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Clinical Pharmacy Advancement through the PCNE Classification System in Education

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Abstract: ***This study aims to explore the effectiveness of applying the PCNE Classification System in clinical pharmacy education. By introducing a systematic approach to Drug-Related Problem (DRP) analysis and coding, the study evaluates students' improvement in understanding DRPs, categorization, root cause analysis, intervention selection, and problem resolution assessment. The PCNE Classification System was integrated into the clinical pharmacy curriculum using a combination of case-based teaching and group discussions. Through real case analyses and scenario simulations, students were guided to systematically and scientifically analyze DRPs, followed by coding and management. Pre- and post-course questionnaires and performance assessments were conducted to evaluate students' mastery of the PCNE Classification System and its effectiveness in DRP analysis. Additionally, interviews were conducted to gather student feedback on teaching methods and learning experiences. The results indicate high student acceptance of the PCNE Classification System, with a noticeable increase in learning interest. Students demonstrated a more systematic approach to analyzing and solving DRPs. Compared to traditional teaching methods, the PCNE Classification System significantly improved students' accuracy in DRP categorization, root cause analysis, intervention selection, and problem resolution assessment. It also enhanced their clinical reasoning and pharmaceutical care capabilities [1]. The application of the PCNE Classification System in clinical pharmacy education effectively enhances students' systematic analysis skills and clinical reasoning. It is recommended to further promote and integrate this system into future courses, combined with case-based teaching and scenario simulations, to improve students' practical abilities and pharmaceutical care competencies.***

Keywords: PCNE Classification System, Clinical Pharmacy, Drug-Related Problems, Pharmacy Education, Teaching Application.

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1. Introduction

1.1 Research Background

Drug-Related Problems (DRPs) are commonly encountered in clinical medication processes, potentially leading to reduced drug efficacy, compromised medication safety, and even severe adverse reactions and medical incidents. Moreover, DRPs can increase healthcare resource consumption, resulting in unnecessary economic burdens. Consequently, effectively identifying, analyzing, and resolving DRPs has become a critical research focus in clinical pharmacy.

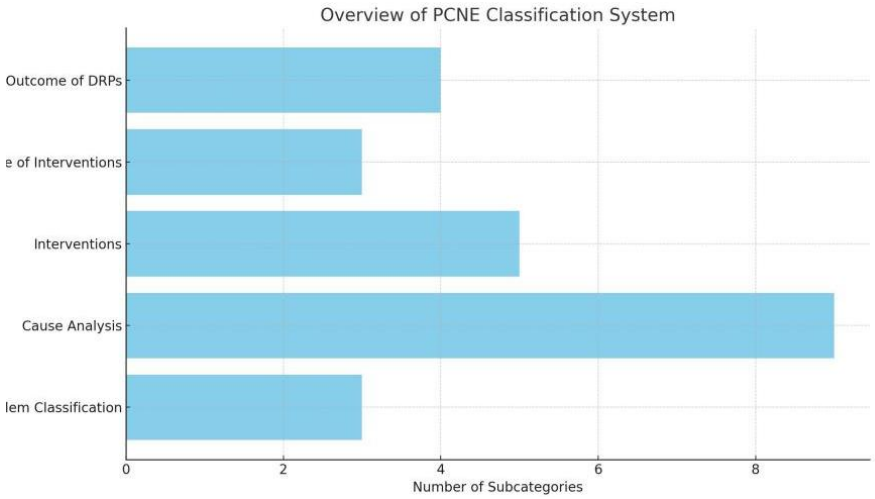

Figure 1: Overview of PCNE Classification System

This figure illustrates the structure of the PCNE Classification System, detailing its five main modules and hierarchical coding system. It helps students understand the systematic approach to analyzing Drug-Related Problems (DRPs).

The Pharmaceutical Care Network Europe (PCNE) Classification System is widely used worldwide for the analysis and management of Drug-Related Problems (DRPs) and has been updated to version 9.1. This system employs a systematic and scientific coding approach to categorize DRPs into five main modules: problems, causes, interventions, acceptance of interventions, and current status of problems, with further detailed subcategories. The PCNE Classification System not only assists pharmacists in systematically analyzing and managing DRPs but also serves as an educational tool to cultivate students' abilities to scientifically analyze and solve drug-related issues.

However, the application of the PCNE Classification System in clinical pharmacy education in China remains limited. Most institutions still adopt traditional pharmacotherapy teaching models, focusing on drug knowledge dissemination while lacking in-depth exploration of systematic DRP analysis and scientific management. Consequently, students often have a vague understanding of DRPs and exhibit weak problem-solving abilities, making it challenging to meet the demands of clinical pharmacy practice. Therefore, integrating the PCNE Classification System into clinical pharmacy education is crucial for equipping students with systematic DRP analysis methods, thereby enhancing their clinical reasoning and pharmaceutical care capabilities.

