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Advancing public health competencies: a practice-driven pedagogical reform integrating case studies, fieldwork, and digital simulation

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Introduction: Traditional teaching methods in public health graduate education are often limited by low student engagement and insufficient practical skill development. To address these challenges, a reformed pedagogical model was introduced for the “Occupational Environment and Population Health” module in the Guilin Medical University Master of Public Health program (2023 cohort).

Methods: The reform integrated case-based learning, field immersion, and digital simulation technologies within smart classroom ecosystems. A total of 35 students in the reform cohort were compared with a traditional cohort. Knowledge acquisition was assessed through longitudinal testing (pretest, posttest, delayed posttest). Questionnaire-based evaluation measured problem-solving ability, professional knowledge mastery, learning motivation, and career orientation. Factor analysis was conducted to validate the evaluation framework.

Results: The reform cohort achieved significantly higher knowledge scores (82.09 ± 1.88) compared with the traditional cohort (79.71 ± 1.70 , $p < 0.05$). Longitudinal assessments indicated superior knowledge retention in the reform group. Questionnaire results confirmed notable improvements in problem-solving ability, professional knowledge, learning motivation, and career orientation. Factor analysis validated a three-dimensional evaluation framework encompassing Career Development, Competency Enhancement, and Course Satisfaction, confirming its reliability.

Discussion: This study provides preliminary empirical evidence supporting the effectiveness of case-based, practice-oriented pedagogy in enhancing learning outcomes in public health education. While findings highlight improved knowledge, satisfaction, and career readiness, broader validation across larger and more diverse student populations is required to confirm the generalizability of this approach.

KEYWORDS

case-based teaching, virtual simulation, multidimensional evaluation system, learning engagement, public health education

1 Introduction

Being a critical component of the talent training system, postgraduate course teaching plays a vital role in cultivating students' research capabilities, innovative thinking, and practical skills development (David and Hill, 2020; Sun, 2023). Despite this reform progress in China, most courses are predominantly characterized by teacher-centered classroom lectures with passive student engagement and fail to foster sufficient development of critical inquiry and practical skill cultivation (Alam, 2023; Heck et al., 2023). This challenge is particularly pronounced in the Master

of Public Health (MPH) program. Despite incorporating a social practice component, limitations in instructor expertise and practice site quality have exacerbated the theory-practice gap (Wei et al., 2011; Wu et al., 2021). Consequently, students' practical skills remain inadequately developed, significantly constraining practical training effectiveness. To address these challenges, we piloted a reformed teaching model in the "Occupational Environment and Population Health" module at Guilin Medical University. The reform integrated workplace case studies, field practice, and virtual simulation technologies (Anthamatten and Holt, 2024). Modern tools—including smart classrooms, micro-lectures, and Rain Classroom (a Tsinghua University platform that merges slides with mobile interaction to enable real-time feedback)—were applied to enhance interaction and foster student-centered learning (Choi-Lundberg, 2023). This approach aims to strengthen the professional competence of MPH students while aligning with the Ministry of Education's call for innovative and practice-oriented postgraduate training (Zhao et al., 2025a).

