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Application of robot-based situational learning with King's Theory of Goal Attainment in critical care training of nursing students: A Quasi-Experimental Study

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Abstract

Background

Nursing students suffer high levels of stress, especially in the critical care.

Objectives

This study aimed to evaluate the effectiveness of robotics-based situational learning based on King's Theory of Goal Attainment in the education of critical care nurses in cardiology.

Design:

This study adopted a two-group comparison design (one control and two intervention groups).

Methods

Sixty nursing trainees from the cardiology department who participated in a standardized training program between September 2022 and September 2023 were selected as research participants. They were divided into control (31 trainees) and experimental (29 trainees) groups, based on the teaching methods employed. The control group received conventional teaching, whereas the experimental group received robotics-based situational learning based on King's Theory of Goal Attainment. Their scores on the theory test, skill test, Self-rating Scale for Nursing Students on Simulation Performance Rubric (SSNSSPR), and the Mandarin Chinese version of the Simulation Learning Effectiveness Inventory (SLEI-SCM) were compared.

Results

The experimental group significantly outperformed the control group in terms of theoretical knowledge, practical skills,behavioral performance, and evaluation of teaching methods ($P < 0.001$). In the control group, there was a significant positive correlation between SLEI-SCM and SSNSSPR scores ($P < 0.001$). Within the experimental group, skill scores were significantly correlated with SLEI-SCM scores ($P < 0.05$). After robotics-based situational learning using King's Theory of Goal Attainment, the theory scores were closely associated with the critical thinking dimension of the SSNSSPR ($P < 0.05$), and the skill scores were closely associated with the clinical capability dimension of the SLEI-SCM ($P < 0.05$).

Conclusion

The application of situational teaching based on King's Goal Attainment and robot simulation effectively enhanced the theoretical knowledge, practical skills scores, self-assessment of behavior, and simulation learning effectiveness of cardiology nursing students.

1. Introduction

With the evolution of modern medical paradigms and increasingly diverse needs of patients, nursing faces substantial challenges. Particularly in the field of cardiovascular diseases, the complexity and rapid progression of conditions have introduced unprecedented difficulties in nursing practice. Nursing students undergoing standardized training in cardiology often have limited opportunities to engage directly in critical emergency interventions, which is detrimental to their understanding of the progression of critical illnesses and enhancement of their clinical capabilities[1]. However, during the resuscitation of critically ill patients, nurses' decision-making abilities, communication skills, and behavioral performance play crucial roles in increasing the likelihood of successful outcomes[2]. Therefore, effective education and training are essential to improve the professional skills and clinical decision-making capabilities of nursing students.

Conventional nursing education predominantly uses a lecture approach, wherein students passively receive information. However, this approach fails to visually demonstrate disease progression in detail. Additionally, in the clinical emergency rescue process, nurse teachers have no opportunity to provide detailed explanations of the relevant knowledge and skills during active resuscitation, making it challenging to meet the needs of nursing students in terms of practical skills and emergency response capabilities[3] Situational simulation teaching through student role-playing facilitates a more immersive portrayal of the requisite knowledge about a specific disease; however, it is susceptible to variations in the comprehension and expression abilities of each actor, thereby resulting in inconsistencies in the repeated presentation of the same scenarios[4], resulting in a vague or incorrect understanding among nursing students. Robot simulations are effective solutions to this problem. Regardless of teaching, a typical case that summarizes the key knowledge points of a specific disease and facilitates the overall instruction on various aspects of knowledge is essential[5]. After inputting a typical case, a robot simulator can simulate the symptoms and physical findings observed in the patients[6,7]. These manifestations evolve dynamically as the operator performs various procedures, thus providing learners with a rigorous, scientific, and highly authentic clinical learning environment that facilitates repeated practice.

Teaching and learning activities are an interactive process between teachers and students and can be guided by King Theory of Goal Attainment developed by Imogene M. King[8]. This theory primarily states that each party can perceive the other across different situations during interactions between individuals, and then aim to communicate effectively through processes such as perception, judgment, action, response, and interaction, finally setting mutual goals, exploring ways to achieve these goals, and ultimately realizing them. Therefore, this study aimed to establish robotic-based situational learning with

King’s Theory of Goal Attainment to enhance the clinical reasoning, decision-making capabilities, and practical skills of nursing students, and to explore its application in the standardized training of cardiovascular nursing students to provide more effective teaching strategies for cardiac nursing education.

