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Research article

The effectiveness of designing and evaluating i-STAR applications in pediatric nursing courses

Hui-Man Huang, Yu-Wen Fang *

Department of Nursing, School of Nursing, Tzu Chi University of Science and Technology, Hualien, Taiwan, ROC

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ABSTRACT

To apply the App to the curriculum could improve students' motivation and concentration, and also strengthen the effectiveness of professional knowledge of nursing students. Objectives: To construct and evaluate the effectiveness of smartphone applications (i-STAR) in pediatric nursing courses. Methods: Quasi-experimental study and two-group repeated-measure design were used to evaluate the effectiveness of smartphone applications (i-STAR) in pediatric nursing courses. The "i" means "interactive", students had to log into App and finish four steps, including "Situation(S), Task(T), Action(A), and Reflection(R). A total of 163 nursing students in the third grade of associate's degree in nursing (ADN) participated in the study. The experimental group consisted of 77 participants, whereas the control group consisted of 86 participants. The instruments included the clinical reasoning readiness scale (CRRS), self-directed learning instrument (SDLI), and learning satisfaction of students. The 1st phase was the development, construction, and testing of the "i-STAR App", including hyperbilirubinemia, pneumonia, and urinary tract infection (UTI). In the 2nd phase, students operated and applied the App in the classroom. The 3rd phase was to evaluate the effectiveness of the "i-STAR App" in the course. Results: The average scores of CRRS and SDLI were not significantly different between the two groups in the T0 andT1 ($p > .05$). The experimental group of CRRS and SDLI were better than the control group in T0-T1, T1-T2, and T0-T2 ($p < .001$). The experimental group showed better CRRS and SDLI scores than the control group in T0-T1, and T0-T2 with Repeated measures ANOVA. Also, the experimental group showed prolonged learning effectiveness. The experimental group (41.22 ± 6.08) was more satisfied than the control group (37.29 ± 7.40) ($p < .05$), although their academic performance was about the same ($p > .05$). Conclusion: "i-STAR App" could enhance students' interest in pediatric nursing courses, strengthen nursing students' clinical reasoning and self-directed learning ability.

1. Introduction

The global impact of the COVID-19 pandemic opens a new era of education, which has produced a rapid development and utilization of smartphone applications (Apps) [1,2]. The smartphone App was to supply students on getting information on health care, which made numerous benefits such as better access to educational material, improvement in knowledge and confidence, and support in decision-making for detection and nursing care in practice [3,4]. Using smartphone Apps plays an important role for nurses and

* Corresponding author. ;
E-mail address: yvonnef1998@gmail.com (Y.-W. Fang).

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nursing students [3].

Pediatric nurses play an essential role in promoting and coordinating children's and teenagers' healthcare, to provide high-quality and evidence-based nursing interventions [5]. Nursing educators have involving in different types of information technology to increase nursing students' knowledge and skills [6–8]. However, the traditional pediatric nursing course was harder to attract the attention and motivation of nursing students in the classroom. The Z and Alpha generations were used to get available technology resources [9]. Thus, nursing educators need to undertake more evidence-based research to support the teaching and learning outcomes of smartphone technology in nursing students [7].

Clinical reasoning (CR) and self-directed learnings are vital core competencies and educational standards for nursing students [10, 11]. To improve nursing students' CR and SDL competency, some research had applied teaching strategies, such as simulations, flipped classrooms, case-based learning (CBL) [12-14], and gaming [15] on nursing education. These results of studies showed positive outcomes, however, the e-learning environment must have a solid theoretical foundation to support the development of CR for nursing students [16]. Moreover, there were few studies combining the clinical reasoning model with smartphone App, especially working in the pediatric nursing course. Thus, this study was to develop based on a framework, to apply the App in the classroom, and to evaluate the effectiveness of "i-STAR App" in pediatric nursing courses.