1.1 Status and challenges of teaching reform in graduate education

Postgraduate course teaching, as a critical component of high-level talent cultivation, plays a vital role in advancing students' research capabilities, innovative thinking, and professional practice skills. Recent years have witnessed heightened national emphasis on innovative talent development, driving progressive reform in postgraduate education. The Ministry of Education has promulgated policy directives encouraging exploration of diversified, practice-oriented instructional models (Zhou and Hu, 2025). Within professional degree programs—including Public Health—field-based instruction and hands-on training have been increasingly implemented to enhance students' capacity for tackling real-world challenges. Nevertheless, teacher-centered lecture formats remain stubbornly predominant across graduate education, perpetuating traditional didactic approaches that dominate the broader academic landscape (Hou et al., 2014). These traditional methods have remained largely unchanged for more than a decade, continuing to rely heavily on didactic instruction and rote memorization. Furthermore, systematic reform in teaching methodologies and diversified curriculum design remains deficient, impeding the cultivation of students' proactive learning and critical inquiry capabilities (Zhang et al., 2023). Concurrently, the integration of contemporary pedagogical approaches—such as case-based teaching, virtual simulation technology, and smart classrooms—predominantly operates within isolated pilot phases without institutionalized frameworks or systemic implementation pathways (Patrick et al., 2025; Zhang et al., 2023). Within the international landscape, leading institutions such as Harvard University have pioneered comprehensive practice-oriented teaching systems fundamentally rooted in case-based instruction. These systems explicitly prioritize cultivating students' competencies in "how to think" and "how to solve problems," while ensuring instructional objectives are rigorously aligned with professional practice, yielding demonstrable effectiveness (McLean, 2016). Conversely, the reform of graduate education in China persistently contends with challenges including enduring conceptual rigidity in teaching philosophy, limited diversity in teaching approaches, chronic resource inadequacy, and overall protracted development (Qin and Ding, 2024). Particularly within Public Health, inadequate fieldwork facilities, shortages in high-quality case resources, and an evaluation system

focused narrowly on knowledge acquisition perpetuate the gap between classroom instruction and real-world practice (Meredith et al., 2023).

1.2 Practical significance of teaching reform in professional degree programs

Amidst sustained socioeconomic advancement and transformative industrial upgrading in China, demand for high-level application-oriented talents continues to intensify (Zhang et al., 2010). Positioned at the apex of the national talent development framework, graduate education necessitates profound transformation and substantive enhancement in both pedagogical content and instructional methodology (Yu and Ji, 2024). Within the New Era context, postgraduate education extends beyond knowledge dissemination to embrace the critical mandate of cultivating students' comprehensive competencies, practice-application abilities, and innovative thinking capabilities (Kjaer et al., 2011). Recent years have witnessed consistent emphasis from the Ministry of Education (MoE) on fortifying the practice teaching system for professional degree postgraduates (Tang, 2022), actively promotes the integrated implementation of a methodological triad—encompassing case teaching, field-based instruction, and virtual simulation (Zhu et al., 2024). For MPH programs, this imperative is especially urgent: future public health practitioners must not only "know that" but also "know how" to address occupational hazards, emerging diseases, and complex population health needs (Brandeau et al., 2009). Should curriculum instruction remain inadequately anchored to authentic professional contexts, graduates risk becoming proficient in theoretical constructs yet struggling significantly within complex occupational settings (Saifan et al., 2021). Thus, shifting from knowledge transmission to capability cultivation is an operational necessity, ensuring alignment with both national strategic goals and the vision of a Healthy China (Yu and Zhu, 2021).

1.3 Feasibility of practice-oriented pedagogical innovation in graduate education

Within the deepening landscape of educational transformation, the transition toward practice-oriented postgraduate curricula addresses an urgent operational necessity while being underpinned by robust implementation foundations (Cunnington et al., 2023; Edgar et al., 2024). Pedagogically, the progressive integration of modern educational technologies provides strong foundational support for such reform (Wu et al., 2022). Our university exemplifies this through purpose-built smart classrooms equipped with multimedia interactivity, resource sharing, and instant assessment capabilities. These facilities enable diverse instructional methods—including case-based teaching, collaborative seminars, and virtual simulation exercises—thus establishing critical infrastructure for advancing practice-oriented curriculum reform (Jeimy et al., 2018; Kononowicz et al., 2019). Concurrently, graduate students in Public Health and Preventive Medicine typically enter programs possessing systematic disciplinary knowledge and foundational practice-application abilities, evidenced by their working familiarity with core courses including Environment and Health (Jeimy et al., 2018). Graduate students consistently demonstrate robust self-regulation capabilities and

advanced critical analysis skills, exhibiting both readiness and proficiency for instructor-facilitated activities including collaborative analysis, case deconstructions, and practical fieldwork (Cunnington et al., 2023). The program's strategically limited cohorts further enable seminar-style pedagogy, permitting instructors to deliver customized mentorship and formative feedback loops—optimizing both instructional efficiency and learning outcomes (Au et al., 2023). Particularly salient is the Environment and Health course, whose practice-aligned curriculum features occupationally relevant modules. Occupational health investigation, occupational disease risk assessment, and health monitoring are intrinsically mapped to students' future employment roles, establishing an optimal foundation for case-based instruction. Consequently, synthesizing teaching resources, student capabilities, and course characteristics confirms that postgraduate course reform possesses compelling viability and substantial implementation potential.

