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Research Article

Effect of a Nursing Comprehensive Skill Training Course (NCST-C) on Nursing Students' Metacognitive Awareness: A Quasi-experimental Study

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SUMMARY

Purpose: This study explored the effect of a nursing comprehensive skill training course (NCST-C) on the metacognitive awareness of nursing students to provide a scientific foundation for improving metacognitive awareness.
Methods: This study used a quasi-experimental two-group matched pretest, post-test, and follow-up test. Ninety-six junior nursing students were recruited using convenience sampling and assigned to two groups by drawing lots with odd and even numbers in a nursing school at Huzhou University. The control group received a traditional skill-training course. The intervention group received NCST-C. Nursing students' metacognitive awareness inventory (MAI) was evaluated at the baseline, 16-week, and 20-week follow-up points. A repeated-measures analysis of variance and a simple effect test was used to compare each outcome measure of the two groups three times.
Results: The NCST-C resulted in greater benefits for nursing students' metacognitive awareness as well as various dimensions (knowledge of cognition and regulation of cognition) in the intervention group. Combined with a simple effects test, the MAI and dimension scores of those in the intervention group significantly improved at 16 weeks after the baseline ($F = 9.78–44.03$; all $ps < .01$). The sustainable effect of NCST-C lasted 1 month after the intervention ($F = 14.24–62.36$; $ps < .01$), reaching statistical significance ($p < .05$).
Conclusions: The NCST-C effectively developed metacognitive awareness among nursing students. Its design provides a new type of experimental course for improving metacognitive awareness.
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Introduction

Rapid developments in science and technology have had positive effects on the quality of education [1]. Online courses have facilitated student-centered education and the innovative development of diversified teaching models [2]. Construction of online courses is both a challenge and an opportunity. Research shows that the construction and implementation of online courses cannot meet the needs of contemporary students' learning, and students call for returning to classroom learning [3]. The view that high-quality resource construction of online courses and free learning environment beyond space are auxiliary carriers of classroom teaching has been recognized by scholars [4]. Therefore, exploring the design of online and offline hybrid courses, integrating the advantages of online platforms and the original motivation of classroom teaching is the focus of research to adapt to social and professional development. Recent study has shown that these all require the drive of students' metacognitive awareness [5].

Metacognitive awareness includes knowledge of cognition and regulation of cognition, it has been defined as the ability to reflect upon, understand, and control one's learning [6]. Knowledge of cognition can help students recognize their strengths and weaknesses, and then affects learning motivation and interest [7].

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Regulation of cognition includes planning, implementing, monitoring, debugging, and evaluating strategies and it is a trigger for evaluating and adjusting students' learning strategies [4,8]. Knowledge of cognition and regulation of cognition are interrelated, but not simply compensatory [9]. Studies show that students with higher knowledge of cognition have shown better test performance. However, if their regulation of cognition ability decreases, students will show unreasonable planning and self-debugging, thus affecting their exam results [10,11]. Recent studies have shown that metacognitive awareness contributes to the development of critical thinking and positive learning [12,13]. Students with low metacognitive awareness often adopt ineffective learning strategies and fail to use critical thinking or to develop practical skills to overcome learning challenges [14]. Therefore, focusing on metacognitive awareness as a means to adjust learning motivation, positive learning ability, and professional thinking can be considered important for improving the quality of nursing education.

Evidence suggests that active learning can improve students' metacognitive awareness [15,16]. Active learning is defined as a process in which learners play an energetic and dynamic role in their education [17]. Examples of active learning modes include mixed online and offline teaching modes and cooperative learning [18]. Mixed online−offline teaching modes involve multi-spatial teacher−student interaction. Here, teachers need to design online teaching content and methods while also designing offline classroom teaching methods and content [19,20]. Studies have suggested that the design of the teaching method before, during, and after class is the key content of hybrid online−offline teaching [20]. Cooperative group learning is another online−offline teaching mode that can promote learning interaction and knowledge exchange among students [21]. Research has shown that the instructional design of cooperative group learning is an important technical aspect of successful teaching [22,23]. Thus, whether cooperative group learning in mixed online−offline teaching can successfully replace traditional teaching depends on the course content and the feasibility of the teaching design.

Undergraduate nursing education in China has been subject-oriented, with a strong emphasis on theoretical knowledge and technical competence [24]. Mixed online−offline teaching with cooperative group learning has been found to achieve good results in nursing theory courses but not research in skill training courses [25,26]. Previous studies have shown that mixed online−offline and cooperative group learning needs to be guided by case problems, the integration of diversified teaching methods, and scientifically feasible teaching design [27]. Research suggests that undergraduate nursing education should focus on the high-level development of skill training content and assessment courses [28]. Therefore, this study aimed to develop students' metacognitive awareness by using online−offline teaching and cooperative group learning that integrated experimental technology curriculum content and a multi-station nursing skill examination design.

