scheduling instructional time	- Time-Independent Access: Live and recorded lecture support, along with 24/7 video replay, accommodates shift-work schedules while enabling self-paced review. - WeChat Ecosystem Integration: Seamless integration within the WeChat ecosystem reduces technological barriers and promotes ubiquitous learning.	Meng et al., 2023; Zhu et al., 2024; Zhang et al., 2022; Tang et al., 2020; Fang et al., 2024; Liu et al., 2024; Zhou et al., 2021; Chen et al., 2022; Lin et al., 2023

RQ 2: What implementation challenges and practical limitations have been encountered when adopting Rain Classroom in nursing education settings?

Several challenges were mentioned in the included articles, and we have categorized them into three facets. For more details, see supplemental material Table 4.

Table 4. Challenges of Rain Classroom in Nursing Education Identified in Included Studies (N=27)

Challenges	Rain Classroom description	Citation references
Teacher	- Technical Proficiency: Increased preparation time and the need for ongoing IT training. - Workload Balance: Simultaneous clinical duties, e-teaching, and monitoring 24/7 student interactions increase the risk of instructor burnout and pose significant time management challenges.	Meng et al., 2023; Liu et al., 2021; Zhu et al., 2024; Fang et al., 2024;
Student	- Time Demands: Increased extracurricular workload may lead to a higher risk of burnout. - Learning Pressure: The fast-paced instructional flow significantly increases students' stress levels. - Self-Directed Learning: It demands effective autonomous progress management from students.	Zhu et al., 2024;; Liu et al., 2021;
Others	- Technical Infrastructure: Requires stable, high-speed network connectivity. - Instructional Design: Involves complex sequencing of learning activities. - Student Monitoring: Limited ability to track off-task behaviors and increased risk of internet addiction. - Academic Integrity: Raises concerns about the potential for unauthorized online answer retrieval.	Meng et al., 2023; Wang et al., 2021; Liu et al., 2021; Fang et al., 2024; Zhou et al., 2021

5.0 Discussion

In addition to the evaluation in Section 4, this section discusses the findings and their implications. Rain Classroom is compatible with various teaching approaches, as shown by the 27 studies reviewed. It has improved nursing courses by increasing teaching satisfaction, fostering self-directed learning, and enhancing exam performance.

Rain Classroom enhances instructional effectiveness through interactive features such as bullet-screen discussions, real-time polling, in-class quizzes, and gamified activities. These tools promote active student engagement, particularly supporting introverted learners by reducing communication barriers a direct alignment with the "affective domain" of Bloom's Taxonomy, which emphasizes willingness to respond and sustained involvement (Wang et al., 2021; Liang, 2023). The dynamic attendance system, exemplified by

time-sensitive QR codes, ensures accountability with minimal disruption to instruction, reflecting principles of procedural efficiency and automated classroom management (Yu & Yi, 2020; Yongfen et al., 2021). Moreover, in-class quizzes motivate students to move beyond passive reception and engage with the "application" and "analysis" levels of Bloom's cognitive domain, thereby fostering critical thinking and cognitive growth (Xiaoqing et al., 2023). Collectively, these components create a structured yet interactive learning environment that synergistically supports teaching objectives across cognitive, affective, and managerial dimensions.

Rain Classroom enhances instructional responsiveness by integrating real-time data. Features such as the 'I don't understand' and 'bookmark' buttons allow students to report difficulties, enabling instructors to adjust content dynamically (Li, 2020; Liu et al., 2022). The platform's aggregation of learning analytics across instructional phases operationalizes data-driven instruction principles, generating actionable insights for personalized teaching strategies (Zhang & Li, 2021). Rain Classroom (RC) offers exceptional adaptability in instructional settings through its cross-platform compatibility (mobile/PC) and WeChat integration, providing easy access to learning resources (Liu & Zhang, 2021). By delivering course materials directly to personal devices, RC removes physical constraints like poor visibility or inadequate equipment, ensuring equitable content access (Liu et al., 2021; Xie et al., 2021). This design supports flexible learning environments where internet connectivity alone enables full functionality. Rain Classroom enhances education flexibility with livestreaming and replays functions (Huang et al., 2021). It enables QR-code-activated classes and provides on-demand access to pre-class materials and recordings, supporting self-paced learning. This functionality embodies the principles of differentiated instruction by accommodating varied learning paces and preferences, allowing students to revisit challenging content and reinforcing comprehension through repetition, thus balancing structured teaching with learner autonomy (Ma et al., 2021; Qi & Meng, 2021).

Rain Classroom also presents several challenges. For educators, technical demands and extra preparation time hinder adoption, while balancing clinical duties with constant online interactions increases burnout risk (Meng et al., 2023; Liu et al., 2021; Fang et al., 2024). Students struggle with time management due to extracurricular workloads and feel stressed by the platform's fast pace, requiring strong self-directed learning skills (Zhu et al., 2024). Systemic issues include reliance on stable internet, complex instructional design, difficulty monitoring off-task behaviors, and concerns about academic integrity in assessments (Meng et al., 2023). Potential solutions could involve IT support for teachers, structured time management programs for students, and AI-driven systems to enhance engagement and address integrity concerns.

6.0 Conclusion & Recommendation

Rain Classroom acts as a modern bridge between conventional teaching methods and digital learning, offering data-informed insights through sophisticated visualization tools while fostering interactive and self-directed learning. Despite its transformative potential, issues such as maintaining student engagement, managing instructor workload, and addressing implementation challenges persist. Future studies should prioritize: (1) long-term evaluations of its educational effectiveness, (2) the development of flexible strategies suited to various academic fields, and (3) the integration of AI-driven personalization. Addressing these areas is essential to fully realize Rain Classroom's capabilities as an innovative educational platform.

Acknowledgements

Paper Contribution to Related Field of Study

This scoping review makes three significant contributions to the fields of nursing education and digital learning research. First, it synthesizes existing evidence regarding the technological affordances of Rain Classroom specifically for nursing training, thereby addressing a gap in the literature that predominantly focuses on general medical education. Second, by systematically mapping implementation challenges such as faculty resistance and the demands of self-directed learning, it offers actionable insights for institutions adopting blended learning models. Most importantly, the review highlights understudied areas that warrant future investigation, particularly the platform's long-term effects on clinical competency development and equitable access in resource-constrained settings. These findings not only enhance theoretical understanding of technology-enhanced nursing education but also provide practical guidance for educators and policymakers.

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