1.2 Research Objectives

This study aims to investigate the effectiveness of applying the PCNE Classification System in clinical pharmacy education by introducing a systematic approach to DRP analysis and coding, thereby cultivating students' abilities to scientifically analyze drug-related problems. Specifically, the study integrates the PCNE Classification System into case-based teaching and scenario simulations, guiding students in DRP classification, root cause analysis, intervention design, and evaluation of problem resolution status. This approach seeks to enhance students' abilities to analyze problems systematically and scientifically.

Additionally, the study will assess students' acceptance of the PCNE Classification System and its practical effectiveness, comparing the outcomes with traditional teaching methods. Through pre- and post-test questionnaires, performance evaluations, and interviews, the study will explore the role of the PCNE Classification System in improving students' abilities in DRP analysis, clinical reasoning, and pharmaceutical care. Based on teaching feedback, the study will also explore optimized teaching methods and curriculum designs, providing a reference for the future promotion and application of the system in clinical pharmacy education.

1.3 Research Significance

Integrating the PCNE Classification System into clinical pharmacy education can help students systematically learn DRP classification, root cause analysis, intervention strategies, and status evaluation, thereby enhancing their clinical reasoning and pharmaceutical care capabilities. Compared to traditional teaching models, the PCNE

Classification System employs a structured and scientific coding approach that guides students in systematic thinking, fostering their abilities to scientifically analyze and solve problems.

This study provides a new teaching approach and practical model for clinical pharmacy education in China, facilitating the promotion and application of the PCNE Classification System in domestic pharmacy education. The research findings will offer data support and scientific evidence for curriculum design and teaching method optimization, promoting innovation and development in clinical pharmacy talent training. Furthermore, the study provides valuable insights and references for international pharmacy education and clinical practice, contributing to the internationalization and competitiveness of pharmacy education in China.

2. Methods

2.1 Teaching Design

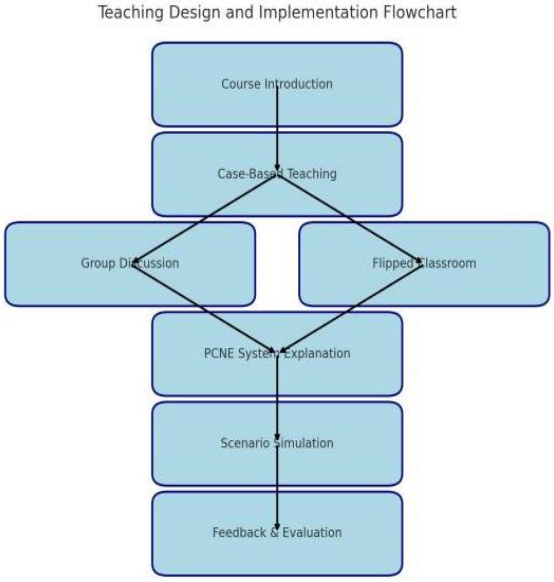

Figure 2: Teaching Design and Implementation Flowchart

This flowchart outlines the teaching design and implementation of PCNE Classification System in clinical pharmacy education, including case-based teaching, group discussions, and flipped classroom activities. It provides a clear visual representation of the instructional process.

2.2 Course Content

In this study, the PCNE Classification System was integrated into the clinical pharmacy curriculum, covering modules related to Drug-Related Problems (DRPs), including categorization, root cause analysis, intervention strategies, and problem resolution assessment. The course emphasized the five main modules of the PCNE Classification System: problem classification, cause analysis, interventions, acceptance of interventions, and current status of problems. Detailed explanations of each module's coding rules and practical application methods were provided.

To ensure comprehensive understanding, the course utilized case-based teaching, scenario simulations, and group discussions, enabling students to systematically master the fundamental principles and practical operations of the PCNE Classification System.

2.3 Evaluation Tools

Pre- and post-course questionnaires were administered to assess students' understanding of DRPs, mastery of the PCNE Classification System, and satisfaction with the teaching methods. The questionnaire covered aspects such as understanding of DRP concepts, classification accuracy, root cause analysis ability, selection of interventions, and evaluation of problem resolution. A Likert five-point scale was used for scoring, and the data were statistically analyzed to measure changes in cognitive levels and learning outcomes [2].