2. Materials and Methods

2.1. Training Participants

Sample Size Calculation

An a priori sample size calculation was performed using PASS software. For a two-sample t-test comparing two independent means, with a two-sided significance level (α) of 0.05 and a statistical power (1-β) of 0.80, a total sample size of 56 participants (28 per group) was determined. This calculation was based on an anticipated mean SLEI-SCM score of 122 in the control group and 131 in the experimental group, with a common standard deviation of 15, with reference to previous studies on high-fidelity simulation learning[9].

This study used a case-control design. A total of 60 nursing trainees (31 in the control group and 29 in the experimental group) were ultimately enrolled.Sixty standardized training nursing students in cardiovascular medicine were enrolled between September 2022 and September 2023. The inclusion criteria were as follows: 1) trainees officially recruited by the hospital, 2) all participants had completed theoretical coursework in cardiovascular nursing, and 3) all participants were undergoing first-year standardized training in cardiology. The exclusion criteria were as follows: 1) trainees who had already worked in cardiology for more than three months; 2) trainees who had previously been exposed to any teaching in King’s Theory of Goal Attainment, and 3) trainees who withdrew from the program for any reason.

2.2. Training Content

The training focused on the care of six common critical emergencies encountered in patients with cardiovascular diseases: acute left heart failure, acute myocardial infarction, secondary ventricular fibrillation or sudden cardiac arrest, cardiac tamponade, hypoglycemic coma, post-interventional vagal reflex complications, and acute chest pain.

The instructors involved in the training possessed intermediate or high professional titles and demonstrated extensive experience and expertise. They are equipped with exceptional teaching skills and a wealth of clinical knowledge, enabling them to effectively identify common and frequently occurring diseases. Due to text length limitations, we used acute left heart failure as an illustrative example to introduce the training effects of robot-based situational learning using King’s Theory of Goal Attainment.

2.3. Training Methods

The control group comprised 31 trainees enrolled from September 2022 to February 2023 who received instructions using conventional teaching methods. These methods include theoretical lectures, instructional video viewing, teacher demonstrations and guided student training. To ensure the effective implementation of robot-based situation learning using King’s Theory of Goal Attainment, the "Cardiovascular Medicine Simulation-Based Situational Teaching Project Team" was established in March 2023. This team was responsible for developing the teaching plan and designing the simulation manikin for the teaching case programs. The experimental group comprised 29 trainees who were enrolled from April 2023 to September 2023 and received training via robotics-based situational learning using King’s Theory of Goal Attainment. This training method provides a more interactive and dynamic learning environment that closely mirrors real clinical scenarios to enhance trainees' practical and decision-making skills.This study was obtained an exemption from ethics review from the Biomedical Ethics Committee of .This study was reviewed by the Biomedical Ethics Committee of Mianyang Central Hospital and was granted an exemption from ethical review because the study involved educational evaluation without patient participation or identifiable personal data.

2.4. Specific Scheme of Robot-based Situational Learning with King’s Theory of Goal Attainment

Establishment of the "Cardiovascular Medicine Simulation-Based Situational Teaching Project Team:" The team was composed of key staff members, including the cardiology head nurse, nursing education team leader, teaching assistants, department head, senior coronary care unit physicians, and clinical skills training center instructors. The cardiology head nurse and department head were responsible for overseeing implementation. The nursing education team leader was tasked with creating a clinical case; that is, setting the parameters of the robot simulators according to the designed case and designing a care outline that simulates real-life clinical decision-making situations. Senior coronary care unit physicians reviewed and revised the cases according to current medical standards and practices to ensure scientific accuracy and clinical applicability of the training scenarios. The teaching assistants were responsible for preloading the predesigned case scenario programs onto the simulation mannequin computer system. Clinical skills training center instructors manage logistical tasks, such as preparing and maintaining the necessary materials and teaching aids.

