Macrothink Institute™

Journal of Biology and Life Science
ISSN 2157-6076
2025, Vol. 16, No. 2

An Empirical Study of the Effectiveness of Micro-project Teaching Method on Nursing Students' Integrative Qualities by Using Visualization Analysis

Minghao Xu, Maocai Zhu, Huilian Ren, Jianmei Yang

Deyang People's Hospital Blood Purification Center, China

Ruixin Peng (Corresponding Author)

Deyang People's Hospital Anesthesia and Surgery Center, China.
Email: 13890896210@163.com

Received: April 4, 2025 Accepted: May 16, 2025 Published: May 23, 2025

doi:10.5296/jbls.v16i2.22879 URL: https://doi.org/10.5296/jbls.v16i2.22879

Abstract

To investigate the effectiveness of Micro-project Teaching Method on cultivating comprehensive and integrative quality of nursing interns (hereafter referred to as nursing students), and to provide scientific basis for optimizing the nursing teaching mode,50 nursing interns were selected from April 2024 to November 2024 in Deyang People's Hospital, and were divided into 2 groups of 25 each by using the Random-number Table Method. During the whole internship, the control group was taught by the traditional lecture method combined with the demonstration method in strict accordance with the syllabus, while the observation group was taught by the well-designed micro-project teaching cases. At the end of the teaching period, the scores of the nursing students in the two groups were compared in terms of assessment scores (theoretical scores and operational scores), communication ability, collaboration ability, innovation and creativity, and critical thinking ability. After the teaching experiment, the scores of nursing students in the observation group in the indicators of theoretical assessment scores (81.60±4.83), skills assessment scores (82.32±4.79), communication ability (7.16±1.07), collaboration ability (7.28±1.34), innovation and creativity (8.32±0.99) and critical thinking ability (277.12±7.45) were significantly higher than those of the control group ($P < 0.05$). As a result, the conclusion could be drawn as Micro-project Teaching Method could effectively enhance the clinical communication ability, collaboration ability, innovation and creativity, and critical thinking ability of nursing students while improving their theoretical knowledge and practical skill operation level, promoting the comprehensive quality of nursing students in an all-round way, and significantly improving students' learning efficiency, which is an effective nursing teaching

method of great popularization value.

Keywords: micro-project, nursing practice, comprehensive/integrative quality, visualization analysis

1. Introduction

With the deepening of China's educational reform, the cultivation of complex medical talents with innovative ability and practical literacy has become an important proposition for nursing education in the new era (Giddens & Mansfield, 2023). Nursing clinical teaching, used as a pivotal link between theory and practice, is still in great need of a breakthrough in its teaching mode from the traditional framework. Although the current mainstream didactic and lecture methods can systematically impart medical knowledge, there are significant limitations: First, the evaluation system is overly reliant on theoretical and operational assessment, ignoring the cultivation of core competencies such as communication and collaboration, critical thinking, and other core competencies; Second, in the face of the dynamics and complexity of clinical nursing work, one-way knowledge inculcation is difficult to stimulate students' problem-solving ability (Chi et al., 2022). Thus, this teaching paradigm, which emphasizes knowledge over competence, can hardly meet the requirements of the “Healthy China” strategy on the integrative quality of nursing talents.

Micro-project-based Learning (MPBL) provides an innovative path to this end. This model is rooted in Project-based Learning (PBL), which is based on deconstructing the complex medical knowledge system, designing short-cycle and contextualized practical tasks, and guiding students to complete the whole inquiry process of “problem identification - solution design - practical verification - reflection and optimization” in the form of group collaboration and cooperation (Parra-Anguita et al., 2023). Compared with traditional PBL, micro-project teaching has 3 major advantages: Firstly, fine-grained disassembly of knowledge modules to fit the fragmented nature of nursing teaching; secondly, demonstration of milestones to strengthen learning motivation; furthermore, multiple evaluation systems to comprehensively map the development of comprehensive quality (Zhang & Ma, 2023). Existing studies have shown that this type of teaching model can significantly improve medical students' clinical decision-making ability and teamwork spirit, but there is a lack of empirical research on its systematic application in nursing education (Montrezor & Passos, 2024).