In 2021, China's National Nursing Skills Competition adopted a new form of multi-station nursing skill examination (Ministry of Education of China). This consists of both personal operation and team cooperation. The number of test stations can be set to three or eight. Starting from the first test station, each student conducts nursing assessment, preparation, planning, and integration using an advanced simulation model to implement individual or team skill operations [29,30]. Each station requires 6 or 10 min to complete all case operations. Scoring is done using a combination of computer scoring and manual scoring. Multi-station nursing skill examination establishes higher standards for nursing students' skill operation accuracy.

A comprehensive course can move beyond existing traditional disciplinary frameworks, re-integrate internally related content, and form new courses [31]. For this study, we constructed a comprehensive nursing skill training course, which includes integrate medicine nursing, surgical nursing, and emergency and critical care experimental content, design online−offline teaching model, use cooperative group learning methods, design multi-station skill assessment examination to evaluate the course's effect on students' metacognitive awareness.

We hypothesized that nursing students who participated in the NCST-C would have a better performance on metacognitive awareness than the control group. We further hypothesized that there were differences in short-term and long-term effect outcomes between a tailored integrated nursing comprehensive skill training course intervention and traditional teaching skill training course.

Materials and methods

Study design

This study used a two-group matched pretest, post-test, and follow-up test designs which utilized a quasi-experimental study.

Ethical considerations

Huzhou University's Ethics Committee review board approved our study (no. 202012-JG01), and the study complied with the Declaration of Helsinki. All participants were informed of the study's objectives, procedures, and potential risks, and informed that they have the right to withdraw at any time. Written consent was obtained from the participants.

Sample and setting

The participants were recruited from junior-year nursing students at Huzhou University, Zhejiang Province, China. G*Power 3.1 was used for sample size calculations. Repeated-measures analysis of variance (ANOVA) was selected, there were three measurements and two groups. With a power (1-β) of .80 fests, the effect size was .25, error probability value was .05. Based on per-experimental data, we established a correlation among the repeated measures of .50. Consequently, the total sample consisted of 96 people, 48 in the experimental group and 48 in the control group.

The inclusion criteria were as follows: (1) nursing students in the second semester of the third year in University; (2) voluntary course selection; (3) informed consent, willing to cooperate. The exclusion criteria were as follows: (1) not interested and (2) research objects who are participating in other teaching reform.

Sampling and recruitment method

Our research team conducted publicity and knowledge lectures on the curriculum teaching reform project among the nursing students in the third year of the University. According to the interests and with informed consent, the students were recruited in the form of voluntary registration. After that, nursing students applied to join through the curriculum registration network system. The computer randomly assigned the students to the experimental group and control group according to cardinal and even number of the submission system sequence. Students participating in the project will be taught in an independent laboratory. The nursing students in the experimental group joined the online course platform through personal application and the course administrator agree. According to the principle of equality, nursing students in the control group were informed that after the course was completed, they would join the course platform and learn freely.

Intervention

Control group

Traditional teaching skill training course methods comprised a total of 64 class hours, offline teaching in the laboratory. Curriculum content included 27 items single experiment technology. Part of the content as shown in Figure 1, course chapter content included basic nursing experiment technology, internal nursing experimental technology, surgical nursing experimental technology, and experimental techniques of emergency nursing. Teaching method and assessment were based on teacher demonstration, students practice by themselves, and one-way technical examination. Teaching organization was under the guidance of two teachers, a total of 16 weeks of course teaching was completed in the form of classroom teaching (Figure 2).

Intervention group

(1) Curriculum content

According to the independence and team-based nature of the technology application, the integrated nursing experiment technology included 30 items, as shown in Figure 1.

(2) Curriculum design

The curriculum involved a three-module, mixed online–offline teaching mode. It comprised a total of 64 class hours: 16 h online and 48 offline. One class "hour" was 45 min. Module one, during the first week, included 2 h online and 2 h offline; it covered the curriculum introduction and learning method training. Module two lasted 12 weeks, with a unit module every 2 weeks (2 h online, 6 h offline), for a total of six unit modules. This covered online problem-oriented self-learning skills, classroom guidance and training skills, and multi-station examination. Module three (3 weeks; 2 h online and 10 h offline) covered online team skill self-learning, in-classroom multi-station examination guidance and exercises, team multi-station examination, and a nursing practice module.

(3) Teaching method

Online teaching adopted a task-oriented approach that included 1 h of video learning, 15 min of online practice, 10 min of discussion and interaction, and 1000 words of operation process writing. Offline teaching adopted cooperative group learning methods, including group scenario simulation, and group discussion. After class, students completed post-learning tasks on the online teaching platform.

(4) Teaching organization

Online teaching was organized and managed by a teacher, who would post online videos, tasks, assignments, and interactions. In-class teaching used the form of cooperative group learning. First, before class started, students were randomly divided into four groups of 12. Second, matching of teachers and student groups was determined by lottery for each lesson. All four teachers conducted collective lesson preparation and training before class.

