Article

Evaluation of open collaborative practice teaching reform based on students satisfaction: Public health practice courses integrating medicine, teaching, and research in Yunnan province, China

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Abstract: To address gaps in practical skills among Public Health and Preventive Medicine graduates, an 'open collaborative practice teaching model' integrating medicine, teaching, and research was introduced. A cross-sectional study surveyed 312 Preventive Medicine undergraduates at a Yunnan medical university from 2020 to 2023, utilizing satisfaction scores and analyses (cluster, factor, SWOT) to assess the impact of the reform. Satisfaction scores from baseline, mid-term, and end-term assessments showed minor variations (4.30, 4.29, 4.36), with dissatisfaction primarily related to teaching content and methods. Key influences on satisfaction included teaching content, methods, and effectiveness. The SWOT analysis highlighted the importance of continuously updating teaching strategies to meet changing student expectations. This study suggests that the model has the potential for wider use in enhancing public health education, particularly in regions facing similar challenges.

Keywords: student feedback; practical skill development; student satisfaction analysis; educational reform evaluation; cross-sectional study; higher education innovation; public health education improvement

1. Introduction

Yunnan Province, located on the southwestern border of China, presents unique public health challenges due to its complex geographical, economic, and sociocultural environment. The province shares long borders with several countries, which increases its vulnerability to cross-border health issues, including emerging infectious diseases (Li et al., 2012). Additionally, Yunnan's diverse ethnic composition and remote, rural communities exacerbate disparities in access to healthcare and public health services. These challenges are compounded by a significant shortage of public health infrastructure and medical resources, which limits the capacity to effectively address both everyday health needs and public health emergencies.

The region's proximity to international borders, combined with socio-economic inequalities, creates heightened risks for the spread of infectious diseases, such as malaria, tuberculosis, and COVID-19. Public health efforts in Yunnan must also contend with underdeveloped health surveillance systems and a lack of healthcare personnel trained in modern epidemiological practices. These factors underscore an urgent need for comprehensive reform in public health education, particularly in enhancing the practical skills of graduates who will serve these high-risk, underserved areas.

Despite the increasing demand for skilled public health professionals capable of handing these complex challenges, many recent graduates lack the necessary practical competencies, particularly in areas such as data analysis (Dai et al., 2016), epidemiological investigation, communication, collaboration, and problem-solving skills (Centoni, 2017; Chen et al., 2017; Li, 2021; Vatresia et al., 2022). This skill gap significantly limits their ability to contribute to frontline roles and hinders the effectiveness of public health responses in border communities.

In response to these pressing needs, this study introduces and evaluates an "open collaborative practice teaching model" that integrates medicine, teaching, and research. The model aims to enhance student satisfaction with practical teaching and improve the overall quality of public health education. The study has three main objectives: (1) to demonstrate that teaching reforms can increase student satisfaction and improve teaching outcomes, (2) to identify key factors influencing student satisfaction, and (3) to use various analytical tools (satisfaction score, cluster analysis, factor analysis, and SWOT analysis) to assess the impact of the teaching reforms over three years. By achieving these goals, the study proposes innovative strategies for improving public health practice education in Yunnan Province, with a focus on aligning teaching methods with both student needs and the evolving demands of the public health sector.

2. Materials and methods

2.1. Research design

This study assessed student satisfaction with practical teaching in core Preventive Medicine courses before and after implementing the "open collaborative practice teaching model in public health, integrating medicine, teaching, and research." Surveys were conducted in 2021 (baseline), 2022 (mid-term), and 2023 (end-term) to evaluate practical teaching satisfaction in six professional core courses: Health Microbiology, Health Chemistry, Fundamentals of Toxicology, Environmental Health, Nutrition and Food Hygiene, and Occupational Health and Occupational Medicine.

These courses were selected based on their relevance to the practical competencies required in public health practice. Each course represents a foundational subject in Preventive Medicine that directly aligns with the practical skills students need for public health emergencies, disease prevention, and health promotion. The selection aimed to cover a diverse range of public health disciplines, ensuring that the reform model could be applied and assessed across multiple key areas.