2. Research Methodology

This study takes nursing interns as the subject, and by comparing the implementation effect of micro-project teaching and traditional teaching method, it will provide theoretical basis and practical reference for the transformation of nursing education from “knowledge-based” to “competence-oriented”. Detailed research plan is reported as follows:

2.1 Data and Methods

2.1.1 General information: 50 nursing internship students in Deyang People's Hospital were selected from April 2024 to November 2024, and grouped accordingly based on the random

number table method, with 25 students in each group, 6 males and 19 females in the control group, with an average age of (20.28±1.21) years old, and educational level of 9 undergraduates from medical universities and 16 ones from vocational medical colleges. While 3 males and 22 females in the observation group were observed, with an average age of (20.36±1.00) years old, with the educational level of 11 undergraduates from medical universities, 14 ones from vocational medical colleges, and the difference between the background information of the 2 groups is not statistically significant (P>0.05).

2.1.2 Inclusion criteria: 1. nursing students; 2. age ≥ 18 years; 3. signed informed consent. Exclusion criteria: 1. those who did not attend regularly according to the arrangement of the department of hospital, 2. those who left early for working internship during the experiment; 3. those who quit the research experiment in the middle.

2.2 Research Methods

Control group: adopting traditional teaching methods, i.e. the combination of lecture method and demonstration method, and carrying out teaching activities in strict accordance with the syllabus. In the teaching process, the teacher systematically explains the theoretical knowledge, combined with practical demonstration, to help students master nursing professional knowledge and operational skills.

Observation group: According to the syllabus, a well-designed micro-project teaching case is used to carry out lecturing process. This teaching mode includes the following 6 key links: 1. pre-study link design: before the project begins, students are issued with a micro-project task list, which clearly requires students to review their nursing knowledge and consolidate their basic operational skills, ensuring that students can expand their learning experiences on their existing knowledge system. At the same time, students are encouraged to pre-study the content of the textbook independently to familiarize themselves with the project's related knowledge in advance, so as to prepare themselves well for the upcoming micro-project learning. 2. Team formation and planning: Team formation is based on the principle of differentiation within the group and convergence between groups. Fully consider the differences in knowledge reserves, skill levels, personality characteristics and other aspects of the students, students of different advantages are combined together, in order to achieve the complementary advantages of the members. The person in charge, based on the task list, organizes team members to work together to develop a detailed project planning, clear tasks and time nodes of each stage, to ensure that the project is advanced in an orderly manner. 3. Project task decomposition: Given the short learning cycle of micro-projects, which will usually be completed in 1-2 class hours, in order to improve the learning efficiency, the overall project tasks are decomposed into multiple specific, executable steps. In this way, teachers and students can clearly control the progress of the project and find and solve problems in time. 4. Project advancement stage: After completing the preliminary preparation and planning, students formally enter the project implementation process. On this stage, students focus on the core issues in the project tasks, give full play to the spirit of teamwork, active communication, and work together to put forward a preliminary solution. Using critical thinking, combining existing nursing knowledge and relevant information collected, the

solutions are circularly demonstrated and repeatedly optimized. Teachers pay close attention to the progress of students' projects, provide professional guidance and advice to ensure the smooth execution of each sub-project and lay a solid foundation for the subsequent tasks. 5. Presentation of project results: This is a key part of the teaching process, in which each group presents its learning results in the form of an oral presentation. In the display process, students need to clearly explain the collaborative problem-solving ideas, detailed description of the project implementation plan, and graphs, models and other visualization tools, and if necessary, to make the display more intuitive, vivid, easy to understand and communicate with each other. 6. Project evaluation and reflection: Teachers will conduct a comprehensive and objective evaluation of students' overall performance after the completion of the micro-project. In-depth reflecting and summarizing the experience and shortcomings in the process of project implementation, refining the key knowledge points in the learning of micro-projects, emphasizing their important value and application scenarios in the nursing profession; guiding students to organize the core content in a visual way, such as a mind map or a table. After the class, try to help students build a systematic knowledge system and organize students to conduct self-assessment and mutual assessment to promote the exchange and mutual learning of sharing and experience among the students, thus jointly enhancing the learning effect and efficiency as a consequence.