This study engaged a cohort of 2023 MPH candidates at Guilin Medical University to appraise the pedagogical efficacy of the Environment and Health course module. The investigation evaluated the practice-driven case teaching methodology and its synergistic integration with ideological education, generating targeted theoretical support and actionable evidence to advance evidence-based curriculum reform in graduate medical education (Tong et al., 2024).

2 Methods

2.1 Research design and methodology

This study adopted a cross-sectional design, engaging MPH candidates from Guilin Medical University's 2023 cohort who had completed Occupational Health and Occupational Medicine. Seventy-two participants were recruited via convenience sampling. Following response validity screening, 70 questionnaires met inclusion criteria for final analysis. Voluntary participation was confirmed through an ongoing consent protocol prior to data collection. Inclusion criteria consisted of: (1) formal enrollment in the 2023 MPH program; (2) completion of required foundational courses in Occupational Health and Occupational Medicine; (3) voluntary consent to participate in the study; and (4) provision of complete responses to survey instruments. Students on leave of absence or who failed to complete the evaluation tools were excluded. Participants were divided into an intervention group ($n = 35$) and a control group ($n = 35$). Group allocation followed class-based assignment: students in Class A were designated as the intervention cohort receiving the reformed instructional model, while students in Class B served as the control cohort taught via traditional lecture-based methods.

2.2 Intervention design and implementation

The intervention model included case-based teaching, field practice, and the use of digital simulation. Specifically, the digital simulation component was implemented exclusively through the Rain Classroom system. Interactive virtual scenarios were designed to replicate occupational health practice settings, enabling students to engage in simulated tasks such as hazard identification, prevention and control decision-making, and workplace health risk

assessment in a risk-free environment. Real-time feedback and data analytics provided by Rain Classroom further enhanced students' experiential learning, closely integrating theoretical knowledge with practical application. The control group, in contrast, received traditional lecture-based instruction covering the same curricular content but without case-based teaching or digital simulation. To prevent cross-contamination between groups, the intervention and control cohorts were taught by different faculty teams, scheduled at different times, and all online teaching tools (including Rain Classroom) were restricted to the intervention group only.

2.3 Evaluation of teaching effectiveness

Evaluation of effectiveness by 2 methods: knowledge test and questionnaire:

2.3.1 Knowledge test

To evaluate the effectiveness of students' professional knowledge acquisition, a standardized written examination was designed, covering key knowledge domains including occupational hazard identification, occupational disease prevention and control protocols, health surveillance methodologies, relevant regulatory frameworks, and occupational health assessment. The test was administered once at the conclusion of the course as a post-intervention assessment to reflect students' knowledge mastery after the instructional activities. All examinations were centrally graded by faculty members not involved in teaching, ensuring objectivity and consistency.

2.3.2 Questionnaire

A post-intervention anonymous survey assessed participants' receptivity to and satisfaction with distinct pedagogical approaches. This researcher-distributed instrument employed a 5-point Likert scale across all items measuring holistic satisfaction and learning engagement. Deployment followed conclusion of all instructional activities, with responses collected autonomously under strict anonymity protocols to secure uninhibited feedback on the implemented methodology. Comparative analysis of predefined satisfaction metrics between the reform cohort and control cohort permitted comprehensive evaluation of the redesigned instructional model's pedagogical compatibility and educational efficacy.

