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Problem-solving method and cooperative learning model in nursing education: a single-group pre-post-test study

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Abstract

Background Prior studies suggest that traditional teaching methods often fail to accommodate students' individual differences, needs, problem-solving skills, and cooperative learning abilities. This study evaluates the effectiveness of a problem-solving method (PSM) and cooperative learning model (CLM) in nursing education, with a focus on their impact on nursing students' progress in Paediatric Nursing (PN).

Methods A single-group pre-post-test was employed from September 2021 to January 2022. A convenience sample of 51 third-year nursing students enrolled in the PN course at Da-Yeh University, Taiwan, participated in the study. The intervention consisted of an 18-week PN course that was conducted from September 22, 2021 to January 25, 2022 (every Thursday, 13:20 – 16:10). Quantitative questionnaires were administered at three intervals: the first, ninth, and eighteenth weeks of the semester. The research tools included a Basic Information Form (BIF) and the Quantitative Learning Effectiveness Score (QLES). Data were analysed using descriptive statistics, analysis of variance (ANOVA) tests, and linear regression analysis.

Results The post-test results at Week 9 revealed that students' self-perceived PSM, self-perceived problem-solving ability, and self-perceived cooperative learning were significantly greater than their baseline scores ($p < 0.05$). Similarly, the post-test results at Week 18 indicated that students' self-perceived problem-solving ability, learning satisfaction, and quantitative learning effectiveness were significantly greater than their baseline scores ($p < 0.05$).

Conclusion This study highlights the benefits of incorporating PSM and CLM into nursing education. The findings suggest that these approaches can enhance learning effectiveness and provide valuable insights into improving PN outcomes for nursing students.

Keywords Problem solving, Cooperative learning, Learning effectiveness, Nursing students, Paediatric nursing

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Introduction

The evolving social environment, advances in medical technology, and shifting medical models, combined with increased consumer awareness, are transforming the challenges faced by nursing education and nursing educators. Consequently, nursing education must adapt to support students in developing the skills necessary to thrive in ever-changing clinical practice [1]. In the past, traditional nursing education was primarily classroom-based in which professors deliver lectures according to weekly course units. Although this approach has advantages, such as facilitating knowledge acquisition, it also has drawbacks, including a reliance on passive learning [2–4]. Conventional teaching methods struggle to accommodate students' individual differences and needs, thereby hindering the development of essential skills such as problem-solving and cooperative learning [2].

According to the literature [3], there is a positive correlation between knowledge acquisition and meeting learning needs. In this era, it is essential to empower nursing students to take a proactive and prominent role in the profession [4]. Traditional nursing education involves students entering the classroom and learning face-to-face with teachers during class. Learning is based on the lecture model, which presents knowledge in a relatively one-dimensional manner and whose learning environment is confined to the classroom. Teachers are the transmitters and performers of knowledge, while students are the receivers. Time, space, and teaching activities are limited. Therefore, single-classroom teaching cannot achieve specific teaching goals [5, 6]. For example, it remains uncertain whether students can develop problem-solving and cooperative learning skills, which are crucial for preparing future nursing students for clinical practice and nursing roles [6].

Recent studies have shown that developing cooperative learning-related courses leads to statistically significant improvements in learning outcomes [7–9]. One study noted that a 15-week course titled "Global Health and Nursing" was designed for undergraduate nursing students using a collaborative project-based learning method. This approach was especially effective in improving learners' communication skills and problem-solving abilities [7]. The literature supports enhancing learners' cooperation, partnerships, communication, autonomy, learning experience, and continuous learning, in contrast to traditional nursing education [8–10].

Studies have shown that cooperative learning effectively fosters critical thinking skills in students [11]. Moreover, problem-solving processes require a combination of cognitive and social skills, including confidence, decision-making, and endurance [12].

The literature suggests that employing the problem-solving method (PSM) facilitates active knowledge acquisition, promotes learning, and encourages discussion [13–15]. Previous research [16] has focused primarily on junior clinical respiratory therapists and clinical teachers involved in healthcare-related professional fields. This research reported positive feedback from a satisfaction survey conducted after implementing problem-solving teaching activities. The PSM approach was found to be more satisfactory and effective in facilitating learners' proactive knowledge acquisition and improving their clinical problem-solving skills, with a reported 100% satisfaction rate. However, few studies have explored the learning outcomes of problem solving in Paediatric Nursing (PN). One study [17] demonstrated the significant impacts of cognitive problem-solving, including enhanced problem-solving cognition, decision-making skills, and critical thinking abilities, on nursing students. Thus, incorporating problem-solving into the nursing curriculum is essential.