2.3 Observation Indicators

Examination results: the discharge examination results are used as an important standard to measure the mastery of students' theoretical knowledge and the level of operational skills. The exit exam covers the core knowledge and key skills of nursing specialty, and comprehensively examines students' learning outcomes.

Communication skills: they were assessed using the Liverpool Communication Skills Evaluation Scale (Qureshi & Zehra, 2020), which has a high reliability with Cronbach's coefficient alpha = 0.86. The scale contains 4 dimensions: basic communication ability (0-3 points), respect and empathy (0-3 points), questioning ability (0-3 points), and the ability to give information (0-3 points), which comprehensively assesses the students' communication ability by quantitatively scoring their performance in each dimension, with higher total scores indicating stronger communication ability.

Innovative and creative ability: it refers to the evaluation scale designed by Li Guimei (Li, 2022) for developing students' core literacy, with Cronbach's coefficient $\alpha = 0.791$, which has a certain degree of reliability. The scale evaluates students' innovative and creative ability from 3 dimensions: innovative personality (0-3 points), innovative thinking (0-3 points), and innovative practice (0-3 points), and the higher the score, the stronger the innovative ability they possess.

Collaborative competence: The Organization for Economic Cooperation and Development (OECD) used the Collaborative Competence (agreeableness) Scale (Tang et al., 2021) from the “Big Five personality” model for assessment, with Cronbach's coefficient $\alpha = 0.867$, which indicates strong reliability. The scale contains 3 sub-competencies of empathy (0-4 points), trust (0-4 points), and cooperation (0-4 points), and the students' collaborative

competence was comprehensively assessed by scoring their performance in these sub-competencies, and also the higher the score, the stronger the collaborative competence.

Critical Thinking Ability: The Critical Thinking Scale-Chinese version revised by Peng et al. (Peng et al., 2004) was used to measure the critical thinking ability, and the Cronbach's coefficient $\alpha = 0.9$, with a high reliability. The scale includes 7 traits: open-mindedness, truth-seeking, systematicity, analyticity, inquisitiveness, assertiveness, and maturity, with a total score of 50 for each trait, in which the score ≥40 indicating positivity, 30-39 indicating moderateness, and <30 indicating negativity. The scale total scores range from 70-420, with a total score of ≥280 indicating positive critical thinking skills, a total score of ≤210 indicating negative critical thinking skills, and a total score in between indicating moderate critical thinking skills. The assessment of students' critical thinking skills is used to understand and recognize the level of students' independent thinking ability to analyze and solve problems.

2.4 Statistical Methods

The quantitative statistical software used in this study were SPSS 25.0 and Office Excel respectively, and the collected initial data were entered into Excel, and then the data were organized and analyzed according to the research needs, thereafter the data were processed and analyzed in the SPSS 25.0 software, and the counting data were expressed as (n, %), and the $\chi 2$ test was used. Measurement data were expressed as ($\bar{x} \pm s$) and Independent-samples T-test was used, in which $p<0.05$ indicating that the difference was statistically significant.

3. Results

3.1 Assessment Results in the Teaching Process

After the teaching process, the teaching methods adopted by the observation group were more effective in enhancing students' theoretical knowledge and practical operation ability ($P < 0.05$), indicating that the teaching mode of the observation group had a more prominent effect on the enhancement of students' assessment scores. See Table 1.

Table 1. Appraisal Scores (points, $\bar{x} \pm s$)

Group	*n*	Theoretical performance		Operational performance	
		Before teach	After teach	Before teach	After teach
Control group	25	76.16±3.99	77.04±4.91	78.48±3.60	79.48±4.00
Observation group	25	76.52±4.23	81.60±4.83	79.12±3.41	82.32±4.79
t		0.31	3.31	0.646	2.277
p		0.758	0.002	0.52	0.027

3.2 Communication Ability

After teaching, the observation group scored significantly higher than the control group in the total score of communication ability as well as the scores of dimensions such as basic communication ability, ability to give information, respect and empathy, and ability to ask questions ($p < 0.05$), which indicates that the teaching mode of the observation group has a more prominent effect on the enhancement of students' communication ability. See Table 2.