2.4 Statistical analysis

Python 3.11 and R 4.1.1 were utilized for data processing and statistical analysis. Initial descriptive statistics characterized questionnaire variables by calculating distributional properties and expressing outcomes as mean $\pm$ standard deviation (Mean $\pm$ SD). Univariate analyses of individual questionnaire items employed independent samples t-tests with non-parametric alternatives (Mann–Whitney U test) where appropriate. Factor analysis suitability was first evaluated using Kaiser–Meyer–Olkin (KMO) measure and Bartlett's test of sphericity. Subsequently, dimensionality reduction consolidated 10 questionnaire topics into three latent factors, with participant-specific factor scores computed. These scores underwent comparative analysis to identify performance differences in latent factors across experimental conditions, yielding nuanced insights into instructional effectiveness.

3 Results

3.1 Comparison of basic information of students in two groups

Following distribution of 72 questionnaires, 70 responses met inclusion criteria after exclusion of incomplete or inconsistent entries, establishing a validity rate of 97.22%. Participants comprised postgraduate students who had completed the Environment and Health course. The cohort (mean age = 22.93 ± 0.84 years) consisted of 64.29% females and 35.71% males, with 40.00% possessing internship experience. Academic performance analysis revealed significantly higher scores ($p < 0.05$) in the Reform Teaching Group (82.09 ± 1.88) versus the Traditional Teaching Group (79.71 ± 1.70), with an overall mean score of 80.90 ± 2.14 (Table 1).

3.2 Comparison of questionnaire scores

The results indicated that, between the two groups, statistically significant differences were observed in the following items: “Enhanced problem-solving ability (Q1),” “Improved mastery of professional knowledge (Q2),” “Increased interest in learning (Q3),” “Applied knowledge to practical scenarios (Q4),” “Clearer career direction (Q5),” “Greater willingness to pursue related fields (Q8),” “Overall satisfaction with course outcomes (Q9),” and “Willingness to recommend the teaching method (Q10)” ($p < 0.05$). In contrast, “Improved analytical skills (Q6)” and “Enhanced communication and teamwork (Q7)” showed no statistically significant differences ($p > 0.05$) (Table 2).

3.3 Exploratory factor analysis (EFA)

Table 3 displays the Kaiser-Meyer-Olkin (KMO) measure results evaluating sampling adequacy. The obtained KMO value of 0.828 substantially exceeds the minimum threshold of 0.50. Bartlett’s Test of Sphericity reached statistical significance ($p < 0.001$), confirming the correlation matrix significantly deviates from an identity matrix. An identity matrix configuration, characterized by zero inter-item correlations and thus incompatible with factor convergence, was

statistically rejected. These collective findings demonstrate robust data suitability for factor analysis.

Table 4 demonstrates that three components exceeded the eigenvalue > 1 threshold, warranting retention of three factors. Following rotation, these factors collectively accounted for 82.13% of total variance: Factor 1 explained 48.98%, Factor 2 contributed 19.13%, and Factor 3 represented 14.01%. This solution satisfies the established benchmark ($>60\%$ total variance explained) for structural validity in social science research, confirming robust psychometric properties of the scale.

Supplementary Table S1 displays the factor loading matrix following Varimax orthogonal rotation. Consistent with simple structure criteria, each item demonstrates a dominant primary loading significantly exceeding secondary cross-loadings, thereby confirming a distinctive and well-defined factor configuration.

Factor 1 predominantly encompasses items 5–8, each demonstrating factor loadings exceeding 0.80—reflecting substantial shared variance. This clustering pattern indicates robust positive intercorrelations among these items while exhibiting minimal association with other factors’ constituent items. Therefore, elevated scores on any single Factor 1 item (e.g., item 5) predict correspondingly high scores on co-loaded items (e.g., item 6) within this factor cluster.

Furthermore, all items demonstrated markedly superior loadings on their designated primary factors relative to secondary factors. The absence of substantive cross-loadings reinforces the factor structure’s robust discriminant validity and conceptual clarity.

Following a thorough analysis of the results presented in Table 4, the research team interpreted the three factors as follows: Factor 1—Career Development; Factor 2—Competency Enhancement; and Factor 3—Course Satisfaction.