Development of simulated teaching scenarios The teaching project team convened to discuss and select six typical cases (detailed in the Training Content section). Project team members were assigned to develop detailed simulated teaching scenarios for each case, including the simulated teaching subject, objectives, environmental setting, equipment or materials, duration, and guided feedback outline. Once these teaching scenarios were approved by the teaching project team to meet educational needs, the SimMan 3G robot (a high-fidelity simulator; Laerdal Medical, Norway) was programmed, including scripting actions, reactions, and physiological changes according to disease progression as well as the corresponding actions, reactions, and physiological changes for both correct and incorrect procedural responses. After programming, preliminary runthroughs were conducted to observe and verify the simulator’s responses accurately and effectively, reflecting real-life medical scenarios.

Implementation of robot-based situational learning using King's Theory of Goal Attainment: Based on King's Theory of Goal Attainment, the process of robot-based situational learning can be divided into three phases: adaptation, teaching, and feedback. In the adaptation phase, the focus was on orienting learners to the simulation settings, scenario objectives, role assumptions, expected outcomes, and key success indicators according to predefined goals. Both parties must agree on the objectives set forth by King's theory, which serve as the foundation for subsequent teaching activities. During the teaching phase, learners engage in simulated clinical tasks by applying their knowledge and skills to a controlled environment that mimics real-life situations. The instructor monitored the performance closely, but allowed the learners' autonomy to make decisions and execute tasks, intervening only when necessary to guide or correct actions. Throughout this phase, the objectives agreed upon during the adaptation phase were actively pursued by both the instructors and learners, striving to meet these goals. The feedback phase is a critical part of the learning process, wherein the instructor and learners review the outcomes of the simulation. They assessed whether the goals set in King's Theory were met. If the goals were achieved, the interaction was considered successful and the exercise was concluded. However, if the objectives were not met, the reasons were analyzed collaboratively. The instructor and learners then revised the plan, adjusted strategies or approaches as needed, and prepared to reenter the simulation with new targets, thereby initiating another cycle of interaction aimed at goal attainment.

2.5. Assessment and Evaluation

Educational outcomes were assessed in four key areas: the theory test, skill test, Self-rating Scale for Nursing Students on Simulation Performance Rubric (SSNSSPR), and the Mandarin Chinese version of the Simulation Learning Effectiveness Inventory (SLEI-SCM). These assessments were conducted four weeks after the completion of training.

Both the theory and skill tests had a maximum score of 100. This met the required standard, achieving a score of 80 or above on the theory test and 85 or above on the skill test.The theoretical examination questions and skill evaluation checklist were developed by a panel of experts consisting of senior cardiology nursing educators and clinical specialists. The content was reviewed to ensure consistency with the standardized cardiology nursing training curriculum. Prior to implementation, the assessment tools were reviewed by three senior clinical nursing educators for content validity, and pilot testing was conducted with a small group of trainees to ensure clarity and feasibility.Specifically, the theoretical examinations were graded by independent nursing educators who were not involved in the training program. Skill assessments were conducted by two senior clinical instructors who were not involved in the teaching of either group. The assessors were blinded to the group allocation of the participants to minimize potential evaluation bias.

The SSNSSPR tool developed by Liu[10]was employed to evaluate the trainees' behaviors in five dimensions: communication, collaboration, clinical decisions, professional skills, and critical thinking. The assessment consisted of 24 items and utilized a five-point Likert scale (ranging from one to five), with higher scores indicating superior performance. The SSNSSPR demonstrated high reliability and validity with a Cronbach's alpha of 0.924 and a content validity index of 0.977.

The SLEI-SCM was used to assess the efficacy of instructional approaches. This scale comprises three subscales encompassing 31 items across six dimensions: debrief, clinical ability, problem-solving, resources, course, and confidence. Each item is rated on a five-point Likert score (one = strongly disagree, five = strongly agree). The total score ranges from 31 to 155, with higher scores indicating enhanced learning efficiency. Moreover, this tool exhibited robust reliability and validity with a Cronbach's alpha coefficient of 0.95 and a test-retest reliability coefficient of 0.88 over a two-week period.

Specifically, the theoretical examinations were graded by independent nursing educators who were not involved in the training program. Skill assessments were conducted by two senior clinical instructors who were not involved in the teaching of either group. The assessors were blinded to the group allocation of the participants to minimize potential evaluation bias.