Table 2. Communication Ability Scores (points, $\bar{x}\pm s$)

Group	*n*	Total communication ability		Basic communication ability		Elicit information ability		Respect and Empathy ability		Questioning ability	
		Pre-teach	Post-teach	Pre-teach	Post-teach	Pre-teach	Post-teach	Pre-teach	Post-teach	Pre-teach	Post-teach
Control group	25	5.64±0.86	5.84±0.75	1.68±0.48	1.72±0.46	1.36±0.49	1.40±0.50	1.36±0.49	1.44±0.51	1.32±0.48	1.40±0.50
Observation group	25	5.96±0.94	7.16±1.07	1.80±0.48	2.00±0.50	1.76±0.58	1.84±0.62	1.40±0.50	1.80±0.65	1.48±0.51	1.76±0.60
t		1.260	5.067	0.869	2.064	0.264	2.311	0.286	2.194	1.147	2.311
p		0.214	＜0.001	0.389	0.044	0.793	0.025	0.776	0.033	0.257	0.025

3.3 Innovative and Creative Ability

After teaching, the total score of the observation group's innovative and creative ability and the scores of the dimensions of innovative personality, innovative thinking and innovative practice were significantly higher than those of the control group ($P < 0.05$), showing the positive impact of the observation group's teaching methods on the cultivation of students' innovative and creative ability. See Table 3.

Table 3. Innovative and Creative Ability Scores (Points, $\bar{x}\pm s$)

Group	*n*	Total score of innovative and creative ability		Innovative personality		Innovative thinking		Innovative practice	
		Pre-teach	Post-teach	Pre-teach	Post-teach	Pre-teach	Post-teach	Pre-teach	Post-teach
Control group	25	4.68±0.80	6.52±1.09	1.56±0.51	1.72±0.68	1.60±0.50	1.68±0.63	1.52±0.51	1.56±0.58
Observation group	25	4.76±1.17	8.32±0.99	1.60±0.58	2.28±0.54	1.64±0.64	2.08±0.57	1.52±0.59	2.04±0.68
t		0.283	6.133	0.260	3.226	0.247	2.357	0	2.689
p		0.779	＜0.001	0.796	0.002	0.806	0.023	1	0.010

3.4 Collaboration Ability

After teaching, the observation group's scores on the total collaboration ability and the sub-competencies of empathy, cooperation and trust were significantly higher than those of the control group ($P < 0.05$), indicating that the observation group's teaching method was more conducive to enhancing students' collaboration ability. See Table 4.

Table 4. Collaboration Skills Scores, (Points, $\bar{x}\pm s$)

Group	*n*	**Total Collaboration Ability Score**		**Empathy Ability**		**Cooperation Ability**		**Trust Ability**	
		Pre-teach	Post-teach	Pre-teach	Post-teach	Pre-teach	Post-teach	Pre-teach	Post-teach
Control group	25	4.84±0.90	5.28±1.06	1.68±0.69	1.84±0.80	1.56±0.51	1.72±0.79	1.60±0.50	1.72±0.54
Observation group	25	5.00±1.12	7.28±1.34	1.72±0.68	2.60±0.87	1.64±0.64	2.32±0.63	1.64±0.49	2.36±0.76
t		0.56	5.852	0.207	3.223	0.491	2.970	0.286	3.437
p		0.580	＜0.001	0.837	0.002	0.626	0.005	0.776	0.001

3.5 Critical Thinking Ability

After teaching, the observation group scored significantly higher than the control group on the total critical thinking score and multiple trait dimensions ($P < 0.05$), reflecting the promotion effect of the observation group's teaching mode on the development of students' critical thinking ability. See Table 5.