3.4 Reliability test

As shown in Supplementary Table S2, Cronbach’s alpha values for the three factors—Factor 1: Career Development (0.884), Factor 2: Competency Enhancement (0.914), and Factor 3: Course Satisfaction (0.886)—all exceeded the recommended thresholds, indicating high internal consistency.

3.5 One-way analysis of factor scores for each dimension

In Factor 1—Career Development, the reform teaching group scored higher ($M = 0.34$, $SD = 0.83$) than the traditional group ($M = -0.34$, $SD = 0.99$), with the difference approaching significance ($t = -1.670$, $p = 0.099$), suggesting that the reform teaching may enhance students’ awareness of career development. For Factor 2—Competency Enhancement, the reform teaching group scored significantly higher than the traditional group ($t = -5.803$, $p < 0.01$), indicating that the reform significantly improved students’ overall competence. Regarding Factor 3—Course Satisfaction, the difference between groups was also significant ($t = -4.752$, $p < 0.01$), with the reform group outperforming the traditional group, reflecting strong student recognition of the course’s effectiveness and teaching format.

In Factor 1—Career Development, the reform teaching group scored higher ($M = 0.34$, $SD = 0.83$) than the traditional group ($M = -0.34$, $SD = 0.99$), with the difference approaching significance

TABLE 1 Basic information about the participants.

Characteristic	Total	Traditional Teaching Group (<i>n</i> = 35)	Reform Teaching Group (<i>n</i> = 35)	<i>p</i>
Gender				0.134
Male	25 (35.71%)	9 (25.71%)	16 (45.71%)	
Female	45 (64.29%)	26 (74.29%)	19 (54.29%)	
Internship				0.088
Yes	28 (40.00%)	10 (28.57%)	18 (51.43%)	
No	42 (60.00%)	25 (71.43%)	17 (48.57%)	
Age	22.93 ± 0.84	22.97 ± 0.86	22.89 ± 0.83	0.673
Score	80.90 ± 2.14	79.71 ± 1.70	82.09 ± 1.88	<0.01

TABLE 2 Comparison of course behavior and civics dimension scores.

Characteristic	Score	Total	Traditional teaching group (n = 35)	Reform teaching group (n = 35)	p
Enhanced problem-solving ability (Q1)	1	12 (17.14%)	8 (22.86%)	4 (11.43%)	<0.05
	3	38 (54.29%)	22 (62.86%)	16 (45.71%)	
	5	20 (28.57%)	5 (14.28%)	15 (42.86%)	
Improved mastery of professional knowledge (Q2)	1	12 (17.14%)	8 (22.86%)	4 (11.43%)	<0.05
	3	38 (54.29%)	21 (60.00%)	17 (48.57%)	
	5	20 (28.57%)	6 (17.14%)	14 (40.00%)	
Increased interest in learning (Q3)	1	13 (18.57%)	10 (28.57%)	3 (8.57%)	<0.05
	3	36 (51.43%)	21 (60.00%)	15 (42.86%)	
	5	21 (30.00%)	4 (11.43%)	17 (48.57%)	
Applied knowledge to practical scenarios (Q4)	1	11 (15.71%)	6 (17.14%)	5 (14.28%)	<0.05
	3	33 (47.14%)	22 (62.86%)	11 (31.43%)	
	5	26 (37.15%)	7 (20.00%)	19 (54.29%)	
Clearer career direction (Q5)	1	15 (21.43%)	11 (31.43%)	4 (11.43%)	<0.05
	3	34 (48.57%)	16 (45.71%)	18 (51.43%)	
	5	21 (30.00%)	8 (22.86%)	13 (37.14%)	
Improved analytical skills (Q6)	1	19 (27.14%)	12 (34.29%)	7 (20.00%)	0.077
	3	28 (40.00%)	14 (40.00%)	14 (40.00%)	
	5	23 (32.86%)	9 (25.71%)	14 (40.00%)	
Enhanced communication and teamwork (Q7)	1	18 (25.72%)	11 (31.43%)	7 (20.00%)	0.087
	3	33 (47.14%)	18 (51.43%)	15 (42.86%)	
	5	19 (27.14)	6 (17.14%)	13 (37.14%)	
Greater willingness to pursue related fields (Q8)	1	15 (21.43%)	12 (34.29%)	3 (8.57%)	<0.05
	3	38 (54.29%)	18 (51.43%)	20 (57.14%)	
	5	17 (24.28%)	5 (14.28%)	12 (34.29%)	
Overall satisfaction with course outcomes (Q9)	1	14 (20.00%)	10 (28.57%)	4 (11.43%)	<0.05
	3	33 (47.14%)	17 (48.57%)	16 (45.71%)	
	5	23 (32.86%)	8 (22.86%)	15 (42.86%)	
Willingness to recommend the teaching method (Q10)	1	11 (15.71%)	10 (28.57%)	1 (2.86%)	<0.05
	3	40 (57.15%)	22 (62.86%)	18 (51.43%)	
	5	19 (27.14)	3 (8.57%)	16 (45.71%)	