The cooperative learning model (CLM) is designed to promote collaboration, study, communication, sharing, and discussion among learners with diverse experiences and abilities. By fostering these interactions, the CLM enhances motivation, skills, learning quality, and interactive learning among students [18–20]. Like practical courses, the CLM has received positive feedback from students, who perceive it as a more effective approach to improving learning outcomes than non-cooperative approaches. Research highlights the CLM's emphasis on collaboration and group dynamics, creating an environment where students can internalise knowledge, participate in discussions, and engage in debates [20–21]. Moreover, studies support the use of the CLM to address problems [18, 22].

For PN learners, the CLM has the potential to increase confidence. However, a review of the literature reveals a significant gap in research on its application in PN education, particularly with respect to teaching practices and confidence-building in problem-solving. Developing these skills is essential for students preparing for future clinical practice and nursing care roles [23–25].

Third-year paediatric nursing students are at a critical juncture—the middle and late stages—of nursing training. While they have acquired basic nursing skills, they still need to develop advanced clinical reasoning, problem-solving, and teamwork abilities [6]. This raises questions about whether the PSM and CLM can effectively facilitate students' transition to the PN clinical stage. Specifically, can the PSM and CLM enable students to develop problem-solving skills, engage in collaborative learning, enhance learning satisfaction, and improve learning effectiveness during the PN learning process?

This project aims to integrate PSM and CLM into PN education, with the goal of effectively implementing the course and improving learning outcomes for PN

students. Additionally, this project aims to prepare third-year nursing students in PN for future clinical practice or nursing care roles and provide a reference point for the future development of local PN courses and intervention measures.

Methods

Study design and setting

This study employed a single-group pre-post-test design from September 2021 to January 2022. The participants were selected through convenience sampling, and the sample consisted of 51 third-year nursing students enrolled in the PN course at Da-Yeh University, Taiwan. These students participated in an 18-week course conducted from September 22, 2021, to January 25, 2022, with classes held every Thursday from 13:20 to 16:10.

The study was conducted in a traditional classroom setting as part of an undergraduate PN course, a prerequisite for clinical internships in PN. The course aimed to prepare students for the National Nurse Examination in Taiwan, with a focus on both academic and practical knowledge. Learning effectiveness was assessed using a research questionnaire consisting of a Basic Information Form (BIF) and a Quantitative Learning Effectiveness Score (QLES) [6]. The study evaluated students' self-perceived problem-solving abilities, cooperative learning experiences, learning satisfaction, and quantitative learning effectiveness. A pre-test was administered in the first week of the semester, followed by post-tests in the ninth and eighteenth weeks.

The participants in this study were third-year students enrolled in the PN course at Da-Yeh University who met the inclusion criteria. These criteria included being over 20 years old, taking the PN course, and being willing to participate in the research project after being informed of its purpose. The exclusion criteria included students who had not taken PN courses or who failed to provide consent forms.

The intervention course progress is illustrated in Fig. 1. During weeks 1 to 3, the course introduced PN