Table 5. Critical Thinking Skills Scores, (Points, $\bar{x}\pm s$)

Group	*n*	Total Critical Thinking Score		Open-mindedness Score		Truth-seeking Score		Systematicity Score	
		Pre-teach	Post-teach	Pre-teach	Post-teach	Pre-teach	Post-teach	Pre-teach	Post-teach
Control Group	25	263.04±7.14	264.28±6.92	38.52±2.40	39.28±2.25	37.52±2.22	38.16±2.51	37.40±2.65	38.32±2.33
Observation Group	25	264.20±6.87	277.12±7.45	38.66±2.42	41.76±3.44	37.64±2.45	40.48±3.29	37.84±3.00	36.46±1.90
t		0.585	6.316	0.645	3.016	0.182	2.801	0.550	2.139
p		0.561	＜0.001	0.522	0.004	0.857	0.007	0.585	0.038
Group	n	Analytical Ability		Inquisitive Ability		Confident Ability		Mature Ability	
		Pre-teach	Post-teach	Pre-teach	Post-teach	Pre-teach	Post-teach	Pre-teach	Post-teach
Control Group	25	37.88±2.15	38.24±2.33	38.28±1.84	39.12±1.92	36.85±2.21	37.52±2.33	36.56±2.49	36.92±2.47
Observation Group	25	37.88±2.21	39.72±1.90	38.45±1.94	40.32±1.97	36.92±2.24	39.08±2.48	36.48±2.20	38.36±2.38
t		0	2.458	0.374	2.178	0.064	2.291	0.121	2.102
p		1	0.018	0.710	0.034	0.949	0.026	0.905	0.041

4. Discussion

This study focuses on the application of Micro-project Teaching Method in nursing education, and by comparing with the traditional teaching method, its effect on cultivation of the comprehensive quality of nursing students is explored in depth. The results show that micro-project teaching is effective and efficient in improving nursing students' assessment scores, communication ability, innovation and creativity, collaboration ability and critical thinking ability etc., which not only provides a new direction for nursing education practice, but also enriches the relevant research outcome at the theoretical level.

In terms of assessment scores, the theoretical and operational scores of the observation group improved significantly more than those of the control group after teaching. Micro-project teaching is task-driven in essence, allowing nursing students to deepen their understanding and application of theoretical knowledge in the process of solving practical problems, while increasing the opportunities for practical operation and exercising operational skills in the class. In the project advancement stage, students carry out practice around nursing cases, integrating theoretical knowledge into the operational process, realizing the effective transformation of knowledge and skills, and further enhancing the learning effect. In terms of communication ability, teamwork and results presentation in micro-project teaching provide nursing students with a large number of communication scenarios. Through discussing the program and reporting the results, students practiced basic and necessary abilities like

communication, information giving, respect and understanding of others and effective questioning, which improved their communication ability in all aspects and helped them establish good nurse-patient relationships in future clinical work (Chou et al., 2024). The enhancement of innovation and creativity is attributed to the openness and exploratory nature of micro-project teaching (Yu, 2024; Snow, 2019). During the implementation of the project, students need to use critical thinking, combine existing knowledge and information to propose and optimize solutions, thus stimulate innovative thinking. The diversity and flexibility of the project tasks also provide students with opportunities for innovative practice and cultivate innovative personality. Meanwhile, the enhancement of collaborative ability originates from the team model of micro-project teaching. Based on the principle of intra-group differentiation and inter-group convergence to form a team, each member could learn from each other and make progress together in cooperation, enhance empathy, trust and cooperation ability, and cultivate the spirit of teamwork, which is in line with the requirements of clinical nursing teamwork. The development of critical thinking ability is an important outcome of micro-project teaching, students need to analyze, judge and integrate all kinds of information in the face of project tasks, and in the process of repeatedly arguing for solutions, critical thinking qualities such as open-mindedness and truth-seeking are practiced, which helps to make proper and accurate decisions in complex clinical situations (Krzysiak et al., 2022). Numerous studies (Lee et al., 2024; Si, 2020) have shown that active learning approaches such as project-based learning and collaborative group learning are superior to traditional lecture methods in enhancing students' general competence, and the findings and results of this study are consistent with those previous researches. These types of active learning methods emphasize students learning autonomy and initiative, increase student engagement, and promote deeper understanding and application of knowledge. A typical study (Saimon et al., 2023) found that project-based learning can effectively enhance students' practical skills and problem-solving abilities, which is consistent with the results of this study that micro-project teaching enhances nursing students' manipulative skills and critical thinking abilities. Meanwhile, cooperative group learning can enhance students' communication and collaboration abilities, which is consistent with the effect of micro-project teaching on nurturing nursing students' communication and collaboration abilities in this study.