(5) Course assessment

Course assessment adopted a combined online–offline form. The curriculum design included 30 learning tasks, seven multi-station nursing skill examinations, and three nursing practices. Based on the tasks published online, online course assessment involved calculating a total score using a big data platform. Offline

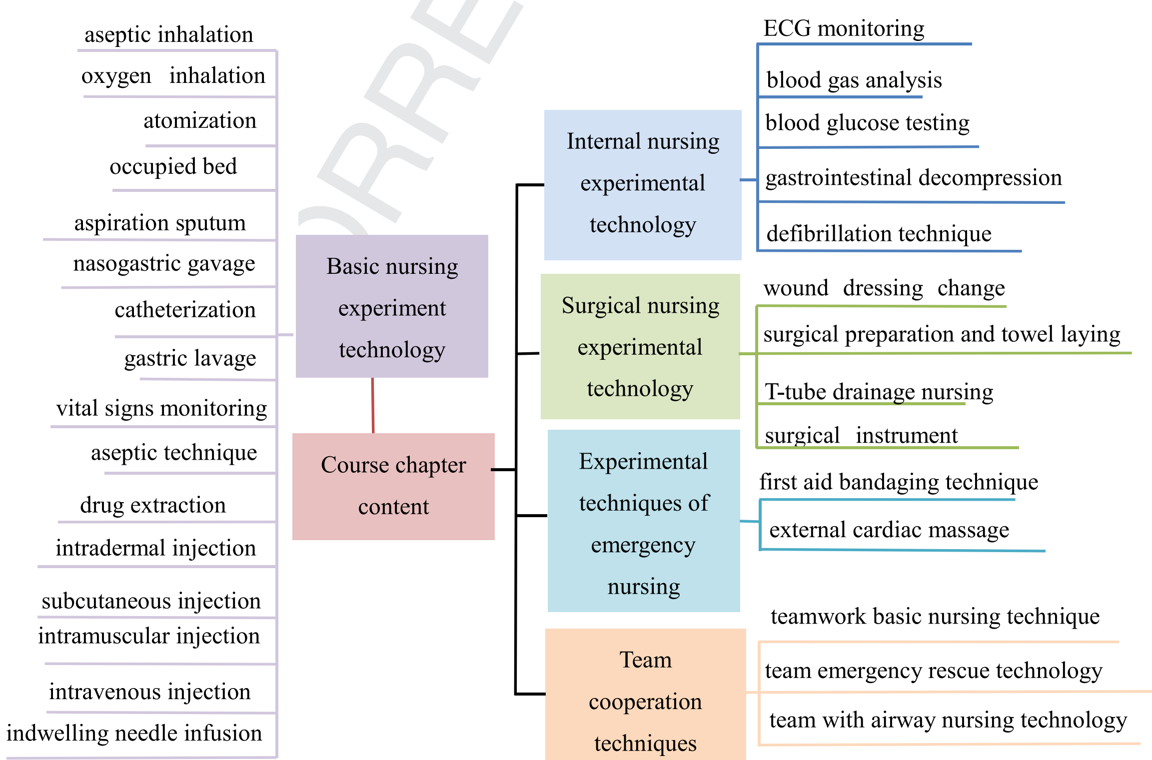
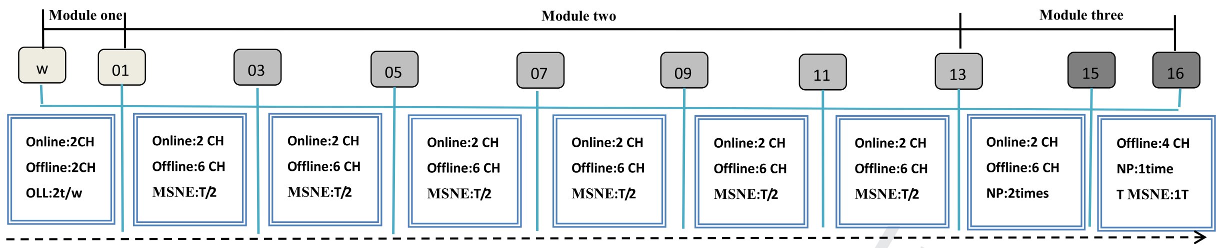


Figure 1. Nursing comprehensive skill training (NCST-C) curriculum content.



Abbreviations:W: week; CH: Class hour; NP:nursing practice;OLL: Open laboratory learn;2t/w: Twice a week;MSNE: multi-station nursing examination;T/2:Once every two weeks; T MSNE: team multi-station nursing skill examination; Module one: curriculum introduction, earning methods training; Module two: Implementation of online problem-oriented skills self-learning-classroom skills guidance and training, multi-station nursing skill examination;Module three: implement online team skills self-learning, classroom team multi-station nursing skill examination guidance and exercises, team multi-station nursing skill examination and nursing practice module.

Figure 2. Online and offline mixed curriculum design.

course assessment involved the skill learning and multi-station assessment of teams and individuals. Each multi-station examination included three stations, individual examinations were 6 min per station, and team examinations were 10 min per station.