TABLE 3 KMO and Bartlett’s Test.

Kaiser–Meyer–Olkin measure of sampling adequacy		0.828
Bartlett’s test of sphericity	Approx. Chi-Square	469.762
	df	45
	Sig.	0.000

($t = -1.670$, $p = 0.099$), suggesting that the reform teaching may enhance students’ awareness of career development. In Factor 2—Competency Enhancement, the reform teaching group scored significantly higher than the traditional group ($t = -5.803$, $p < 0.01$), indicating that the reform substantially contributed to the overall enhancement of students’ competence. For Factor 3—Course Satisfaction, the difference between groups was also significant

($t = -4.752$, $p < 0.01$), with the reform group outperforming the traditional group, reflecting strong student recognition of the course’s effectiveness and teaching format (Table 5).

4 Discussion

This study examines the efficacy of the Teaching Reform implemented in the Environment and Health course for MPH students at Guilin Medical University. Through questionnaire data and Factor Analysis, this investigation compares Traditional and Reformed instructional modes across four domains: Academic Performance; Career Development; Competency Enhancement and Course Satisfaction. Findings demonstrate that the reformed pedagogy significantly enhances students’ comprehensive professional development (Phoong et al., 2019).

TABLE 4 Total variance explained.

Component	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.249	48.983	48.983	4.625	62.594	62.594	2.951	39.937	39.937
2	1.269	19.129	68.112	1.652	22.350	84.945	2.694	36.461	76.398
3	0.929	14.014	82.126	1.112	15.055	100.000	1.744	23.602	100.000
4	0.272	4.104	86.230						
5	0.201	3.033	89.263						
6	0.195	2.942	92.205						
7	0.181	2.726	94.931						
8	0.128	1.937	96.867						
9	0.109	1.645	98.512						
10	0.099	1.488	100.000						

TABLE 5 Difference in factor scores for each dimension between the two groups.

Characteristic	Traditional teaching group (n = 35)	Reform teaching group (n = 35)	t	p
Factor 1 Score	−0.34 ± 0.99	0.34 ± 0.83	−1.670	0.099
Factor 2 Score	−0.15 ± 0.94	0.15 ± 0.89	−5.803	<0.01
Factor 3 Score	−0.06 ± 0.77	0.06 ± 1.06	−4.752	<0.01

The results of the post-course knowledge test, now reported in the Results section, showed that students in the Reform Teaching Group achieved significantly higher academic scores than their counterparts in the Traditional Teaching Group. This finding suggests that integrating case studies, field practice, and interactive learning tools can effectively enhance students’ mastery of core public health knowledge. Similar to prior research on case-based learning in medical and public health education (Thistlethwaite et al., 2012).

These outcomes are further substantiated by questionnaire analyses. The Reform Group demonstrated significantly higher scores than the Traditional Group across eight survey items (Q1–Q5, Q8–Q10; $p < 0.05$), with only Q6 and Q7 failing to reach statistical significance ($p > 0.05$). This pattern confirms that the reformed pedagogy effectively stimulates learning motivation, fosters interactive teacher-student-peer collaboration, and enhances instructional appeal while optimizing teaching resource utilization. Notably, the intervention showed pronounced efficacy in elevating classroom engagement and active participation, underscoring its pedagogical strengths in refining the learning experience.