Students' mastery of the PCNE Classification System was evaluated through end-of-course tests and case analysis reports. The assessments included multiple-choice questions, case analysis scenarios, and coding exercises to comprehensively evaluate students' understanding and application skills. These tools aimed to measure students' proficiency in DRP classification, root cause analysis, intervention selection, and problem resolution assessment.

Semi-structured interviews were conducted with a randomly selected group of students to gain in-depth insights into their acceptance of the PCNE Classification System, learning experiences, and feedback on course design. Interview questions focused on the learning challenges encountered, interest in the subject, perceived effectiveness of the system, and suggestions for improving teaching methods and course content. The qualitative feedback was used to refine curriculum design and optimize teaching strategies for future applications.

2.4 Data Analysis

SPSS statistical software was used for data analysis in this study [3]. First, descriptive statistical analyses, including mean values, standard deviations, and frequency distributions, were conducted on pre- and post-test questionnaires and performance scores for both the experimental and control groups. Then, independent t-tests and chi-square tests were employed to compare the differences in cognitive levels, analytical skills, and academic performance between the two groups, assessing the effectiveness of the PCNE Classification System in clinical pharmacy education.

Additionally, qualitative analysis was performed on the questionnaire responses and interview feedback to summarize students' perceptions and learning experiences with the PCNE Classification System. Interview transcripts were coded and subjected to thematic analysis to identify common themes related to students' acceptance, learning experiences, and suggestions for course design improvements. These insights were used to optimize teaching strategies and curriculum design, providing a reference for future implementation and dissemination of the PCNE Classification System in clinical pharmacy education.

3. Results and Discussion

3.1 Impact of the PCNE Classification System on Student Learning Outcomes

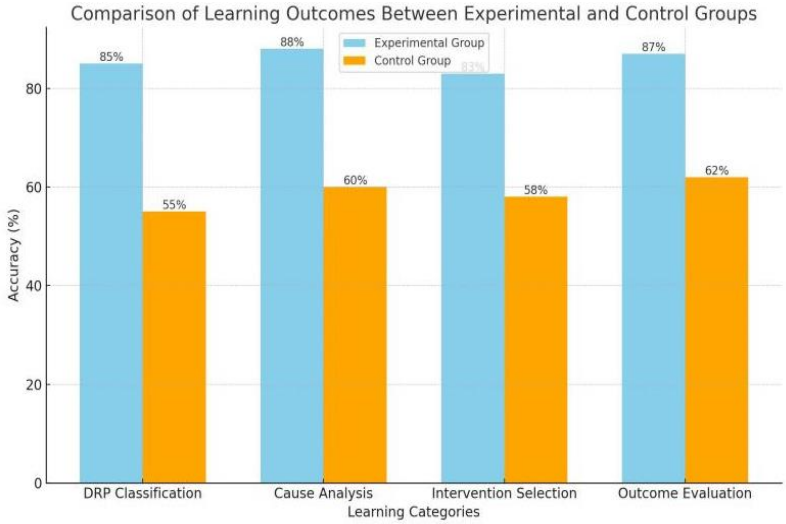

Figure 3: Comparison of Learning Outcomes Between Experimental and Control Groups

This bar chart compares the learning outcomes between the experimental group (using PCNE Classification System) and the control group (traditional teaching method), highlighting the significant improvement in the experimental group.

The study results showed that the experimental group demonstrated significantly higher accuracy rates in DRP categorization, root cause analysis, intervention selection, and problem resolution assessment compared to the control group ($P < 0.05$). Specifically, the accuracy rates for DRP categorization and root cause analysis in the experimental group improved by approximately 30%, while accuracy rates for intervention selection and problem

resolution assessment increased by about 25%.

These findings indicate that the PCNE Classification System effectively enhances students' systematic analytical abilities, enabling them to identify and manage Drug-Related Problems more scientifically and comprehensively. The structured and detailed coding framework provided by the PCNE Classification System promotes a more rigorous approach to problem-solving and decision-making, bridging the gap between theoretical knowledge and practical application in clinical pharmacy education.

Table 1: Questionnaire Survey Results on Student Acceptance and Feedback

Category	Question	Average Score
Learning Interest	Increased interest in learning DRP analysis	4.4
Perceived Usefulness	Found the PCNE system useful for clinical thinking	4.6
Learning Difficulty	Experienced challenges in understanding coding rules	3.4

This table summarizes the questionnaire survey results on student acceptance and feedback towards the PCNE Classification System, including ratings on learning interest, perceived usefulness, and learning difficulty.

Additionally, the questionnaire results showed that over 85% of students expressed positive feedback on the PCNE Classification System, describing it as logical and well-structured. They noted that it effectively helped them organize their thinking for DRP categorization and root cause analysis, while also enabling them to systematically select intervention strategies and evaluate problem resolution. During interviews, students generally reported that the PCNE Classification System was easy to understand and apply, contributing to the development of clinical reasoning and pharmaceutical care skills. They also expressed confidence in its application in future clinical practice.