2.6. Statistical Methods

Data analysis was performed using IBM SPSS Statistics (version 26.0) and MedCalc (version 22.021). Quantitative data were described using the mean and standard deviation. Comparative analyses were performed using the independent sample t-test (for equal variance) or Welch's t-test (for unequal variance). Bivariate correlations were analyzed using Pearson’s correlation analysis. To analyze independent associations, partial correlation analysis was performed using multiple linear regression. Statistical significance was set at 0.05 ($P < 0.05$) was considered statistically significant.

3. Results

3.1. Participant Demographics

The control group consisted of 18 women and 13 men, with ages ranging from 24 to 28 years and an average age of 25.54 ± 1.25 years. The experimental group comprised 17 women and 12 men aged between 23 and 28 years, with an average age of 25.18 ± 1.45 years. Statistical analysis showed no significant differences in the demographic characteristics between the two groups ($P > 0.05$).

3.2. Assessment Scores in the Fourth Week After Training

The experimental group significantly outperformed the control group in terms of theory, skill, SSNSSPR, and SLEI-SCM overall scores ($P < 0.001$). The scores for the various dimensions of the SSNSSPR and SLEI-SCM in the experimental group were also significantly higher than those in the control group ($P < 0.001$).(see Table 1) These results indicate a significant improvement in both the theoretical and practical training through the implementation of robot-based situational learning using King’s Theory of Goal Attainment.

Table 1
Assessment Results (Using Acute Left Heart Failure as an Example)

Item	Control (n = 31)	Experimental (n = 29)	t	P
Theory test (scores)	84.30 ± 2.77	93.90 ± 1.42	-6.680	<0.001
Skill test (scores)	82.22 ± 4.69	89.29 ± 3.01	-6.900	<0.001
SSNSSPR (scores)	82.52 ± 11.30	111.31 ± 9.28	-10.747	<0.001
Communication (scores)	10.16 ± 1.21	13.52 ± 1.96	-8.039	<0.001
Collaboration (scores)	14.74 ± 2.18	17.93 ± 2.51	-5.274	<0.001
Clinical decision (scores)	23.71 ± 2.58	27.48 ± 2.86	-5.366	<0.001
Professional skill (scores)	16.48 ± 3.54	23.83 ± 1.98	-9.821	<0.001
Critical thinking (scores)	17.42 ± 3.15	28.55 ± 2.06	-16.076	<0.001
SLEI-SCM (scores)	103.42 ± 15.67	135.24 ± 15.35	-7.938	<0.001
Debrief (scores)	14.77 ± 2.7	18.07 ± 2.34	-5.027	<0.001
Clinical ability (scores)	13.23 ± 1.26	18.28 ± 2.02	-11.725	<0.001
Problem-solving (scores)	31.52 ± 5.83	44.97 ± 5.01	-9.552	<0.001
Resource (scores)	13.23 ± 2.45	18.17 ± 2.14	-8.315	<0.001
Course (scores)	11.45 ± 2.77	13.66 ± 1.54	-3.774	<0.001
Confidence (scores)	16.35 ± 3.58	22.1 ± 2.87	-6.829	<0.001

Note: Compared to the control group, the experimental group presented higher scores in theory tests, skill tests, SSNSSPR, and SLEI-SCM, as well as in each dimension of the two scales (all $P < 0.001$).

3.3. Bivariate Correlations Among These Scores

Pearson's correlation analysis revealed a significant positive correlation between theory, skill, SLEI-SCM, and SSNSSPR scores(see Table 2), ranging from 0.274 to 0.740 across both groups (Fig. 1A–F; all $P < 0.05$). Further correlation analysis within each group revealed a significant positive correlation between the SLEI-SCM and SSNSSPR scores in the control group (Fig. 1G; $r = 0.613$, $P < 0.001$) and a significant positive correlation between practical skills and SLEI-SCM scores in the experimental group (Fig. 1H; $r = 0.388$, $P = 0.038$). These results suggest better practical proficiency in simulation-based situational teaching, whereas in conventional teaching settings, the enhancement of behavioral performance appears to be more closely associated with instructional efficacy.