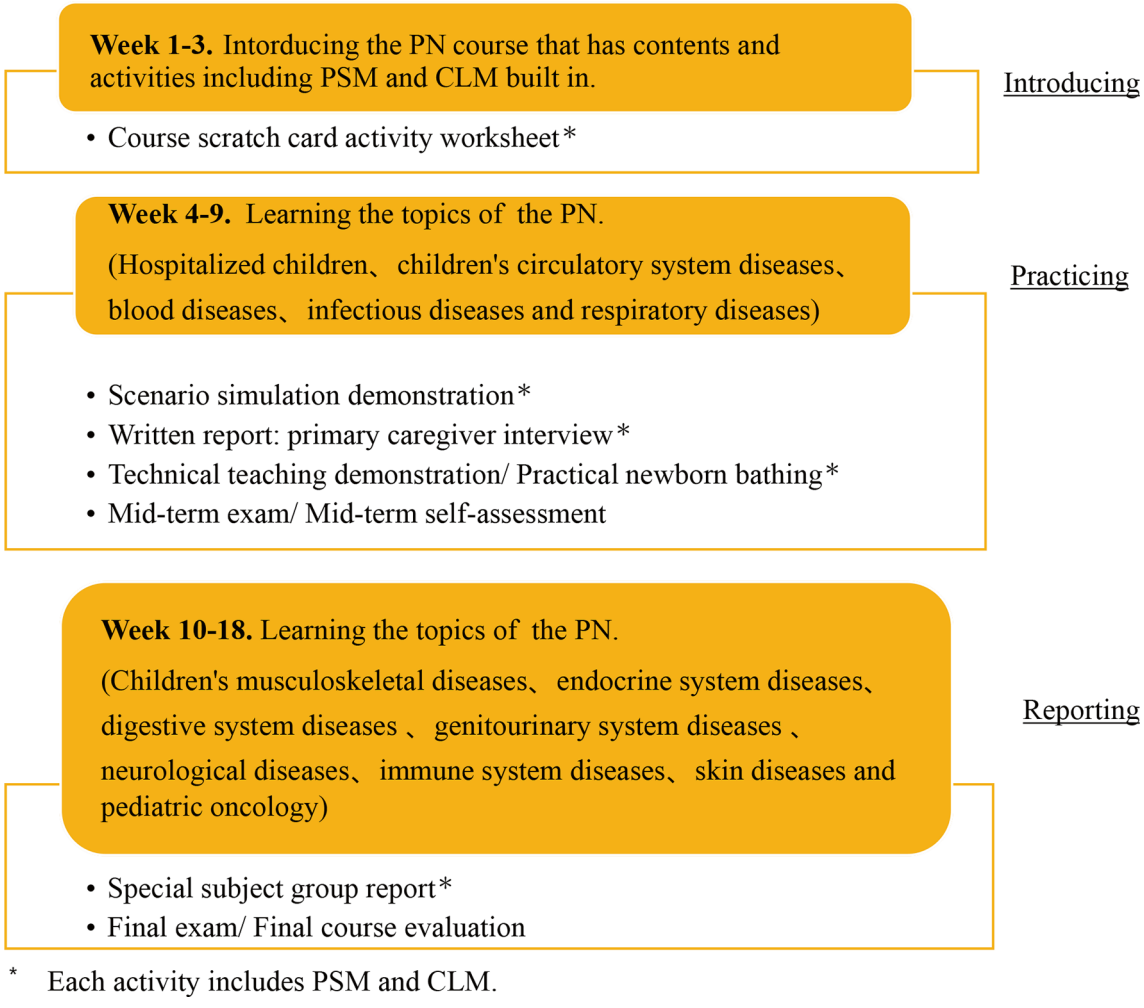

Fig. 1 Intervention course progress. *Each activity includes PSM and CLM

and incorporated activities designed to enhance problem-solving and cooperative learning, including course orientation and worksheet-based activities. Weeks 4 to 9 covered topics such as care for hospitalised children, circulatory system diseases, blood diseases, infectious diseases, and respiratory diseases. These topics were supplemented with scenario simulations, written reports, interviews with primary caregivers, technical teaching demonstrations, practical newborn bathing sessions, mid-term exams, and self-assessments. Weeks 10 to 18 focused on various topics, including musculoskeletal diseases, endocrine system diseases, digestive system diseases, genitourinary system diseases, neurological diseases, immune system diseases, skin diseases, and paediatric oncology. The activities during this period included special subject group reports, final exams, and course evaluations, as illustrated in Fig. 1.

The course unit theme was presented by the professor in a large classroom setting. Activities related to PSM and CLM (Fig. 1) were conducted in small groups during or after class. Each group consisted of approximately 6–8 nursing students, who selected a leader to organise the discussion process. During discussions, group members worked together, taking notes and sharing responsibilities for the rehearsal.

Before the group activity, the professor explained the key aspects of PSM and CLM to focus on during the group activities. These activities included a course scratch card activity worksheet, a scenario simulation demonstration, a written report on primary caregiver interviews, a technical teaching demonstration, practical newborn bathing, and a special subject group report.

The professor refrained from intervening in the group discussion, including avoiding participating in students' discussions, stimulating learning motivation, and providing corrections. Instead, feedback and comments were provided only after the group completed the activity. Each small group was encouraged to assume multiple roles, thereby employing PSM to facilitate active knowledge acquisition, promote learning and discussion, understand the problem-solving process, and improve problem-solving ability. Additionally, PSM helped foster learners' cooperation, communication, and autonomy.