This empirical study is targeted at nursing students, and the teaching cases and tasks are closely aligned with the core knowledge points of the nursing specialty and the actual clinical needs. The micro-project prep content centers around the core knowledge of nursing specialty, and the project tasks simulate clinical nursing scenarios. The specialization and relevance are the keys to differentiate the study from the research in the field of general education, and the results of the study have more direct guiding significance to the practice of nursing education. In practice, the micro-project teaching method provides a practical teaching mode for nursing education, which helps to improve the quality of teaching and enhance the professional competitiveness of nursing students; in theory, it enriches the theoretical research on teaching in the field of nursing education, and provides theoretical support for the subsequent optimization of teaching methods and the exploration of a more appropriate educational model.

In summary, the micro-project teaching method is effective in improving the comprehensive quality of nursing students, and has unique advantages and important value. Future research can further explore the application effect of micro-project teaching method in different nursing courses and various levels of nursing students, as well as how to better integrate it with other orthodox teaching methods, so as to realize the continuous improvement of the quality of nursing education.

5. Limitations and Conclusion

In this study, the application of micro-project teaching method in nursing teaching was deeply explored, and the results show that this teaching method has a significant positive impact on the improvement of students' comprehensive quality through unique teaching design and practice links. Micro-project teaching is student-centered, and it guides students to carry out in-depth learning with the help of small-scale practical projects, which greatly exercises students' communication ability, innovation and creativity, collaboration ability and critical thinking ability, and the enhancement of these abilities not only contributes to students' current learning improvement, but also lays a solid foundation for their lifelong learning and future career development, which is highly in line with the concept of cultivating all-rounded talents as advocated by modern education.

However, there are still some limitations in this study. On the one hand, due to the limitations of sample selection, the sample size of the study is relatively small, which may affect the generalizability of the results to a certain extent. On the other hand, in the process of practice, it was found that for some profound theoretical knowledge points, it was difficult to design micro-projects to match them, and it was more difficult to construct projects that could reflect the core content of the knowledge points and at the same time be practicable. This challenge undoubtedly puts higher requirements on project teachers, who not only need to have profound professional knowledge reserves and be able to accurately grasp the key points and difficulties of theoretical knowledge, but also need to have excellent project management skills and be able to skillfully integrate complex theoretical knowledge into applicable micro-projects. To this end, project teachers need to actively organize multi-party discussions, gather the wisdom of all parties, and carefully design truly effective teaching micro-projects to achieve accurate guidance for students. In the subsequent teaching practice, the micro-project teaching method plus other teaching methods will be further modeled. By integrating the advantages of multiple teaching methods, we can make up for the shortcomings of micro-project teaching in the transmission of strong theoretical knowledge and give full play to the strengths of micro-project teaching method in the cultivation of students' practical ability and comprehensive literacy, so as to realize the optimization of teaching effect, further improve the quality of nursing teaching process and provide powerful support for the cultivation of more excellent well-rounded nursing talents.

Acknowledgments

Not applicable.

Authors contributions

Not applicable.

Funding

This work was supported by 2023 Education and Teaching Reform Fund Project of Southwest Medical University (JG2023jdyb016).