1.1. Literature review

The proportion of smartphones used in Taiwan was ranked 33rd in the world in 107, and the penetration rate of mobile phones nationwide reached 60% [17]. Teenagers were most use social media platforms such as Instagram, Snapchat, and TikTok [18]. Compared to using other information sources, the smartphone App was the third most popular method [7]. The younger generations had shifted learning methods from traditional to digital devices and gamified [19-21]. To combine smartphone App into the curriculum which was without the limitations of time and space, nursing students could improve their professional knowledge and lessen the anxiety of facing clinical practices [6,22]. The smartphone App also could increase students' learning motivation and concentration, making self-learning flexible, and saving more time and energy from the faculty's viewpoint [23].

The faculty should ensure that nursing students already had learned about the pediatric disease process, medication, and nursing care knowledge before the pediatric nursing internship [24]. The health problems of children, adolescents, and families need to be emphasized in nursing curriculums [9]. Some education strategies have been applied to nursing courses, such as tutorials, case studies, problem-based learning (PBL), serious games, animated teaching agents, and virtual patients. Appropriate educational courses, it would make nurses and students feel more confident to develop clinical skills in children's primary care [25].

The development of CR for nursing students should be the school's highest education priority [16]. The recent COVID-19 pandemic also has highlighted the critical need for clinical reasoning competency in nurses [1]. Critical reasoning is a "complex cognitive process that uses formal and informal thinking strategies to gather and analyze patient information, evaluate the significance of this information and weigh alternative actions" [26], (p.1155). Insufficient clinical reasoning could affect the nursing care quality and patients' safety [26,27], and unable to maintain safe medication administration or make medication errors [28]. To fit complicated patient contexts and circumstances, it is professionally and ethically vital for nursing students to be equipped with CR ability before entering the practice settings [29,30]. Applying tools to learn and evaluate CR was a challenge in nursing education [16]. An E-learning learning environment could cultivate of clinical reasoning ability of nursing students [16]. On the other hand, self-directed learning, and lifelong learning are also inseparable. The students with self-direct learning ability could not only increase their motivation of learning but also rebuild their self-confidence in learning [31]. To understand students' SDL ability before implementing teaching strategies which were helpful for faculty [30,31].

For the increasingly complex medical environment and the learning needs of the new generation, researchers should involve in developing and testing mobile apps and evaluating the outcomes [2]. Thus, this study of objectives was to construct the i-STAR applications and evaluate the effectiveness of the intervention in pediatric nursing courses. Students would follow the app's directions step by step to complete their learning programs of pediatric nursing. This study of research problems was "Was there any difference in the basic demographics of the two groups?" "Were there significant differences in the clinical reasoning ability of different groups of nursing students?"; "Were there significant differences in the self-directed learning of different groups of nursing students?

1.2. The theoretical framework

The "i-STAR" was based on the Framework of Competencies in Clinical Reasoning for Nursing Students [30]. This model was constructed from nursing professionals' viewpoints, including four domains: 1. Awareness of clinical cues; 2. Confirmation of clinical problems; 3. Determination and implementation of actions; and 4. Evaluation and self-reflection (p.112) [30]. It showed that clinical reasoning was a process; nursing students could follow the dynamic circle and form their clinical reasoning competency [30]. "Nursing educators could understand the issues and needs students to encounter during the reasoning process with this framework, more, which may promote students' ability to provide care [30]." The clinical reasoning "i-STAR" transformed the abstract concept into concrete steps. The "i" means "interactive", students had to log into App, and pass four stages "STAR". The first stage "S" means "Situation" (=awareness of clinical clues), the second stage "T" means "Task (=confirmation of clinical problems), the third stage "A" means "Action" (=determination and implementation of actions), and the last stage "R" means "Reflection" (=evaluation and reflection). The i-STAR applications could guide nursing students not learning pediatric nursing, but also in improving their clinical reasoning and self-directed learning ability.