Using cluster sampling, we selected participants from the 2016, 2017 and 2018 cohorts of the School of Public Health. These cohorts were chosen because they had experienced both the pre-reform and post-reform phases of teaching, allowing for a comprehensive comparison of student satisfaction before and after the implementation of the teaching model. Cluster sampling was used to ensure that students from different academic years were adequately represented, providing a broad and balanced view of the reform's impact. **Figure 1** illustrates the changes in practical teaching satisfaction over time among these cohorts.
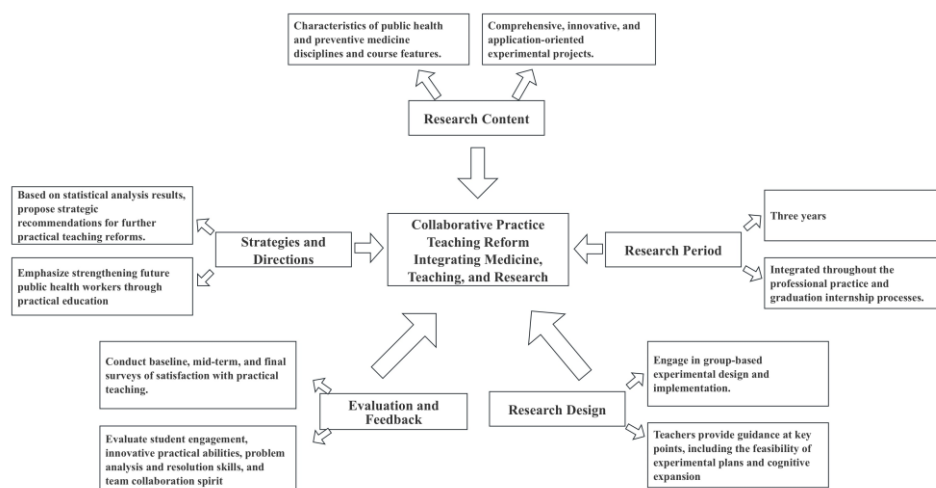
Figure 1. Diagram of teaching reform research.

2.2. Reform content

The open collaborative practice teaching model, integrating medicine, teaching, and research, is a student-centered practical teaching approach. It consolidates public health resources from schools and internship bases. Based on six main practical courses, it merges several practical teaching contents into one project, such as basic public health experiments, environmental health risk assessment, food safety evaluation, and emergency drills for sudden public health events. Students, grouped in teams, design and complete experiments autonomously with teacher guidance on aspects like feasibility of experimental plans, thus enhancing public health thinking, practical, and innovative abilities. This model breaks the boundaries of traditional practical teaching and achieves interdisciplinary integration.

2.3. Participants

The participants in this study were undergraduate students from the School of Public Health. Students from the 2016, 2017 and 2018 cohorts were involved in three survey stages: baseline, mid-term, and end-term. A total of 312 students participated in the surveys, and 312 valid questionnaires were returned. The survey period covered students enrolled between 2021 and 2023.

2.4. Questionnaire design

The questionnaire was developed based on a literature review and was refined through discussions with a team including students, in-school and off-campus teachers, and educational administrators. It was structured to measure key educational objectives and student learning outcomes in alignment with international standards, such as ABET criteria. The questions were classified into five dimensions: basic information, teaching content, teaching methods, teaching effectiveness, overall evaluation.

Satisfaction for each item was measured on a five-point Likert scale: very satisfied (5 points), fairly satisfied (4 points), neutral (3 points), dissatisfied (2 points), and very dissatisfied (1 point). The results from the questionnaire provide essential insights into student engagement, learning effectiveness, and areas for pedagogical

improvement.

A pilot study was conducted with a subset of students to test the questionnaire's reliability and validity. The data were analyzed using Cronbach's Alpha and Exploratory Factor Analysis (EFA), demonstrating high reliability and content validity. The results informed refinements to the item wording and structure, ensuring clarity and relevance to the educational goals.