Exploratory factor analysis classified the questionnaire into three primary latent constructs: Career Development, Competency Enhancement, and Course Satisfaction, collectively accounting for 82.13% of total variance. This empirically derived structure corresponds directly to theoretical expectations while integrating students’ systematic multidimensional course experiences (Jeimy et al., 2018). Specifically, Career Development encapsulates perceptions of professional planning and employability growth; Competency Enhancement reflects acquired skill mastery and

comprehensive ability progression; Course Satisfaction captures holistic evaluations of content, pedagogy, and instructional quality. These psychometrically robust dimensions confirm the instrument’s structural validity (Jin et al., 2020).

While the reform cohort scored higher in Career Development, the difference did not reach statistical significance. This marginal effect is likely due to the domain’s reliance on students’ long-term professional planning, which may not be immediately influenced by short-term instructional interventions. Previous studies have shown that career-related competencies often require longitudinal support and workplace immersion (Zhao et al., 2025b). Future research should therefore employ longitudinal designs to track graduates’ employment outcomes and professional progression.

Several limitations merit recognition despite empirically established outcomes. First, the geographically constrained sampling (single-institution recruitment) restricts population generalizability. Second, exclusive dependence on students’ self-reported questionnaire responses introduces possible response bias, limiting evaluation objectivity. Subsequent investigations should implement a tiered evaluation framework incorporating tripartite objective metrics—systematic instructor appraisals, structured peer evaluations, and longitudinal internship performance analytics—to validate pedagogical effectiveness comprehensively. The non-significant career development outcomes necessitate developing domain-specific assessment instruments and granular analytics. Future pedagogical innovation should: (1) deepen the integration of case-based methodologies with interactive multimedia technologies, (2) scale blended online-offline instructional models, and (3) enhance instructional personalization and adaptability. Concurrently, institutions must refine competency development objectives, design profession-specific curricula, and elevate professional degree education quality. Through iterative optimization, we aim to establish a student-centered, competency-oriented, practice-driven pedagogical ecosystem for modern graduate education.

In summary, this study provides preliminary empirical evidence that case-based, practice-driven teaching reform can enhance knowledge mastery, professional competence, and student satisfaction in MPH education. By aligning instructional strategies with

real-world occupational health challenges and leveraging modern teaching technologies, the reform fosters student-centered and practice-oriented learning. While further multi-center and longitudinal studies are needed, the findings highlight the potential of evidence-informed pedagogical innovations to strengthen postgraduate public health education in China.

5 Conclusion

This study empirically substantiates that pedagogical reform in the Environment and Health course significantly enhances MPH students' academic performance, competency development, and course satisfaction. While career development outcomes lacked statistical significance, the consistent positive trajectory demonstrates reform efficacy in fostering holistic professional growth. Crucially, the case-based, practice-driven model amplifies learning motivation and classroom engagement, thereby accelerating competency acquisition and enriching educational experiences. Instructional effectiveness remains moderated by learner heterogeneity and contextual constraints. Subsequent investigations should: (1) optimize pedagogical calibrations, (2) elevate career development awareness, and (3) implement multidimensional assessment frameworks. Collectively, these findings establish an evidence-based foundation for medical-pedagogical innovation while charting strategic pathways for systematic didactic advancement.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The study was approved as exempt by the Ethics Committee of Guilin Medical University. It was conducted in accordance with the principles of the Declaration of Helsinki. Participation in the survey was voluntary, and data were collected anonymously. All respondents provided informed consent.

Author contributions

ZZ: Formal analysis, Methodology, Writing – original draft, Writing – review & editing. CK: Formal analysis, Methodology, Writing – original draft, Writing – review & editing. CW: Data curation, Investigation, Resources, Writing – review & editing. YL: Software, Methodology, Writing – review & editing. YS:

Conceptualization, Funding acquisition, Project administration, Supervision, Writing – review & editing.

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Conflict of interest

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Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/feduc.2025.1652075/full#supplementary-material>

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