2. Research Design and Methods

Development of the CRRS consisted of three phases: (1) developing, constructing, and testing " i-STAR App", (2) students operating and applying the App in the classroom testing i-STAR App, (3) evaluating the effectiveness of " i-STAR App" in the course. The quasi-experimental study and two-group repeated-measure design were used to evaluate the effectiveness of the smartphone App (i-STAR) in pediatric nursing courses. Convenience sampling and random assignment were used in four classes by coins, two classes were experimental groups, and the others were the control groups. Analyzed with G* Power 3.1.9.7, Effect size = 0.25, α = 0.05, Power = .85, the estimated sample size at least was 92, the default attrition rate was 20%, and the estimated number of cases accepted was 110 in total. A total of 163 nursing students in the third grade of the associate degree in nursing (ADN) participated in the study. The inclusion criteria were: (1) nursing students who were enrolled in the third year of nursing programs, (2) finished basic nursing practicum, and (3) agree to participate in research. The inclusion criteria were: (1) nursing students who were Taiwanese aborigines, (2) disagree to participate in the research. In this study, the experimental group consisted of 77 participants, whereas the control group consisted of 86 participants. Participants using Android and IOS smartphone platforms were recruited. For the experimental group, researchers combined clinical reasoning i-STAR App into the pediatric nursing course, while the control group received lecture and quizzing methods. The pediatric nursing course had a duration of 18 weeks (total 36 h), the experimental group took about 1.5 h for lectures and then provided students with i-STAR App for 30 min in the classroom. The operating system of the App was restricted to the student ID, which could avoid the control group from approaching the App. The i-STAR App would open to the control group students before the final examination of pediatric nursing. The study process was described below.

2.1. Phase I: development, construction, and testing of "i-STAR app"

In this phase, researchers constructed the i-STAR App with four stages which were based on the Framework of Competencies in Clinical Reasoning for Nursing Students [30], which included "Situation", "Task", "Action", and "Reflection". Researchers developed three pediatric scenarios: hyperbilirubinemia, pneumonia, and urinary tract infection (UTI). And then imported these scenarios into the i-STAR App. Each "i-STAR" of scenarios included four stages: (1) Situation: students would watch YouTube videos to find out the clinical cues about children, such as "Which child had the features of jaundice? What did you find?" (2) Task: students must conform the clinical problems from signs and symptoms, such as "Based on the signs of jaundice you noticed, what health problems do you think the baby has?" (3) Action: students would select interventions by priority, such as "The baby currently needs phototherapy, what' nursing intervention will you provide?" and (4) Reflection: this step would collect feedback and reflection from students after using i-STAR. During the development of the App, the game background management system was continuously renewed. The i-STAR started at clinical scenarios, to follow the directions of the App, the students would find clinical clues and problems and go through the next stage of i-STAR step by step. While testing of "i-STAR App", the researcher revised the App.

2.2. Phase II: operated and applied the app in the classroom

This phase followed the course of pediatric nursing to use i-STAR App. The students were going to operate i-STAR in the classroom. Before the course, we conducted a pretest with a clinical reasoning readiness scale (CRRS) and self-directed learning instrument (SDLI). While the researcher finished the lecture, the experimental group of students were to use the i-STAR App with their smartphones for 30

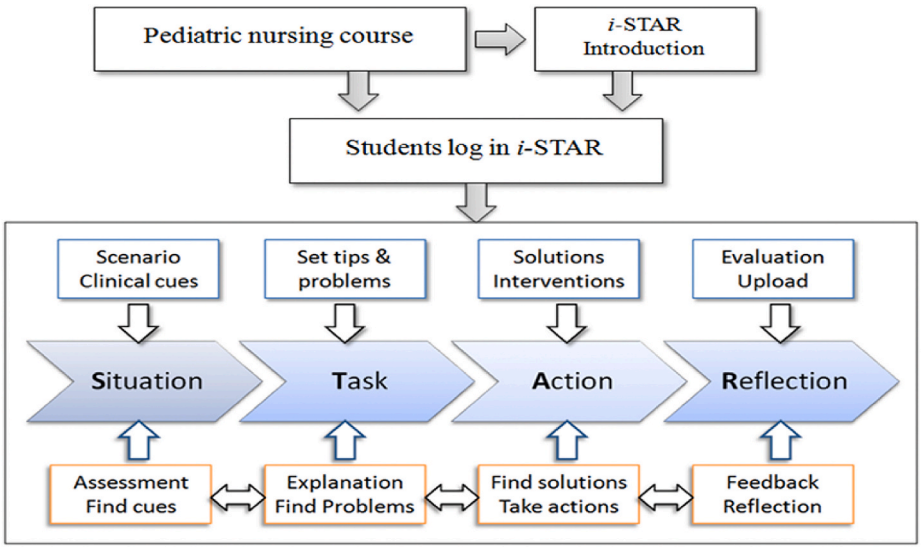


Fig. 1. The design and operation of the *i*-STAR App.