2.5. Statistical analysis

Student Satisfaction Scores: Calculated based on feedback to individual questions. Satisfaction and Complaint Indices: Percentage of students giving positive ("very satisfied" and "satisfied") and negative ("dissatisfied" and "very dissatisfied") feedback. Cluster Analysis: Used the elbow method to determine optimal cluster numbers, followed by K-means clustering to identify groups with similar satisfaction patterns for targeted teaching strategies. Factor Analysis: Principal Component Analysis (PCA) identified main satisfaction influencing factors, interpreting each factor based on factor loading matrices. SWOT Analysis: Identified strengths, weaknesses, opportunities, and threats in practical teaching based on satisfaction data, providing strategic suggestions for teaching reform.

2.6. Ethics approval and consent to participate

Before completing the questionnaire, respondents were ensured that they fully understood the instructions. Participation in the study was voluntary, and all participants provided informed consent.

3. Results

3.1. Reliability and validity analysis of the questionnaire

The Cronbach's alpha coefficient of the questionnaire was 0.978. The overall Kaiser-Meyer-Olkin (KMO) Test value was 0.8451. Bartlett's Test $x^2 = 19.7485$, $p = 0.2873 > 0.05$, indicating homogeneity in the covariance matrix and suitability for factor analysis.

3.2. Information of participating students

Table 1 summarizes the results of the student satisfaction survey in the three phases of the study: baseline, interim and final. Satisfaction scores remained relatively stable, ranging from 4.29 to 4.36. The satisfaction index increased slightly from 86.35 at baseline to 90.45 at the end of the period. At the same time, the complaint index initially increased from 1.12 (13.65%) at baseline to 1.45 (14.98%) in the medium term, but then decreased to 1.27 (9.55%) at the end of the mid-term.

Table 1. Satisfaction of participating students.

	Baseline Survey	Mid-term Survey	End-term Survey
Satisfaction Scores	4.30	4.29	4.36
Satisfaction Index	86.35	85.02	90.45
Complaint Index	1.12 (13.65)	1.45 (14.98)	1.27 (9.55)

3.3. Cluster analysis of student satisfaction

Figure 2 displays three distinct student clusters based on their satisfaction with teaching content and methods. Cluster 1 (red) shows lower satisfaction in both areas, while Cluster 2 (blue) indicates higher satisfaction with content but lower satisfaction with methods. Cluster 3 (green) reflects high satisfaction in both content and methods. The yellow dots mark the centroids of each cluster. This analysis suggests the need for differentiated teaching strategies; for example, Cluster 1 could benefit from improvements in both teaching content and methods to increase student satisfaction.
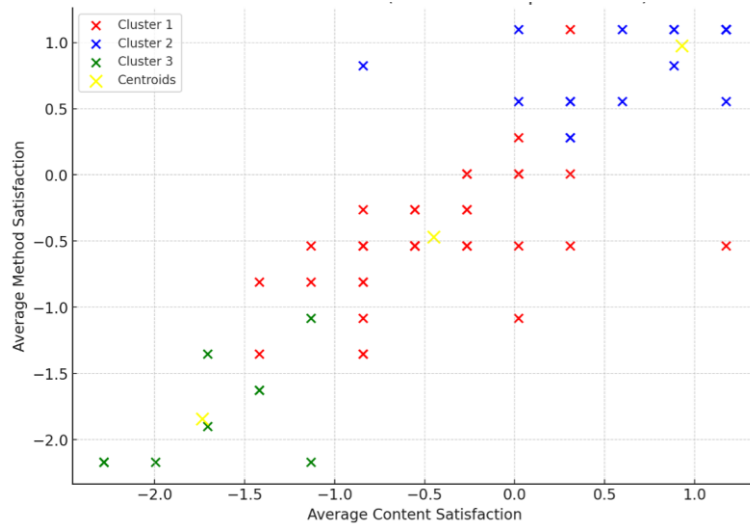

Figure 2. Clusters of students' satisfaction.