Instruments

Demographic information

General demographic information was collected, including age, gender, only child or not, and family location.

Metacognitive awareness inventory

Metacognitive awareness inventory (MAI) consists of knowledge of cognition (17 items) and regulation of cognition (35 items), a total of 52 items [7]. Knowledge of cognition includes declarative knowledge, procedural knowledge, and conditional knowledge. Regulation of cognition includes planning, information management, monitoring, debugging, and evaluation. Each item is scored on a 5-point Likert scale. Total scores ranged from 52 to 260. The higher the score, the stronger the metacognitive awareness. To revise the MAI for nursing students in China, we carried out translation, back translation, expert consultation, and exploratory factor analysis (EFA). The Cronbach's alphas of the scales and subscales were .96 and .87–.99, respectively. The KMO measure was computed to be .84, the C-WAI (52 items) had a eight-factor solution, accounting for 89.44% of the total variance, and the content validity index at the scale level (S-CVI) was .912. The questionnaire was demonstrated good reliability and validity. Our study used the total scale on knowledge of cognition comprehensively observe the changes of metacognitive knowledge.

Data collection

Data collection were conducted at 3 time intervals, which were evaluated at the baseline (T0), 16-week (T1), and 20-week follow-up points (T2). No nursing student dropouts during the experiment. All investigators participated in one-day training before the survey, they were independent of the research team. The same investigators completed the collection, inspection, and analysis of the scales, with a recovery rate of 100%.

Statistical analysis

SPSS 21.0 was used for data analysis. Descriptive analysis was used to describe the collected demographic data, normal distribution, and MAI scores at T_0, T_1, and T_2. A repeated-measures analysis of variance was used to compare the MAI between the two groups. The statistical significance was established at *p*-value less than 0.05. Cohen's d was used to calculate the effect sizes post-intervention, mainly using the mean and combined standard deviation of the conditional measures (less than 0.33 was small, 0.33–0.55 moderate, and 0.56–1.2 large) [31].

Results

Participant characteristics

Participants' mean age was 21.07 ± 1.03 years. Table 1 shows that there were no significant differences in demographic information between the two groups of students ($p > .05$).

Intervention efficacy

The data of the intervention group and the control group were normally distributed ($p > .05$). Table 2 shows that the results of metacognitive awareness and subcategory measures of Mauchly's identity matrix test showed significant ($X^2_{(2,96)} = 5.02–95.34$; all $ps < .01$). Metacognitive awareness and subcategory measures were found significant interaction effects ($F_{(2,\ 96)} = 11.43–50.30$; all $ps < .01$). Also, a statistically significant main effect for the group factor was observed for debugging ($F_{(1,\ 48)} = 4.93$, $p = .032$) and evaluation ($F_{(1,\ 48)} = 9.60$, $p = .013$). Significant group factors were found for other subcategory outcome measures ($F_{(1,\ 48)} = 14.87–23.10$; all $ps < .01$). Meanwhile, a statistically significant main effect for the time factor was observed ($F_{(2,\ 96)} = 15.52–64.20$; all $ps < .01$) for metacognitive awareness and the subcategory outcome measures.

Table 1 *Sociodemographic Characteristics of Participants in the Two Groups.*

Sociodemographic characteristics	Invention Group ($n = 48$)	Control Group ($n = 48$)	*T* or *Chi* square -*Value*	*p*
Age, mean (SD)	21.20 ± 1.60	20.99 ± 1.01	0.77	.444
Sex, *n* (%)			0.33	.563
Men	6 (12.5)	8 (16.6)		
Women	42 (87.5)	40 (83.4)		
An only child in a family, *n* (%)			0.42	.838
Yes	25 (52.1)	26 (54.2)		
No	23 (47.9)	22 (45.8)		
Family location, *n* (%)			0.04	.838
Rural area	24 (50.0)	23 (47.9)		
Town	24 (50.0)	25 (52.1)		

Notes: SD = standard deviation.

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Table 2 *Impact of the Intervention on Metacognitive Awareness Outcome Measures at Three Time-points (Group × Time) test (N = 96).*