min by App's instructions (See Fig. 1). The i-STAR was not only to make sure nursing students' pediatric knowledge, but also to make students play games in the internet world at the same time. For example, in the newborn hyperbilirubinemia case, in the first stage of the i-STAR App, students assessed the signs and symptoms of virtual videos and scenarios. In the second stage, students must answer a series of questions, which were related to clinical clues of pediatric diseases and nursing care. Students tried to connect the relationship between the clinical cues and diseases mechanism. In the third stage, which was based on the first two stages, students would find out the most appropriate treatment and nursing interventions according to the different situations. In the last stage of the App, students had to evaluate the outcome of problem-solving and respond to their process of clinical reasoning by describing their experience. Every student must pass through four stages the of i-STAR App in time. To match the different group of students' needs, the i-STAR App would open before the final examination for three days. To attract students' eyeballs, once finishing each stage of the i-STAR App, students would be rewarded with 10 golden stars and join score point ranking. (Fig. 1 insert here).

2.3. Phase III: evaluate the effectiveness of "i-STAR app" in the course

This phase was to evaluate the effectiveness of the "i-STAR App" in pediatric nursing courses. Self-reported surveys were conducted before and after the operating App in the course. The research data were collected with nursing students' clinical reasoning scale (CRRS) and self-directed learning instrument (SDLI) to evaluate the effect of the intervention. After finishing 1 week of app use, we conducted a posttest time 1 (T1) on CRRS and SDLI. And then, using the same items as in the posttest time 2 (T2) before the final examination of pediatric nursing. The qualitative data was students' feedback and reflection by i-STAR App stage four. The CRRS and SDLI data were analyzed with Repeated measures ANOVA. Demographic data collected from the participants were age, sex, finished basic nursing practicum, student self-perceived academic performance, the experience of App, and analyzed with the Chi-square test. The evaluation instruments stated as follows.

2.3.1. Clinical reasoning readiness scale (CRRS)

Based on the clinical reasoning scale developed by Huang &Cheng [33], including four domains (awareness of clinical clues, confirmation of clinical problems, determination and implementation of actions, and evaluation and reflection). Each domain had four items, with total 16 items. The result of confirmatory factor analysis (CFA) showed that the goodness fit of mode no.4 is the best: RMSEA = 0.049, GFI = 0.97, AGFI = 0.95, NNFI = 0.99, NFI = 0.99. The Cronbach's α coefficient was 0.894. The reliability of the four domains was between 0.78 ~ 0.89. This tool has good reliability and validity. With a 5-point Likert scale, the total scores ranged from 16 to 80[33]. This scale has no cutoff values, the higher the score means the better the clinical reasoning competency.

2.3.2. Self-directed learning instrument (SDLI)

Based on the SDLI developed by Cheng and others [34], the scale measurement showed four domains, including learning motivation, planning and execution ability, self-monitoring, and interpersonal communication, with a total of 20 items. The result of CFA showed: RMSEA: 0.057, RMS: 0.04, GFI: 0.94, AGFI: 0.92, NNFI: 0.92, NFI: 0.93, AIC: 0.763, $p < .001$. The Cronbach's alpha values were 0.916, 0.801, 0.861, 0.785, and 0.765. This tool has good reliability and validity. This scale has no cutoff values. The higher the score, the better the self-directed learning ability. With a 5-point Likert scale, the total scores ranged from 20 to 100 [34].

This study was approved by the institutional review board (IRB) of the Saint Mary's hospital Behavior and Social Science Study Ethics Review Committee (IRB108009). The informed consent was obtained from all participants for this study.