For example, during the scenario simulation demonstration, the professor first presented a paediatric clinical situation (approximately 5 min) to the students. Each group of students subsequently engaged in a 40-minute team discussion to resolve the situation, using the PSM to discuss, check books, debate, and share their opinions. After each group confirmed their discussion content, they presented their findings on stage. Following all the presentations, the students shared their experiences and received feedback (approximately 10 min), and finally, the professor provided feedback and suggestions (approximately 20 min). After completing the scenario simulation demonstration, each group of students was required to discuss and write a scenario simulation demonstration record sheet after class. This record sheet included observations made during the course and each student's reflection. All records were kept to help professors better understand the students' group discussions and interactions, providing a basis for appropriate feedback.

With respect to the technical teaching demonstration and practical newborn bathing session, the professor first explained and then demonstrated how to bathe a newborn. The students were then divided into groups for practice and discussion. The professor observed each group's performance and provided feedback after each group completed the drill.

Quantitative questionnaires were employed to collect pre-post-test data, which were administered during the first, ninth, and eighteenth weeks of the semester. The test period spanned the entire course duration, which ran from September 22, 2021, to January 25, 2022. To evaluate the content validity of the questionnaire, an expert panel of five clinical care and education experts conducted a content validity analysis using a 5-point scale, with higher scores indicating greater relevance. The reliability of the questionnaire was assessed using Cronbach's alpha. Statistical significance for all analyses was set at $p < 0.05$.

Measurements

Learning effectiveness was analysed using a Basic Information Form (BIF) and a Quantitative Learning Effectiveness Score (QLES) [6].

Basic Information Form (BIF)

BIFs included gender, self-perceived performance in problem-solving methods, self-perceived problem-solving ability, self-perceived cooperative learning, and learning satisfaction. The expert-rated Content Validity Index (CVI) was 0.99, and the internal consistency reliability, as measured by Cronbach's α, was 0.84 [6].

Quantitative Learning Effectiveness Score (QLES)

The QLES was assessed using a questionnaire designed for this study that had 10 questions that required students to rate various aspects of their learning, such as "Rate the application of your PSM," "Rate your ability to identify problems," "Rate your ability to form strategies," "Rate your ability to implement reality," "Rate your ability to integrate results," "Rate your ability to promote applications," "Rate your problem-solving ability," "Rate your performance in cooperative learning," and "Rate your learning satisfaction." Responses were scored on a scale of 0 to 10, with 0 being the lowest and 10 being the highest;

higher scores indicated better learning outcomes. The expert-rated CVI was 0.99, and the internal consistency reliability, as measured by Cronbach's α, was 0.73 [6].

Ethical considerations

The study was approved by the Ethics Committee of Jen-Ai Hospital, Taichung, Taiwan (IRB Serial No: 110 – 68). All procedures performed in studies involving human participants were in accordance with the ethical standards of the Declaration of Helsinki. Written informed consent was obtained from all participants prior to their involvement in the study. Before starting the survey, all participants were informed about the objectives and methods of the study, the right to withdraw participation from the study, and use and confidentiality of the collected data.

Intervention

The PN course lasted 18 weeks, and its themes and activities are detailed in Fig. 1. PSM was applied through a sequence of steps: "identifying problems," "confirming issues," "developing strategies," " implementing solutions," "evaluating outcomes," and "applying findings." The CLM encouraged group collaboration [13–15].

The activities associated with PSM and CLM include a course scratch card activity worksheet, a scenario simulation demonstration, a written report on interviews with primary caregivers, a technical teaching demonstration, practical newborn bathing, and a special subject group report, as outlined in Fig. 1.

Methodologies for data analysis

Quantitative analysis was conducted using SPSS 22.0 for Windows 2000 statistical software. Both descriptive and inferential statistics were employed for the pre-post-test analyses. Descriptive statistics were used to analyse demographic variables and sex distributions. Inferential statistics included analysis of variance (ANOVA) to compare means between pre-post-test data. Linear regression analysis was used to evaluate the relationships between basic information variables (self-perceived PSM, self-perceived problem-solving ability, self-perceived cooperative learning, and learning satisfaction) and quantitative learning effectiveness across the pre-post-test data. The CVI was 0.99, confirming the appropriateness and applicability of the questionnaire. The internal consistency reliability of the research instrument was assessed using Cronbach's α, which was found to be 0.79. A significance level of $P < 0.05$ was set for all the statistical tests.

Results

Analysis of basic information and quantitative learning effectiveness

ANOVA tests were conducted to compare pre-post-test data on basic information and quantitative learning effectiveness from baseline (Week 1) to Week 9 and Week 18. A total of 51 students (13 boys and 38 girls) participated in the study. At baseline, the students reported their perceived PSM, self-perceived problem-solving abilities, self-perceived cooperative learning, learning satisfaction, and quantitative learning effectiveness (Table 1).