Note

A-F, intergroup correlations among the four assessment scores of both groups; G, intragroup correlation between SLEI-SCM and SSNSSPR scores within the control group; H, intragroup correlation between skill scores and SLEI-SCM scores within the experimental group. These findings highlight the different dynamics in learning and assessment between conventional and simulation-based situational teaching methods as well as the impact of teaching methods on both objective performance metrics and subjective evaluations of the learning experience.

3.4. Partial Correlations Between Student Scores and Dimensions of the Rating Scales

Partial correlation analysis controlling for potential confounding variables was used to explore the relationships between theory scores/skill scores and the specific dimensions of the SSNSSPR and SLEI-SCM. The results revealed a significant close association between theory scores and the critical thinking dimension ($r_{partial}$=0.317, P = 0.025), as well as between skill scores and the clinical ability dimension ($r_{partial}$=0.346, P = 0.014).

Table 2
Partial Correlation Analysis of Theory Scores and Skill Scores with the Scores of Vatious Dimensions in the SSNSSPR and SLEI-SCM.

Independent variables	**Theory scores**			**Skill scores**		
	$r_{partial}$	*t*	*P*	$r_{partial}$	*t*	*P*
Debrief	-0.154	-1.082	0.285	0.003	0.021	0.984
Clinical ability	-0.018	-0.123	0.903	0.346	2.558	0.014
Problem-solving	0.053	0.367	0.716	0.081	0.561	0.577
Resource	-0.084	-0.587	0.560	0.012	0.085	0.933
Course	0.084	0.581	0.564	0.105	0.731	0.469
Confidence	-0.071	-0.492	0.625	-0.052	-0.360	0.720
Communication	-0.041	-0.287	0.775	-0.096	-0.667	0.508
Collaboration	0.126	0.877	0.385	0.061	0.421	0.676
Clinical decision	-0.096	-0.667	0.508	-0.058	-0.401	0.691
Professional skill	0.153	1.072	0.289	0.050	0.346	0.731
Critical thinking	0.317	2.317	0.025	-0.155	-1.087	0.283

Note: Adjusted for age and gender. These results revealed a close association between the theory scores and the critical thinking dimension, as well as between the skill scores and the clinical ability dimension. This provided a pivotal insight into the impact of utilizing robot-based situation learning with King's theory of goal attainment in fostering critical clinical skills and cognitive abilities in nurse students.

4. Discussion

In the rapidly advancing field of cardiovascular medicine, the prevalence of critical care situations and the high rates of emergency interventions necessitate that clinical nursing staff possess quick clinical thinking and proficient skills. However, for nursing trainees undergoing standardized training, lack of clinical experience is a significant hurdle. Instructors often find it impractical to provide detailed explanations during an emergency. Conventional lecture-based teaching methods can no longer meet the current training needs in cardiovascular medicine. In this study, robotics-based situational learning was implemented using King's Theory of Goal Attainment during training for critical cardiovascular conditions. Using acute left-sided heart failure as an example, the assessment results demonstrated that this teaching mode presented distinct advantages in enhancing both the theoretical knowledge and practical skills of nursing students. This finding aligns with the research by Heeseung Choi[11], who also highlighted the effectiveness of simulations in enhancing learning outcomes. Regarding theoretical knowledge, our teaching mode emphasizes augmenting critical thinking abilities, whereas concerning operational abilities, it focuses on refining practical clinical skills.

Simulation manikins serve as the cornerstone of rigorous scenario-based training in medical education[12]. These manikins enabled realistic replication in clinical settings by emulating the physiological responses of humans to various medical conditions. This allows trainees to focus on improving their behavioral performance in a safe environment where they can practice skills and correct mistakes without jeopardizing patient safety. This approach offers a secure and repeatable platform for beginners to practice, critically reflect on their actions and skills, and evaluate others' clinical judgments. Trainees engage in reflective practice during simulations and critically analyze their own actions and those of others. This process improves their clinical abilities, and enhances their understanding and application of professional knowledge[13,14]. However, objectively assessing the effectiveness of simulation-based teaching remains a challenge due to the lack of standardized evaluation criteria. This study incorporated King's Theory of Goal Attainment as a framework for assessing training processes and outcomes in simulation-based situational teaching. King's theory suggests that in interpersonal systems, individuals perceive the world and influence each other through interactions, leading to behavioral and cognitive changes[15]. Our study applied King's Theory of Goal Attainment combined with simulation-based situational teaching to standardize training for nurses in critical cardiology care. This method encourages interaction between students and instructors, helping trainees clearly define their learning objectives. Trainees first experienced the urgency of critical care situations through perception, interaction, communication, and exchange. Under the guidance of instructors, they reflected on real events, assessed goal achievement, and identified areas of improvement. This integrative approach not only facilitates a deeper understanding of theoretical knowledge but also enhances its application in clinical practice. Repeated hands-on practice improves operational skills and reduces panic and potential mishaps during clinical emergencies, thereby enhancing nursing care quality and ensuring patient safety. In conclusion, the integration of King's Theory of Goal Attainment with high-fidelity simulations provides a structured and effective framework for training healthcare professionals,