Outcome measures	Measure Time			Mauchly 's identity test		Group Factor		Time Factor		Interaction Effect	
	T0 (Mean T SD)	T1 (Mean T SD)	T2 (Mean T SD)	X^2	*p*	F	*p*	F	*p*	F	*p*
Metacognitive knowledge						17.30	.000	59.12	.000	47.09	.000
Experimental group (G1)	66.56 ± 6.40	74.46 ± 6.90	74.95 ± 5.80	17.89	.000						
Control group (G2)	67.00 ± 7.18	67.75 ± 5.11	67.23 ± 4.64	95.34	.000						
Regulation of cognition						20.81	.000	49.36	.000	34.86	.000
Experimental group (G1)	130.92 ± 29.86	165.23 ± 29.08	167.50 ± 24.29	17.89	.000						
Control group (G2)	132.73 ± 34.43	135.63 ± 29.06	136.77 ± 22.47	5.02	.000						
Planning						15.86	.000	57.89	.000	44.82	.000
Experimental group (G1)	26.58 ± 5.91	33.77 ± 5.36	34.54 ± 4.81	18.69	.000						
Control group (G2)	27.06 ± 7.04	27.79 ± 5.97	27.37 ± 5.08	44.69	.000						
Information management						21.11	.000	93.17	.000	46.19	.000
Experimental group (G1)	37.50 ± 5.80	45.97 ± 6.17	46.16 ± 4.99	9.90	.007						
Control group (G2)	37.10 ± 6.99	39.29 ± 5.13	39.12 ± 4.76	30.82	.000						
Monitoring						23.10	.000	64.20	.000	50.30	.000
Experimental group (G1)	26.56 ± 5.81	34.94 ± 6.07	35.35 ± 4.96	9.95	.007						
Control group (G2)	27.00 ± 7.18	27.31 ± 5.15	27.71 ± 4.51	67.07	.000						
Debugging						4.93	.032	30.80	.000	11.43	.000
Experimental group (G1)	18.58 ± 6.35	23.91 ± 6.17	24.31 ± 4.96	17.14	.000						
Control group (G2)	19.12 ± 6.89	20.29 ± 5.14	20.62 ± 4.60	65.46	.000						
Evaluation						9.60	.013	15.52	.000	13.80	.000
Experimental group (G1)	21.68 ± 6.37	26.62 ± 6.09	27.12 ± 5.41	16.87	.000						
Control group (G2)	21.91 ± 7.45	22.25 ± 4.96	21.93 ± 4.16	59.26	.000						
Metacognitive awareness						14.87	.000	53.80	.000	32.90	.000
Experimental group (G1)	197.48 ± 36.05	239.69 ± 35.48	242.64 ± 29.18	18.89	.000						
Control group (G2)	199.21 ± 42.72	204.69 ± 30.98	204.48 ± 27.05	87.72	.000						

Notes: T0, baseline; T1, post-intervention (16 weeks after baseline); T2, 1-month follow-up (20 weeks after baseline); *p* value .000 -mean "<.001".

Simple effect test on interaction effects for metacognitive awareness

Table 3 shows that at the T_0 level, the group factor had no effects on metacognitive awareness and subcategory outcome measures ($F_{(2, 96)}$ = 0.01−0.16; all *ps* > .05). This means that there were no significant differences between the two groups at the baseline. At the T_1 level, two groups had significant effects on metacognitive awareness and the subcategory outcome measures ($F_{(2, 96)}$ = 9.78−44.03; all *ps* < .01). This means that 16-week NCST-C intervention has significant effect on metacognitive awareness. At the T_2 level, two groups had significant effects on metacognitive awareness and the subcategory outcome measures ($F_{(1,48)}$ = 14.24 − 62.36; all *ps* < .01). This means that on the metacognitive awareness and subcategory outcome measures, the NCST-C intervention effect persisted for 1 month. In addition, from post-intervention to follow-up, the intervention group had a higher effect size than the control group (Cohen's d > 0.56).

Each group was compared at three time points as seen in Table 3. The intervention group results revealed that before and after the intervention for all outcome measures had statistically significant differences ($F_{(1, 48)}$ = 17.83−79.85; all *ps* < .01). Metacognitive awareness and subcategory outcome measures effect sizes at post-intervention (Cohen's d = −1.41 to 0.37) and follow-up (Cohen's d = −1.63 to 0.40) were higher than baseline measures in the intervention group. However, metacognitive awareness and subcategory outcome measures in the control group showed that a change trend was not obvious at three time points, and there were no statistically significant differences on follow-up and post-intervention ($F_{(1, 48)}$ = 0.24−2.87; all *ps* > .05).

Discussion

This study found that nursing students' metacognitive awareness significantly improved in the intervention group, but there was no statistically significant difference in the control group. This indicates that traditional skill training courses do not cultivate students' metacognitive awareness. The intervention group results, meanwhile, showed that the NCST-C could improve metacognitive awareness. This may be partially attributable to our study's three-module online−offline design and multi-station examination design [32]. Mansueto's research emphasizes that a maximum learning effect occurs when individuals are reinforced metacognitive beliefs and receive timely feedback [33]. NCST-C provides periodic feedback in the three dimensions of online data feedback, classroom skill examination, and practical service testing. Students can observe their performance in real time, gaining a sense of satisfaction and accomplishment, which can stimulate internal learning motivation and affect metacognitive awareness [34].

The intervention group had a significant improvement in its knowledge of cognition scores at 16 weeks compared with the control group. This improvement was long-lasting (over 1 month; Cohen's d = 1.31) and almost identical to what Gholami found in problem-based learning intervention [35]. Studies on metacognition have shown a positive relationship between students' knowledge of cognition and their problem-solving ability, in this regard, case-based blended learning modules can act as a catalyst for improving the knowledge of cognition in nursing students [21]. Adding case questions to the NCST-C individual and team examinations is the key point to improve the knowledge of cognition on nursing students in this study. A recent study showed that guided reciprocal peer questioning improved nursing students' knowledge of cognition [16]. This is similar to our study in that NCST-C stimulated students to think about how to use online learning resources and cooperative group learning, adapt to a new type of examination, and smoothly complete the cooperative group experimental course. This process promotes the accumulation of declarative, procedural, and conditional knowledge contained in knowledge of cognition.