The post-test results at Week 9 revealed that students' perceived PSM, self-perceived problem-solving ability, and self-perceived cooperative learning were significantly higher than their baseline scores (Week 1) (Table 1).

Similarly, the post-test results at Week 18 indicated that students' self-perceived problem-solving ability, learning satisfaction, and quantitative learning effectiveness were significantly higher than their corresponding baseline scores (Week 1) (Table 1).

Analysis of learning effectiveness from baseline (Week 1) to week 9 and week 18

Linear regression analysis revealed a significant association between Week 9 post-test scores and baseline pre-test scores for self-perceived PSM, self-perceived problem-solving ability, self-perceived cooperative learning, learning satisfaction, and quantitative learning effectiveness. These results indicate that baseline pre-test scores were predictive of subsequent learning effectiveness in these categories (Table 2).

Similarly, the Week 18 post-test scores showed a significant association with baseline pre-test scores for self-perceived PSM, self-perceived problem-solving ability,

Table 1 Analysis of basic information and quantitative learning effectiveness at baseline (Weeks 1, 9, and 18)

Baseline (Week 1)	Week 9			Week 18		
(Mean ± SD)	Mean ± SD	F	*p*	Mean ± SD	F	*p*
Basic Information Self-perceived PSM (3.70 ± 0.67)	3.78 ± 0.57	4.84	0.00*	3.96 ± 0.68	2.15	0.10
Self-perceived problem-solving ability (3.60 ± 0.66)	3.75 ± 0.62	4.68	0.00*	3.88 ± 0.70	5.69	0.00*
Self-perceived cooperative learning (3.76 ± 0.65)	4.13 ± 0.65	7.84	0.00*	4.09 ± 0.72	2.12	0.13
Learning satisfaction (3.52 ± 0.67)	3.67 ± 0.73	3.04	0.05	3.82 ± 0.80	7.4	0.00*
Quantitative learning effectiveness (68.51 ± 15.22)	72.78 ± 10.75	1.8	0.08	73.48 ± 11.66	2.29	0.02*

*$p < 0.05$

Table 2 Analysis of learning effectiveness from baseline (Week 1 to weeks 9 and 18)

Baseline (Week 1)	Week 9				Week 18			
	β	R^2	P	95% Confidence interval	β	R^2	P	95% Confidence interval
Self-perceived PSM	0.45	0.20	0.00*	0.16–0.60	0.29	0.08	0.03*	0.02–0.57
Self-perceived problem-solving ability	0.45	0.20	0.00*	0.18–0.65	0.47	0.22	0.00*	0.23–0.76
Self-perceived cooperative learning	0.49	0.24	0.00*	0.24–0.75	0.19	0.03	0.18	-0.10-0.51
Learning satisfaction	0.28	0.07	0.04*	0.00-0.61	0.41	0.17	0.00*	0.18–0.80
Quantitative learning effectiveness	0.04	0.16	0.00*	0.09–0.46	0.32	0.10	0.02*	0.03–0.44

*$p < 0.05$

learning satisfaction, and quantitative learning effectiveness. These results suggest that baseline pre-test scores significantly explained the variance in learning effectiveness for these categories at Week 18 (Table 2).

Discussion

The results of this study indicate a significant improvement in students' learning effectiveness through the integration of PSM and CLM into PN education. This research investigated students' self-perceived PSM, self-perceived problem-solving ability, self-perceived cooperative learning, learning satisfaction, and quantitative learning effectiveness at three intervals (Week 1, Week 9, and Week 18). Notably, the Week 9 post-test results revealed significant improvements in self-perceived PSM, self-perceived problem-solving ability, and self-perceived cooperative learning. Furthermore, the Week 18 post-test showed improvements in self-perceived problem-solving ability, learning satisfaction, and quantitative learning effectiveness increased. These findings align with the literature on the conscious use of PSM and cooperative learning performance [14, 20, 22, 26], as well as reports on learning satisfaction and quantitative learning effects [23].

The linear regression analysis provides further evidence of the positive impact of integrating the PSM and CLM into the PN course. The problem-solving activities significantly enhanced students' problem-solving skills and abilities, whereas the CLM improved teamwork and interpersonal communication skills and boosted confidence and self-efficacy, which is consistent with previous findings [17, 24, 25, 27]. Through PSM and CLM, students develop their critical thinking and problem-solving abilities, fostering interpersonal communication skills that extend beyond mere knowledge acquisition or application in exams. These findings align with the literature [11, 12], which emphasises the importance of PSM and CLM in nursing education to increase students' confidence in addressing complex challenges. These approaches are essential for preparing students for future clinical practice or nursing care, as these skills are closely tied to the functional aspects of nursing roles [24, 28, 29]. Furthermore, this study supports the literature suggesting that simulation-based demonstration training in nursing education can provide high-quality learning experiences [3, 30].