3. Result

There were 163 participants in this research, 77 people in the experimental group and 86 people in the control group (shown in Table 1). A total of 143 girls accounts for 87.7% and 20 boys accounted for 12.3% of the participants. There was a significant difference between the two groups' sex ratio, self-perceived academic performance, and use time of App was significant in statistics with the Chi-square test ($p > 001$). However, the age of the two groups was not significant. More students in the control group had "finished basic nursing practicum" and "use time of App" experience. (Table 1 insert here).

Table 1
Demography of participants, **(N = 163)**.

Variable		Experimental group (N = 77)	Control group (N = 86)	F/*p*
Age (M/SD)		17.09 (±.33)	17.19 (±.42)	2.531/.114
Sex	**Female**	67 (87.0%)	76 (88.4%)	.000
	Male	10 (13.0%)	10 (11.6%)	
Self-perceived academic performance	**Good**	20 (26.0%)	19 (22.1%)	.000
	Average	50 (64.9)	59 (68.6%)	
	Poor	7 (9.1%)	8 (9.3%)	
Finished basic nursing practicum	Yes	52 (67.5%)	76 (88.4%)	.000
	No	25 (32.5%)	10 (11.6%)	
Use time of Ordinary App Often		39 (50.7%)	33 (38.4%)	.000
		38 (49.3%)	53 (61.6%)	

**$p < .001$.

There was no significant difference between the two groups on CRRS in the pre-test (T0) and post-test (T1) ($p > 05$). Both groups of CRRS improved from T0 to T2 in three-time points (See Table 2). However, the experimental group made obviously an improvement in the CRRS, especially in the post-test (T2). In the post-test (T2), which showed the experimental group had a better score level, with66.88 (±9.83) on CRRS, while the control group got 63.52 (±10.15), it showed a significant difference between the two groups on the pre-test (T2) with ANOVA ($p < .05$) (Table 2). To compare the two groups of T0, T1, and T2 performance of CRRS, which indicated that the scores of the control group were significantly more improbable than the experimental group, results showed a significant difference between the two groups ($p < .001$). (Tables 2 and 3 insert here). Both groups of SDLI improved on the three-time points (T0, T1, T2) (See Table 2). The post-test (T1) showed the experimental group had a better score level of 75.32 (±11.78) on SDLI, while the control group got 74.06 (±12.71) on SDLI (Table 2). The experimental group showed that the posttest scores (T2) of 82.94 (±12.05) were significantly higher than the control group's score of 77.30 ($p < .01$).

There were 77 people in the experimental group and 86 people in the control group, with a total of three scores on CRRS and SDLI. Repeated measure ANOVA analysis results showed that the experimental group had significance appeared between T1 and T2, and between T0 and T2 on CRRS ($p > .05$), while the control group was no significant improvement in the three-time ($p < .05$). The significance also appeared between T1 and T2, and between T0 and T2 on SDLI ($p > .05$), however, the control group was no significant ($p < .05$). Although, both groups improved in the T1 and T2, compared to T0 (Table 3).

Moreover, although the demography of participants showed a significant difference between the two groups ($p < .001$), age, and sex of participants did not affect the score of CRRS and SDLI ($p > .05$) in each group. For privacy reasons, the "academic performance" of students means "students self-perceived their academic performance." The academic performance would affect SDLI (T2) score ($p < .05$), where students felt that the better academic performance the higher SDLI scores. The experimental group (41.22 ± 6.08) (full marks 50) was more satisfied than the control group (37.29 ± 7.40) ($p < .05$) after using i-STAR App in the pediatric nursing course, although their exam scores was about the same ($p > .05$) (Table 2).

To analyze the data in three-time points (T0, T1, T2) by generalized estimating equation (GEE), which showed both groups had improved, however, the score of the experimental groups was better than the control group. The CRRS score of experimental groups stagnated in T1 but made an obvious improvement in T2. It showed the prolonged effectiveness of using i-STAR App, even though T1 and T2 of CRRS, and T1 of SDLI did not reach the significance of statistics ($p > .05$) (Table 4). The experimental group improved their SDLI score to around 3.99 on T2 and had a significant difference in statistics ($p < .05$) (Table 5). (Tables 4 and 5 insert here).