3.4. Principal component analysis of student satisfaction

Figure 3 illustrates the cumulative explained variance of each principal component extracted through Principal Component Analysis (PCA). The first six components account for approximately 80% of the total variance, indicating that these six components capture most of the data's variability. The next step is to analyze the factor loadings of these components to identify the key aspects of teaching satisfaction that have the most influence on overall student satisfaction.
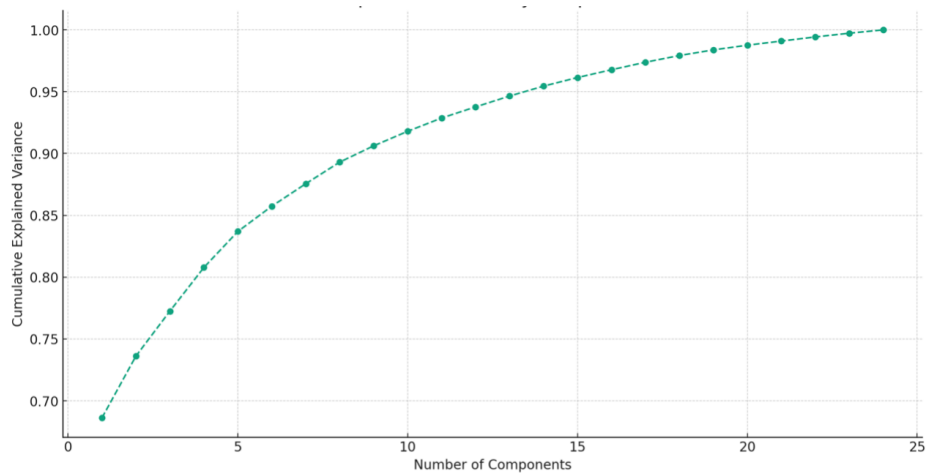

Figure 3. Cumulative explained variance by number of principal components.

Figure 4 presents a heatmap showing the factor loadings of the top six principal components. Each component represents a combination of features, with the magnitude and direction of the factor loadings indicating the contribution of each feature to the component. Components 0, 1, 2, and 3 are primarily correlated with questions related to teaching content, methods, and effectiveness, suggesting these are the critical factors influencing student satisfaction. Components 4 and 5 have weaker, less consistent patterns. This analysis emphasizes the importance of focusing teaching reforms on content, methods, and effectiveness to improve overall student satisfaction.
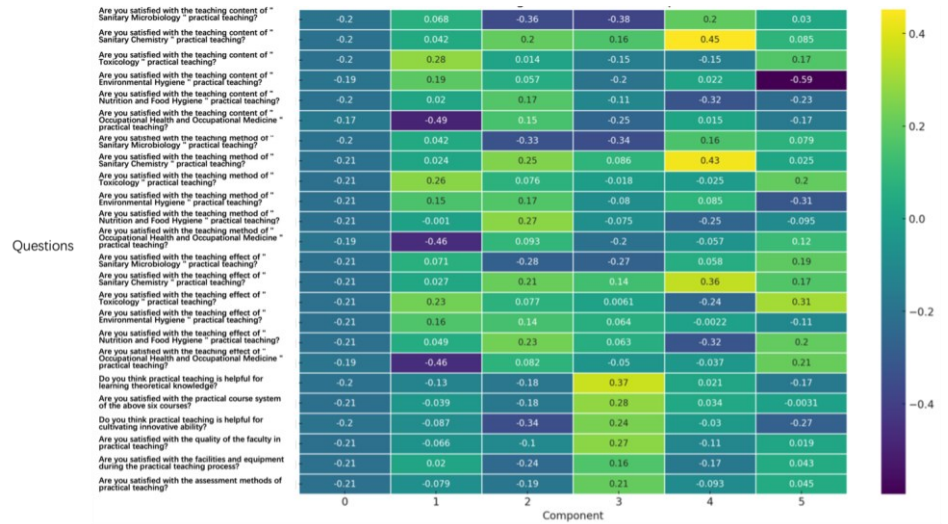

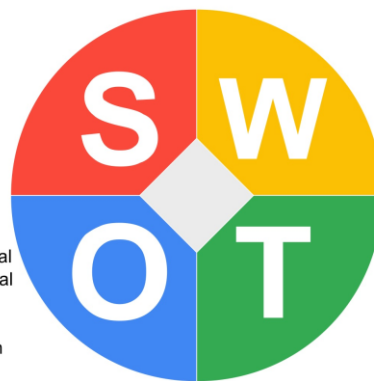**Figure 4.** Heatmap of factor loadings for the top six principal components.