3.2 Advantages and Limitations of the PCNE Classification System in Teaching

The PCNE Classification System demonstrated significant advantages in clinical pharmacy education [4]. Firstly, its systematic coding approach facilitated structured thinking and comprehensive analysis of DRPs, helping students develop a logical and organized thought process. The standardized framework aligns with international practices, equipping students with scientific and standardized DRP analysis methods.

Moreover, the detailed classification and coding system effectively guided students through the entire problem-solving process—from problem categorization to root cause analysis, intervention selection, and problem resolution assessment. This step-by-step approach helped students build a complete clinical reasoning chain, promoting critical thinking and systematic decision-making.

Despite its benefits, some students reported challenges when initially learning the PCNE Classification System. Specifically, they found the coding process complex and the learning curve steep, particularly when dealing with multi-level classifications and detailed coding rules. This sometimes led to confusion and affected their learning efficiency [5].

Additionally, students encountered difficulties in accurately coding and categorizing DRPs during case analysis, indicating the need for further practice to achieve proficiency in system application.

To address these challenges, it is recommended to introduce the PCNE Classification System gradually within the curriculum, starting with simpler coding exercises and progressively advancing to more complex scenarios. This stepwise approach can help students better assimilate the content and maintain learning motivation by avoiding cognitive overload.

Furthermore, incorporating more hands-on practice sessions, guided case studies, and interactive learning activities could enhance students' coding accuracy and classification skills, ultimately optimizing their learning outcomes and clinical application capabilities.

3.3 Recommendations for Improving Teaching Methods and Curriculum Design

To further enhance the teaching effectiveness of the PCNE Classification System, it is recommended to introduce a simplified version at the beginning of the course, gradually increasing complexity as students master the basic

categorization and coding rules. This stepwise approach can alleviate cognitive load and solidify foundational knowledge before advancing to complex multi-level coding. Incorporating case analysis and hands-on exercises can also help reinforce learning outcomes [6].

To increase classroom engagement and improve learning effectiveness, more case discussions and flipped classroom sessions should be integrated to promote active learning and collaborative problem-solving. Through group discussions and role-playing activities, students can apply the PCNE Classification System in realistic scenarios, enhancing their clinical reasoning and problem-solving abilities.

Additionally, leveraging digital teaching tools, such as Learning Management Systems (LMS), for online case analysis and coding exercises could improve accessibility and interactivity [7]. Online feedback mechanisms can provide immediate guidance, aiding students in mastering the PCNE Classification System more efficiently.

To enhance learning motivation and practical application, experienced clinical pharmacists or physicians can be invited as guest lecturers to share real-world cases and guide students through coding and analysis. This approach bridges theoretical knowledge with clinical practice, deepening students' understanding of the PCNE Classification System's practical utility.

4. Conclusion

This study demonstrates that the PCNE Classification System significantly enhances clinical pharmacy education by effectively improving students' systematic analysis of Drug-Related Problems (DRPs) and fostering clinical reasoning skills. Compared to traditional teaching methods, the PCNE Classification System employs a structured, scientific coding framework that guides students through the entire problem-solving process, from problem categorization and root cause analysis to intervention selection and problem resolution assessment.

The findings reveal that students in the experimental group showed significantly higher accuracy rates in DRP categorization, root cause analysis, intervention selection, and problem resolution assessment. These results confirm the effectiveness of the PCNE Classification System in cultivating clinical reasoning and pharmaceutical care skills, showcasing its promising application potential in clinical pharmacy education.

Furthermore, the majority of students expressed positive feedback on the PCNE Classification System, noting its logical and systematic structure, which effectively clarified their thought processes in DRP categorization and root cause analysis. However, some students reported difficulties with the complexity of coding, particularly in multi-level classification, which impacted learning efficiency.

Therefore, it is recommended to introduce the PCNE Classification System gradually within the curriculum, supported by case-based teaching and scenario simulations. This progressive approach can help students master coding rules and enhance application proficiency.

This study provides valuable insights into the implementation of the PCNE Classification System in clinical pharmacy education in China, demonstrating its effectiveness in cultivating systematic analytical abilities and clinical reasoning skills. Future curriculum design can further optimize teaching content and methodologies by incorporating flipped classrooms, digital teaching tools, and interdisciplinary collaboration. These enhancements will stimulate student interest, improve practical skills, and nurture clinical pharmacy professionals with international perspectives and scientific reasoning capabilities.

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