particularly in enhancing their competence in managing critical cardiology situations. This method fosters a comprehensive, interactive, and impactful learning experience that contributes directly to higher patient care standards.

The assessment results four weeks after training demonstrated significant correlations between the theoretical, practical skills, SLEI-SCM, and SSNSSPR scores in both groups. Considering the stratified effect of scores between the two groups, further within-group analysis revealed a significant bivariate correlation only between the SLEI-SCM and SSNSSPR scores within the control group. This suggests that in conventional teaching settings, improvements in behavioral performance are more closely linked to instructional efficacy, that is, what students have learned during the course. However, there was a significant bivariate correlation between skill scores and SLEI-SCM scores in the experimental group, indicating that robotics-based situational learning with King's Theory of Goal Attainment particularly enhanced the practical skills of nursing students. This aligns with the aim of the teaching style of significantly improving hands-on clinical ability in simulated environments. Furthermore, in-depth partial correlation analysis revealed a close relationship between theory scores and the critical thinking dimension. This suggests that simulation-based situational teaching not only enhances practical skills, but also significantly aids in the critical acquisition and application of theoretical knowledge, leading to more comprehensive thinking among trainees[16]. Skill scores were closely correlated with clinical ability, highlighting the fact that skills learned via simulation are highly transferable to clinical practice. The influences of nursing experience and educational background on critical thinking [17] have been well documented. Studies [18,19] suggest that the level of education and quality of training received are closely linked to the development of critical thinking skills among nursing trainees. This highlights the importance of robust training programs that not only focus on skill acquisition, but also foster critical thinking and professional development. Additionally, the better the mastery of clinical operational skills, the stronger the clinical capabilities, which is consistent with findings from other researchers such as Kimberly[20]Nurses who perform well in the clinical setting are more likely to excel in training and assessment scenarios. This underlines the need for nurses to possess proficient clinical skills to meet the demands of their roles[21].

Overall, the development of clinical capabilities cannot be separated from the actual clinical practice. Operational skills are a fundamental part of nursing education and practice, emphasizing the necessity for hospitals to strengthen skill training to enhance clinical abilities.

5. Limitations of the Study

The study has several limitations, primarily related to its non-randomized design, which introduces potential selection bias and confounding variables. The relatively small sample size of 60 participants limits the generalizability of the findings and may reduce the statistical power to detect differences between groups. Additionally, the reliance on self-assessment tools for measuring outcomes introduces the possibility of subjective bias. The lack of long-term follow-up data means the sustainability of the

intervention's effects cannot be determined. Finally, the non-synchronized control group potentially influencing the results.In addition, the control and experimental groups were trained during different time periods, which may introduce potential temporal bias despite the use of the same teaching team, curriculum, and assessment standards.

6. Conclusion

The complex clinical environment and increased patient advocacy pose challenges for nurses in critical care. Robotics-based situational learning, incorporating King's Theory of Goal Attainment, shows promise for addressing these challenges by increasing trainee engagement and interest in critical care nursing training. Simulation-based situational teaching under King's Theory of Goal Attainment fosters a more interactive and dynamic educational experience, which improves both the theoretical knowledge and practical skills of standardized nurses. Importantly, this approach improves the trainees' clinical practice capabilities and emergency response skills, possibly resulting in significantly different patient outcomes under critical situations.