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Macrothink Institute.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

Open access

Copyrights

References

Chi, M., Wang, N., Wu, Q., Cheng, M., Zhu, C., Wang, X., & Hou, Y. (2022). Implementation of the Flipped Classroom Combined with Problem-Based Learning in a Medical Nursing Course: A Quasi-Experimental Design. *Healthcare (Basel, Switzerland), 10*(12), 2572. https://doi.org/10.3390/healthcare10122572

Chou, C. H., Tai, H. C., & Chen, S. L. (2024). The effects of introducing virtual reality communication simulation in students' learning in a fundamentals of nursing practicum: A

pragmatic randomized control trials. *Nurse Education in Practice, 74*, 103837. https://doi.org/10.1016/j.nepr.2023.103837

Giddens, J., & Mansfield, J. A. (2023). A New Era for Nursing Education: Implications for Practice. *Journal for Nurses in Professional Development, 39*(1), 1-4. https://doi.org/10.1097/NND.0000000000000955

Krzysiak, A., Doyle, C., & Huff, M. O. (2022). Exploring the relationship between genotype and phenotype using yeast alcohol dehydrogenase 1. *Biochemistry and Molecular Biology Education: A Bimonthly Publication of the International Union of Biochemistry and Molecular Biology, 50*(1), 149-157. https://doi.org/10.1002/bmb.21594

Lee, S., Yoon, J. Y., & Hwang, Y. (2024). Collaborative project-based learning in global health: Enhancing competencies and skills for undergraduate nursing students. *BMC Nursing, 23*(1), 437. https://doi.org/10.1186/s12912-024-02111-8

Li, G. M. (2022). The design and practice of using micro-project learning to cultivate students' "4C abilities" (Master's Thesis, Ningxia University). Master's https://link.cnki.net/doi/10.27257/d.cnki.gnxhc.2022.001373

Montrezor, L. H., & Passos, C. L. T. (2024). Project-Based Learning Adapted as a Physiology Teaching Strategy for the Sophomore Undergraduate Medical Students. *Medical Science Educator, 34*(5), 1071-1078. https://doi.org/10.1007/s40670-024-02092-y

Parra-Anguita, L., López-Franco, M. D., Martínez-Galiano, J. M., González-Cabrera, M., Moreno-Cámara, S., & Granero-Moya, N. (2023). Evaluation of the Use of Project-Based Learning in the Nursing Degree. *Nursing Reports (Pavia, Italy), 13*(4), 1648-1657. https://doi.org/10.3390/nursrep13040136

Peng, M. C., Wang, G. C., Chen, J. L., Chen, M. H., Bai, H. H., Li, S. J., Li, J. P., … & Yin, L. (2004). To test the reliability and validity of the critical thinking Disposition inventory. *Chin J Nursing*, (09), 7-10.

Qureshi, A. A., & Zehra, T. (2020). Simulated patient's feedback to improve communication skills of clerkship students. *BMC Medical Education, 20*(1), 15. https://doi.org/10.1186/s12909-019-1914-2

Saimon, M., Lavicza, Z., & Dana-Picard, T. N. (2023). Enhancing the 4Cs among college students of a communication skills course in Tanzania through a project-based learning model. *Education and Information Technologies, 28*(6), 6269-6285. https://doi.org/10.1007/s10639-022-11406-

Si, J. (2020). Course-based research experience of undergraduate medical students through project-based learning. *Korean Journal of Medical Education, 32*(1), 47-57. https://doi.org/10.3946/kjme.2020.152

Snow, F. (2019). Creativity and Innovation: An Essential Competency for the Nurse Leader. *Nursing Administration Quarterly, 43*(4), 306-312. https://doi.org/10.1097/NAQ.0000000000000367

Tang, Y. P., Zheng, J., Sun, X. X., & Huang, Z. J. (2021). Collaborative ability: The third report of Chinese adolescents' social and emotional ability assessment. *Journal of East China Normal University (Education Science Edition), 39*(09), 62-76. doi:10.16382/j.cnki.1000-5560.2021.09.004.

Yu, H. (2024). Enhancing creative cognition through project-based learning: An in-depth scholarly exploration. *Heliyon, 10*(6), e27706. https://doi.org/10.1016/j.heliyon.2024.e27706

Zhang, L., & Ma, Y. (2023). A study of the impact of project-based learning on student learning effects: A meta-analysis study. *Frontiers in Psychology, 14,* 1202728. https://doi.org/10.3389/fpsyg.2023.1202728