The intervention group showed a significant improvement in the regulation of cognition scores compared with the control group. This included improvements in students' planning, information management, monitoring, debugging, and evaluation abilities. This could be because metacognitive awareness is a multi-dimensional process that involves individual awareness in recalling and

Table 3 *Results of Simple Effects of Interaction Effects on All Outcomes.*

Source of variation	Metacognitive knowledge			Metacognitive regulation			Planning			Information management			Monitoring			Debugging			Evaluation			Metacognitive awareness		
	F	Value	Cohen's d	F	Value	Cohen's d	F	Value	Cohen's d	F	Value	Cohen's d	F	Value	Cohen's d	F	Value	Cohen's d	F	Value	Cohen's d	F	Value	Cohen's d
G WITHIN T0	0.01	.753	−0.06	0.00	.979	−0.06	0.13	.722	−0.07	0.01	.924	0.06	0.11	.743	−0.07	0.16	.694	−0.08	0.03	.875	−0.79	0.04	.831	−0.04
G WITHIN T1	29.28	.000	1.11	38.32	.000	1.02	26.62	.000	1.05	33.36	.000	1.17	44.03	.000	1.36	9.78	.000	0.64	14.88	.000	0.78	26.51	.000	1.05
G WITHIN T2	51.95	.000	1.47	56.75	.000	1.31	50.22	.000	1.45	49.99	.000	1.44	62.36	.000	1.61	14.24	.000	0.77	27.72	.000	1.07	44.16	.000	1.36
T WITHIN G1	63.54	.000	–	54.75	.000	–	63.31	.000	–	79.85	.000	–	73.86	.000	–	24.69	.000	–	17.83	.000	–	51.34	.000	–
G1 (T0 v. T1)			−0.37			−1.16			−1.27			−1.41			−1.41			−0.85			−0.79			−1.18
G1 (T0 v. T2)			−0.40			−1.34			−1.48			−1.60			−1.63			−1.01			−0.92			−1.38
G1 (T1 v. T2)			−0.08			−0.08			−0.15			−0.03			−0.07			−0.07			−0.09			−0.09
T WITHIN G2	1.30	.282	–	0.69	.514	–	1.05	.352	–	2.87	.064	–	0.59	.562	–	1.64	.202	–	0.24	.781	–	0.81	.448	–
G2 (T0 v. T1)			−0.12			−0.09			−0.11			−0.32			−0.05			−0.19			−0.05			−0.15
G2 (T0 v. T2)			−0.04			−0.14			−0.05			−0.31			−0.12			−0.26			−0.01			−0.14
G2 (T1 v. T2)			0.11			−0.04			0.08			0.03			−0.08			−0.07			0.07			0.01

Notes: G, group; G1, Experimental group; G2, Control group; T, time point; T0, baseline; T1, post-intervention (16 weeks after baseline); T2, 1-month follow-up (20 weeks after baseline).

thinking about information and transforming it into behavior [36]. Previous research has shown that more examination setting and team-based learning can improve students' information, time management skills, and enhances students' metacognitive awareness [37]. The NCST-C focused on multi-station nursing skill examination, cooperative group learning, and experiential online resources. The classroom teaching component focused on group teaching, which inspires students to use teamwork to solve problems together. These placed higher requirements on students' planning, information management, team monitoring, and self-debugging abilities. In addition, developing such capabilities would likely take 16 weeks in a university learning environment, which the NCST-C can achieve. The results of the one-month follow-up showed that these abilities were maintained.

The students' adherence rates and open-ended comments indicated that the NCST-C was well-planned, flexible, and acceptable, and students appreciated the teaching and learning environment. The adherence rate of the intervention group was 100%. Our approach was acceptable to the nursing students because it fits in with the current Chinese culture and educational development. First, this high adherence rate may be attributable to the integrated learning and teaching methods. Module one mainly covered learning and teaching methods content, and students were familiarized with the new curriculum and learning forms [38]. Second, we use cooperative group learning methods, integrate experimental content design online−offline teaching mode, and use individual and team multi-station skill assessment were key to controlling teaching quality and enhancing students' interest in learning [12]. The smooth implementation of the NCST-C can also be attributed to the efforts of our course team teachers to course resources and provide professional guidance.