This study was to use i-STAR App in pediatric nursing courses for nursing students, the result showed the experimental group had effectiveness in learning outcomes. To inspect the CRRS scores of four domains, which just respond to the i-STAR App' four stages. Two groups there were no differences in four domains in T0 and T1, while the score of the experimental groups was higher than the control group in the second stage (confirmation of clinical problems), the third stage (determination and implementation of actions), and last stage (evaluation and reflection). The trend of CRRS and SDLI in three-time points (T0, T1, T2) (See Fig. 2), both groups were upward trend analysis. The CRRS and SDLI of the experimental group had significant progress in T2. (Fig. 2 insert here).

4. Discussion

This research was to develop and apply i-STAR App in pediatric nursing courses. The App included four stages: situation, task action, and reflection. The i-STAR App combined pediatric clinical scenarios, pictures, quizzes, and knowledge of pediatric nursing, and could make it more fun for students. In this study, the researcher found that using Apps to learn was closer to students' life, and also made learning pediatric nursing more interesting with games. This opinion was similar to what Betz [9] and Pew Research Center [18] had indicated. Compared with other information sources, the smartphone App was one of the most useful devices for students. Smartphone Apps have become a convenient tool for nursing students when they learn professional knowledge and skills, as the viewpoints of Baccin et al. [3]. And O'Connor, & Andrews [4]. They had learned pediatric nursing from the four clinical reasoning stages of STAR step by step.

Students said they were able to find clinical clues and correspond their findings from videos and the process of clinical reasoning.

Table 2
The mean scores and ANOVA data, **(N = 163)**.

Variable	Experimental group (N = 77)	Control group (N = 86)	F/*p*
	M(SD)	M(SD)	
T0CR	59.87 (±8.43)	57.66 (±7.19)	3.247/.073
T1CR	61.66 (±9.83)	61.97 (±10.15)	.040/.842
T2CR	66.88 (±8.74)	63.52 (±9.27)	5.62/.019*
T0SD	72.79 (±11.63)	71.13 (±10.11)	.941/.334
T1SD	75.32 (±11.78)	74.06 (±12.71)	.424/.516
T2SD	82.94 (±12.05)	77.30 (±11.24)	9.569/.002**
Satisfied level	41.22 (±6.08)	37.29 (±7.40)	13.526/.000**

*$p < .05$, **$p < .01$.
Remark.
T0CR (T0 clinical reasoning readiness scale score); T0SD (T0 self-directed learning instrument score).
T1CR (T1clinical reasoning readiness scale score); T1SD (T1self-directed learning instrument score).
T2CR (T2clinical reasoning readiness scale score); T2SD (T2self-directed learning instrument score).

Table 3
The Repeated measure ANOVA Data of CRRS and SDLI, (N = 163).

Variable	Experimental group (N = 77)		Control group (N = 86)	
	mean deviation	*p*	mean deviation	*p*
T0CR-T1CR	7013	.000	5.860	.000
T0CR–T2CR	1.792	.092*	4314	.000
T1CR-T2CR	−1.792	.092*	−4314	.000
T0SD-T1SD	10.156	.000	6.163	.000
T0SD-T2SD	2532	.72*	2930	.027
T1SD-T2SD	−2532	.72*	−2.930	.027

*$p > .05$.
Remark.
T0CR (T0 clinical reasoning readiness scale score); T0SD (T0 self-directed learning instrument score).
T1CR (T1clinical reasoning readiness scale score); T1SD (T1self-directed learning instrument score).
T2CR (T2clinical reasoning readiness scale score); T2SD (T2self-directed learning instrument score).

Table 4
The GE examination data of CRRS.