Declarations

Ethics approval and consent to participate

This study obtained an exemption from ethics review from the Biomedical Ethics Committee of the Mianyang Central Hospital. The study was conducted in accordance with the Declaration of Helsinki. All participants were fully informed of the purpose, procedures, risks and benefits of the study. Written informed consent to participate was obtained from each participant prior to data collection. Participation was voluntary, and participants were informed that they could withdraw at any time without penalty.

Conflict of Interest Statement

All authors have declared that no competing interests exist.

Author Contributions Statement

X.H. and Y.Y. conceptualized the study and obtained funding support. X.H. and H.L. wrote the manuscript. Y.T., and H.H. performed the experiments. Q.J. and H.J. conducted data curation. Y.Y. prepared the figure. All the authors reviewed the manuscript.

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Author Contribution

X.H. and Y.Y. conceptualized the study and obtained funding support. X.H. and H.L. wrote the manuscript. Y.T., and H.H. performed the experiments. Q.J. and H.J. conducted data curation. Y.Y. prepared the figure. All the authors reviewed the manuscript.

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Data availability statement

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

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Figures

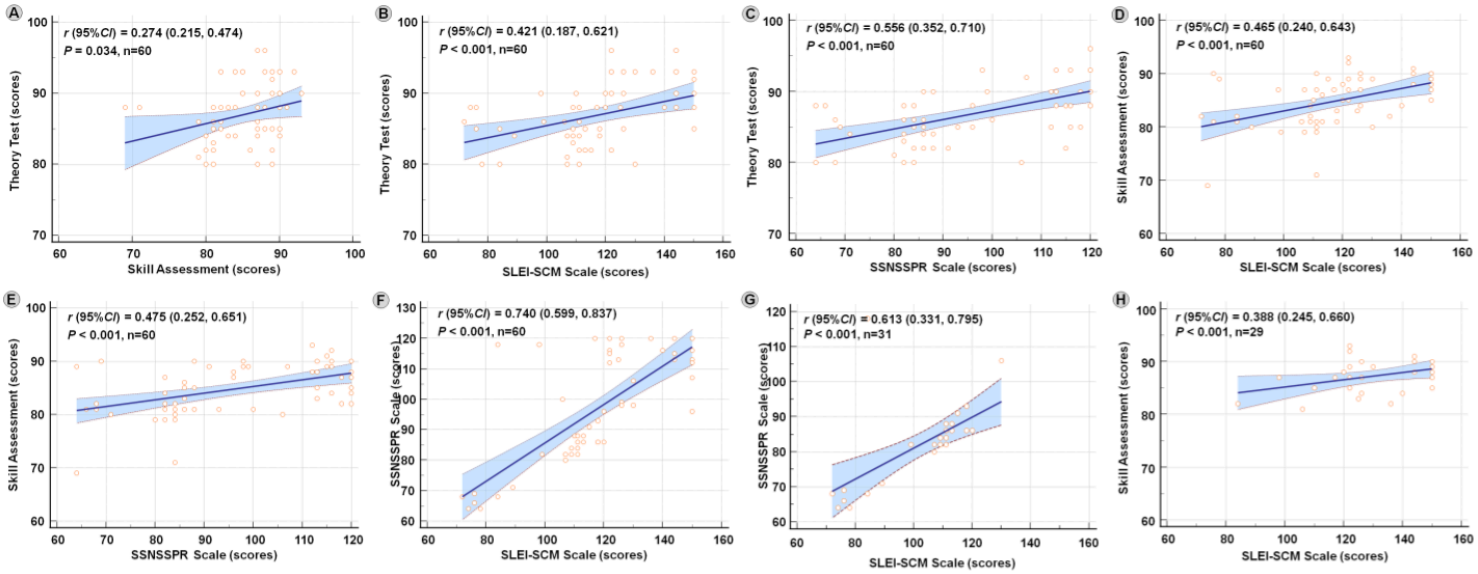

Figure 1

Bivariate Correlations of the Four Assessment Scores

Note: A-F, intergroup correlations among the four assessment scores of both groups; G, intragroup correlation between SLEI-SCM and SSNSSPR scores within the control group; H, intragroup correlation between skill scores and SLEI-SCM scores within the experimental group. These findings highlight the different dynamics in learning and assessment between conventional and simulation-based situational teaching methods as well as the impact of teaching methods on both objective performance metrics and subjective evaluations of the learning experience.