Limitations

Due to time and conditions limitation, our study has some limitations. First, this was a quasi-experimental study and administered in only one school. The limitations of this design include its small sample size, potential desirability bias, selection bias, and limited external validity. Future studies should be tested in other schools and explore the effects of NCST-C using larger and more diverse samples. Second, self-reported questionnaires have inherent limitations, inability to deeply analyze the emotional experience of participating in the course. Future studies should consider adding qualitative interviews to explore students' subjective feelings about participating in a course. Third, given the positive effects on the metacognitive awareness and 1 month long-term effects, future studies could examine its effects on other aspects and explored beyond 1 month long-term effects.

Conclusion

This study demonstrated that the NCST-C effectively developed metacognitive awareness among nursing students. Its design provides a new type of experimental course for improving metacognitive awareness. We hope the findings can specifically inform multi-dimensional structural design in nursing curricula reform while providing a practical basis for nursing curricula development.

Contributions

Shasha Li: conceiving, designing the study and writing the paper. Minerva de Ala: design direction. Dandan Mao: data survey and analyzing the data. Afeng Wang and Congwen Wu: implementation of teaching. The authors gave final approval of the version to be published.

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Conflict of interest

The authors declare that they have no conflicts of interest.

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References

1. Curran VR, Fairbridge NA, Deacon D. Peer assessment of professionalism in under graduate medical education. BMC Med Educ. 2020;20(1):504–10. https://doi.org/10.1186/s12909-020-02412-x
2. Sezer H, Şahin H. Faculty development program for coaching in nursing education: a curriculum development process study. Nurse Educ Pract. 2021;55:1–10. https://doi.org/10.1016/j.nepr.2021.103165
3. Medina MS, Castleberry AN, Persky AM. Strategies for improving learner metacognition in health professional education. Am J Pharm Educ. 2017;81(4):78–86. https://doi.org/10.5688/ajpe81478
4. Abdelrahman RM. Metacognitive awareness and academic motivation and their impact on academic achievement of Ajman university students. Heliyon. 2020;6(9). https://doi.org/10.1016/j.heliyon.2020.e04192, 1–7.
5. Flavell JH. Cognitive development. 2nd ed. Upper Saddle River, NJ: Prentice-Hall; 1988. p. 99–115.
6. Shea N. Metacognition and abstract concepts. Philos Trans R Soc Lond B Biol Sci. 2018;373:1–7. https://doi.org/10.1098/rstb.2017.0133
7. Schraw G, Dennison RS. Assessing metacognitive awareness. Contemp Educ Psychol. 1994;19(4):460–75.
8. Akturk AO, Sahin I. Literature review on metacognition and its measurement. Proc Soc Behav Sci. 2011;15:3731–6. https://doi.org/10.1016/j.sbspro.2011.04.364
9. Song JHH, Loyal S, Lond B. Metacognitive awareness scale, domain specific (MCAS-DS): assessing metacognitive awareness during raven's progressive matrices. Front Psychol. 2021;11:1–14. https://doi.org/10.3389/fpsyg.2020.607577
10. Chang C, Colón-Berlingeri M, Mavis B, Solomon D. Medical student progress examination performance and its relationship with metacognition, critical thinking, and self-regulated learning strategies. Acad Med. 2021;96(2):278–84. https://doi.org/10.1097/ACM.0000000000003766
11. Bernstein A, Hadash Y, Lichtash Y, Fresco DM. Decentering and related constructs: a critical review and metacognitive processes model. Perspect Psychol Sci. 2015;10(5):599–617. https://doi.org/10.1177/1745691615594577
12. Desender K, Teuchies M, Gonzalez-Garcia C, Brass M. Metacognitive awareness of difficulty in action selection: the role of the cingulo-opercular network. J Cogn Neurosci. 2021;33(12):2512–22. https://doi.org/10.1162/jocn_a_01773
13. Shekhar M, Rahnev D. Sources of metacognitive inefficiency. Trends Cogn Sci. 2021;25(1):12–23. https://doi.org/10.1016/j.tics.2020.10.007
14. Bektas I, Bektas M, Ayar D, Celik I. The predict of metacognitive awareness of nursing students on self-confidence and anxiety in clinical decision-making. Perspect Psychiatr Care. 2021;57(2):747–52. https://doi.org/10.1111/ppc.12609
15. Rashwan ZI, Busebaia TJ, Al-Sabbagh AS, Eweida RS. Effect of guided reciprocal peer questioning strategy on pediatric nursing students' self-esteem and metacognitive awareness: current approach and future directions. Nurse Educ Today. 2021;107:1–9. https://doi.org/10.1016/j.nedt.2021.105153
16. Chan CWH, Tang FWK, Chow KM, Wong CL. Enhancing generic capabilities and metacognitive awareness of first-year nursing students using active learning strategy. BMC Nurs. 2021;20(1):81–9. https://doi.org/10.1186/s12912-021-00601-7