3.5. Comprehensive evaluation of practical teaching through SWOT analysis

Figure 5. SWOT analysis of practical teaching satisfaction.

By utilizing a SWOT analysis to evaluate student satisfaction with practical teaching, the project team can gain a comprehensive understanding of the quality and process of practical teaching. This method allows for an assessment of various dimensions, including strengths, weaknesses, opportunities, and threats, as illustrated

in **Figure 5**. This holistic approach provides insights into the areas where practical teaching excels, where improvements are needed, and the potential for future developments.

4. Discussion

The reliability and validity analysis of the questionnaire demonstrate strong internal consistency and suitability for further analysis. The Cronbach's alpha coefficient of 0.978 indicates excellent reliability, suggesting that the items within the questionnaire are highly consistent in measuring student satisfaction with practical teaching. Additionally, the Kaiser-Meyer-Olkin (*KMO*) value of 0.8451 confirms that the sample size is adequate for factor analysis, while Bartlett's Test result ($x^2 = 19.7485$, $p = 0.2873$) shows no significant deviation from homogeneity, further supporting the appropriateness of conducting factor analysis. These results affirm the robustness of the questionnaire as a valid tool for assessing the effectiveness of educational reforms in public health practice teaching.

The findings from this study highlight the importance of tailoring public health education to meet varying levels of student satisfaction with practical teaching. The slightly higher satisfaction scores from the 2018 cohort suggest that refining teaching practices can lead to improved educational outcomes. This underscores the need for ongoing educational reforms that enhancing practical teaching, particularly in public health programs.

The cluster analysis provided deeper insights into student satisfaction, revealing diverse needs of different student groups. These suggests that a one-size-fits-all approach to teaching is insufficient. Instead, educators must develop targeted strategies that address the specific preferences and learning styles of each group, especially those expressing dissatisfaction with both content and methods. A tailored approach can significantly improve the learning experience and increase student engagement (Ngo, 2021).

Factor analysis further emphasized that teaching content, methods, and effectiveness are the primary drivers of student satisfaction. This highlights the need for continuous updates to align teaching practices with both current public health demands and students' career aspirations. Focusing on these areas will better prepare students for the evolving challenges in public health and enhance their readiness for professional practice (Mia et al., 2022; Yao et al., 2022).

The SWOT analysis offers strategic insights into strengthening the overall teaching framework. By leveraging existing strengths, such as high-quality content, and addressing weaknesses, such as the need for more interactive and practical methods, educators can create a more responsive and dynamic learning environment. Additionally, opportunities for industry collaboration and fieldwork must be leveraged to enrich students' practical experiences, while threats posed by rapid technological advancements can be mitigated through continuous course review and adaptation (Pires, 2023; Wang and Tong, 2021; Wang et al., 2022).

5. Conclusion

The results of this study underscore the critical role of student satisfaction surveys in shaping effective public health practice education. These surveys provide invaluable insights that guide educators in refining teaching methods, aligning course content with professional expectations, and enhancing the overall learning experience. Continuous monitoring of satisfaction levels not only allows for real-time adjustments but also helps in anticipating evolving educational demands and addressing future challenges.

However, this study has limitations that should be considered. First, the research was conducted within a specific regional context—public health education in Yunnan Province—where unique socio-cultural and public health challenges may limit the generalizability of the findings to other regions. Future studies could explore whether the same teaching model yields similar results in different geographic or educational settings.

Second, this study primarily focused on student satisfaction as an outcome measure. Future research could broaden the scope by incorporating additional metrics, such as student performance, long-term career outcomes, and the development of professional competencies. Furthermore, exploring the impact of this teaching model in other types of public health education, such as online courses or interdisciplinary programs, could provide more insights into its adaptability.

Moving forward, regular implementation of student satisfaction surveys and continuous evaluation of teaching reforms will ensure that public health education remains responsive to both student needs and the rapidly changing public health landscape. This ongoing assessment is essential for maintaining high-quality instruction and fostering student success in the field.

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