Variable	Clinical reasoning scale (CRRS)			
	B	Std. Error	Wakd χ-Square	*p*
Intercept	57.66	.77	5582.39	.000***
Control	–	–	–	-
「i-STAR App」	2.20	1.22	3.23	.072
Measurement period				
T0				
T1	4.31	1.02	17.87	.000***
T2	5.86	.81	52.13	.000***
Control*T0	–	–	–	-
Control*T1	–	–	–	-
Control*T2	–	–	–	-
「i-STAR App」 *T0	–	–	–	–
「i-STAR App」 *T1	−2.52	1.46	2.98	.084
「i-STAR App」 *T2	1.15	1.32	.763	.382

***$p < .001$.

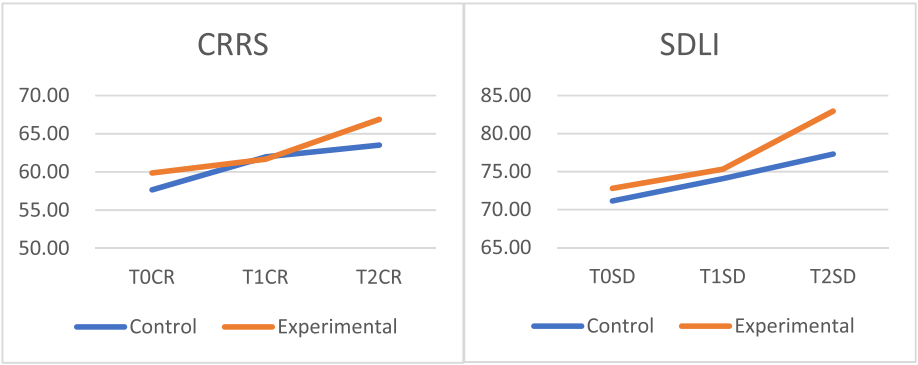
Table 5
The GE examination data of SDLI.

Variable	Self-directed learning instrument (SDLI)			
	B	Std. Error	Wakd χ-Square	*p*
Intercept	71.14	1.08	4302.12	.000***
Control	–	–	–	-
「i-STAR App」	1.65	1.70	.938	.333
Measurement period				
T0				
T1	2.93	1.29	5.12	.024*
T2	6.16	1.10	31.35	.000***
Control*T0	–	–	–	-
Control*T1	–	–	–	-
Control*T2	–	–	–	-
「i-STAR App」 *T0	–	–	–	–
「i-STAR App」 *T1	−.398	1.89	.044	.833
「i-STAR App」 *T2	3.99	1.73	5.30	.021*

*$p < .05$, ***$p < .001$

This study showed if students felt confused or misunderstood, they would seek the answers actively. Students also shared their thinking process through the reflection and feedback stage, which made teachers and students more consistent and had the best effectiveness of learning and teaching in pediatric nursing courses. Kang et al. [21]. Indicated the same viewpoint, that students thought the i-STAR App could improve their pediatric nursing knowledge and use App flexibility. Also, App could increase their learning motivation and concentration, to construct their self-learning habit and custom [21].

Advances in technology could shape the development of CR for nursing students [16]. The result reported experimental group's CR and SDL levels are better than the control group during the pediatric nursing course. The CRRS and SDLI were never set cutoff values,



Remark:
T0CR (T0 clinical reasoning readiness scale score); T0SD (T0 self-directed learning instrument score);
T1CR (T1clinical reasoning readiness scale score); T1SD (T1self-directed learning instrument score);
T2CR (T2clinical reasoning readiness scale score); T2SD (T2self-directed learning instrument score).

Fig. 2. The time trend graph of CRRS and SDLI.

the higher the score of CRRL and SDLI, clinical reasoning and self-directed learning competency were better [33,34]. The mean scores of the control group were lower than the experimental group. Based on the result, researchers found that nursing students with SDL competency have more self-confidence and motivation, which was the same as the study of Kaulback' study [31]. As Alharbi [32] indicated to enhance SDL skills is a challenging mission for educators and students. This study had the same results, using i-STAR App was no difference between the two groups in T1, and had a better SDL score than the traditional teaching strategy in T2. The App could boost nursing students' learning motivation and satisfaction, which are similar to the viewpoints of Lee et al. [35]. Students believed that they were able to grasp the key points of pediatric nursing care through i-STAR App, and also help them find out their insufficient during learning.