Cultivating high-quality nursing talent is crucial for ensuring the stability of future nursing teams during the student socialisation process [1, 29, 31]. The study's curriculum intervention, which comprises a course scratch card activity worksheet, scenario simulation demonstrations, written reports on primary caregiver interviews, technical demonstrations and practical newborn bathing, and special subject group reports, has proven highly effective in enhancing cognitive skills [2].

This study aligns with the literature [32], echoing findings that suggest that CLM can foster creativity, imagination, and solution strategies by generating diverse perceptions, opinions, and ideas. Consistent with previous research [17, 23–25], this study demonstrated the applicability of the CLM in nursing education. Through PSM, PN learners can enhance their mental activities and abilities during the problem-solving process. Additionally, CLM helps students improve learning and teamwork, strengthen problem-solving ability and interpersonal communication skills, increase confidence and personal abilities, and ultimately improve perceptions of learning effectiveness.

Studies [10, 32] have shown that learners are impacted by multiple factors and complex interactions, including teaching effectiveness, educational planning and management, assessment tools, and learning goals. These factors can influence learners' mental health and learning environment. Similarly, the literature [33, 34] highlights various factors affecting nursing students' learning. These factors include personal reasons, learning styles, personality traits, individual learner needs, and professionalism, all of which can potentially influence learning outcomes.

The research results indicate improvements in self-perceived PSM, self-perceived problem-solving ability, self-perceived cooperative learning, learning satisfaction, and quantitative learning effectiveness due to PSM and CLM. However, as emphasised in the literature [35], evaluating and revising the overall curriculum is essential. This study's findings provide valuable insights for clinical training and nursing educational planners.

Limitations

This study has several limitations. First, the absence of a control group restricts our ability to attribute outcome changes solely to the intervention measures. Second, the use of self-rating scales may introduce bias, as social expectations could influence students' responses [36, 37]. Third, the study focused primarily on self-perceived indicators, such as PSM, abilities, cooperative learning, and learning satisfaction, and quantified learning effectiveness, neglecting factors such as barriers to learning effectiveness. Additionally, the research questionnaire was based on a convenience sample of nursing students from a specific university in central Taiwan, limiting the generalisability of the results. Finally, the quantitative nature of the survey highlights the potential for future qualitative research.

Conclusion

This study highlights the importance of integrating PSM and CLM, providing insights for nursing education to increase learning effectiveness. By applying these approaches, we assessed their impact on the learning outcomes of PN students through quantitative questionnaires administered at three intervals over an 18-week course. The analysis revealed significant improvements in learning effectiveness over time. By the ninth week, students exhibited significantly higher levels of self-perceived PSM, self-perceived problem-solving ability, and self-perceived cooperative learning compared to the first week. By the eighteenth week, further statistically significant increases were observed in self-perceived problem-solving ability, learning satisfaction, and quantitative learning effectiveness scores compared with those at baseline. These findings suggest that PSM enhances students' cognitive processes and abilities through active engagement in the problem-solving process, whereas CLM fosters teamwork, interpersonal communication skills, and confidence. Together, these approaches enable students to strengthen their problem-solving skills and perceive improvements in their learning effectiveness. This research highlights the importance of incorporating PSM and CLM into nursing education, particularly in PN programs. These findings provide a foundation for enhancing students' confidence and abilities, ultimately contributing to more effective learning outcomes and better preparation for clinical practice.

Abbreviations

PSM	Problem-Solving Method
CLM	Cooperative Learning Model
PN	Paediatric Nursing
BIF	Basic Information Form
QLES	Quantitative Learning Effectiveness Score
CVI	Content Validity Index
ANOVA	Analysis of Variance

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12912-025-03190-x.

Supplementary Material 1

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Author contributions

C-YH: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Writing – original draft, Writing – review & editing. C-MY: Supervision. S-LY: Project administration, Supervision. All authors read and approved the final version of the manuscript.

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Data availability

The datasets used and analyzed during the currents study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval

The study was conducted and approved by the Ethics Committee of Jen-Ai Hospital, Taichung, Taiwan (IRB Serial No: 110 – 68). The participants provided written informed consent to participate in this study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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