17. Blake TK. Journaling; an active learning technique. Int J Nurs Educ Scholarsh. 2005;2(1):1–15. https://doi.org/10.2202/1548-923x.1116
18. Waltz CF, Jenkins LS, Han N. The use and effectiveness of active learning methods in nursing and health professions education: a literature review. Nurs Educ Perspect. 2014;35:392–400. https://doi.org/10.5480/13-1168
19. Hsu LL, Hsieh SI. Factors affecting metacognition of undergraduate nursing students in a blended learning environment. Int J Nurs Pract. 2014;20(3):233–41. https://doi.org/10.1016/j.nedt.2021.105164
20. Mahmoud H. The effect of cooperative learning strategy on undergraduate nursing students enrolled in nursing administration course. Int J Learn. 2017;7:722–38. https://doi.org/10.5296/ijld.v7i1.11021
21. Siqueira MAM, Gonçalves JP, Mendonça VS, Martins MA. Relationship between metacognitive awareness and motivation to learn in medical students. BMC Med Educ. 2020;20(1):393–401. https://doi.org/10.1186/s12909-020-02318-8
22. Gholami M, Moghadam PK, Mohammadipoor F, Pour AH. Comparing the effects of problem- based learning and the traditional lecture method on critical thinking skills and metacognitive awareness in nursing students in a critical care nursing course. Nurse Educ Today. 2016;45:16–21. https://doi.org/10.1016/j.nedt.2016.06.00
23. Martirosov AL, Moser LR. Team-based learning to promote the development of metacognitive awareness and monitoring in pharmacy students. Am J Pharm Educ. 2021;85(2):131–6. https://doi.org/10.5688/ajpe848112
24. Hao X, Peng X, Ding X, Li K. Application of digital education in undergraduate nursing and medical interns during the COVID-19 pandemic: a systematic review. Nurse Educ Today. 2022;108:1–11. https://doi.org/10.1016/j.nedt.2021.105183
25. Meng XH, Xu XY, Chen HL, Zhang L. The effectiveness of combining e-learning, peer teaching, and flipped classroom for delivering a physiology laboratory course to nursing students. Adv Physiol Educ. 2022;46(1):21–6. https://doi.org/10.1152/advan.00062.2020
26. Schramm J, Uranga T, Birkle A, Taylor L. Improving holistic care skills for advanced practice registered nurses: integration of a complementary and alternative medicine course into a doctor of nursing practice curriculum. J Dr Nurs Pract. 2021;11:421–31. https://doi.org/10.1891/JDNP-D-20-00077
27. Jiang Y, Chen Y, Lu J, Wang Y. The effect of the online and offline blended teaching mode on English as a foreign language learners' listening performance in a Chinese context. Front Psychol. 2021;12:1–16. https://doi.org/10.3389/fpsyg.2021.742742
28. Liu HY. Promoting creativity of nursing students in different teaching and learning settings: a quasi-experimental study. Nurse Educ Today. 2022;108:1–9. https://doi.org/10.1016/j.nedt.2021
29. Hwang GJ, Chang CY, Ogata H. The effectiveness of the virtual patient-based social learning approach in undergraduate nursing education: a quasi-experimental study. Nurse Educ Today. 2022;108:21–31. https://doi.org/10.1016/j.nedt.2021.105164
30. Brauer DG, Ferguson KJ. The integrated curriculum in medical education: AMEE Guide No. 96. Med Teach. 2015;37(4):312–22. https://doi.org/10.3109/0142159X.2014.970998
31. Lipsey MW, Wilson DB. The efficacy of psychological, educational, and behavioral treatment: confirmation from meta-analysis. Am Psychol. 1993;48(12):1181–209.
32. McCabe J. Metacognitive awareness of learning strategies in undergraduates. Mem Cognit. 2011;39(3):462–76. https://doi.org/10.3758/s13421-010-0035-2
33. Mansueto G, Marino C, Palmieri S, Caselli G. Difficulties in emotion regulation: the role of repetitive negative thinking and metacognitive beliefs. J Affect Disorder. 2022;308:473–83. https://doi.org/10.1016/j.jad.2022.04.086
34. Sart G. The effects of the development of metacognition on project-based learning. Procedia Soc Behav Sci. 2014;152:131–6. https://doi.org/10.1016/j.sbspro.2014.09.169
35. Siqueira MAM, Gonçalves JP, Mendonça VS, Martins MA. Relationship between metacognitive awareness and motivation to learn in medical students. BMC Med Educ. 2020;20(1):393–6. https://doi.org/10.1186/s12909-020-02318-8
36. Turan S, Demirel O, Sayek I. Metacognitive awareness and self-regulated learning skills of medical students in different medical curricula. Med Teach. 2009;31(10):e477–83. https://doi.org/10.3109/01421590903193521
37. Rivers ML, Dunlosky J, Persky AM. Measuring metacognitive knowledge, monitoring, and control in the pharmacy classroom and experiential settings. Am J Pharm Educ. 2020;84(5):549–60. https://doi.org/10.5688/ajpe7730
38. Khodaei S, Hasanvand S, Gholami M, Amini M. The effect of the online flipped classroom on self-directed learning readiness and metacognitive awareness in nursing students during the COVID-19 pandemic. BMC Nurs. 2022;21(1):2–11. https://doi.org/10.1186/s12912-022-00804-6