This study showed statistical no significance among both groups of students in relation to students' demographics and academic level just like Alharbis' study [31] and Lee et al. [35]. Although smartphone Apps could improve the learning motivation and satisfaction of nursing students, it was regardless of performance in courses. More, there was no significant variations with gender in the self-directed learning scores just like Alharbis' study [32]. In this study, the students responded that smartphone reception and operation would slow down a few if the software system was different (eg. IOS or Android) and Wi-Fi function unstable, this opinion was just like O'Connor, & Andrews [7] indicated.

The reflection and communication of the digital learning environment can deepen the influence factors of the decision-making process [15]. In this study, the researcher collected the qualitative data from feedback and reflections of the four-stage of App. The result showed that students were involved in learning pediatric nursing care, learning could be a game, and be fun. Moreover, App was a good helper for learning of children's care. This study result was like the literature review of O'Connor, & Andrews' study [4], that mobile technology could reshape students' clinical practice education, enhance knowledge and skills, improve decision-making capabilities, and increase personal self-confidence. As Kang, & Suh [21] said students were interested in a variety of educational nursing smartphone Apps in the future. Nursing educators and students should consider using handheld devices (smartphones) to strengthen nursing education and practical capabilities [4].

4.1. Study limitation

The data were derived from nursing students from only one college in Taiwan, thus the findings have limited to generalize. Some students responded that the internet is not going well when operating the i-STAR App, we were unable to control their smartphone types and operating systems. Therefore, the use of App teaching methods still needs to consider the individuality of students, such as Wi-Fi connection and smartphone function.

5. Conclusion

Pediatric nursing course is one of the important subjects for nursing students to be good nurse. Traditionally, pediatric nursing practice has been isolated from other nursing subjects. The student was hard to comprehend and must take more time to understand and review compared to other subjects. The Z and Alpha generations are used to living with technology devices, which have a profound impact on the learning style, motivation, and attitudes of nursing students. The e-learning culture must be integrated into nursing education.

This study was to construct and evaluate the effectiveness of the clinical reasoning i-STAR App in pediatric nursing courses. The clinical reasoning "i-STAR" was based on the Framework of Competencies in Clinical Reasoning for Nursing Students [30]. "i-STAR

App" could enhance students' interest in pediatric nursing, moreover, to strengthen nursing students' clinical reasoning and self-directed learning ability. Nursing students were able to experience nursing care for children through the operation of App. The App could induce students to find out more clinical cues and background meaning in the virtual clinical situation. Also, App could make students learn the process of clinical reasoning simultaneously. Using i-STAR App in the classroom, learning, and playing games synchronize, which makes learning more fun for nursing students.

In this study, the development of the i-STAR App only focused on three pediatric nursing care of diseases, including hyperbilirubinemia, pneumonia, and urinary tract infection (UTI), future studies were suggested to expand more pediatric diseases or other subjects. Based on the study result, it is hard to speculate that there is a correlation between App and academic performances. Future studies could combine more instruments or include different participants to understand the effectiveness of App in nursing education.

Declarations

Author contributions

Hui-Man Huang- Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Data curation, Original draft preparation.

Yu-Wen Fang-Validation, Formal analysis, Investigation, Data curation, Writing review and editing, Visualization, Supervision, Project administration. All authors have read and agreed to the published version of the manuscript.

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Institutional review board statement

This study was approved by the institutional review board (IRB) of the hospital's Behavior and Social Science Study Ethics Review Committee (IRB108009). The study was conducted in accordance with ethical principles. The informed consent was explained and obtained by the researchers. The participants joined this study voluntarily and had obtained a full explanation before the study. The participants had freedom to withdraw from the study at any time and had nothing to do with academic performance.

Informed consent statement

The collected data is only managed by the researcher, and any personal information that can identify the participant is replaced with a study ID code.

Data availability statement

Data will be made available on request.

Conflicts of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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