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Effectiveness of agile methodology on metacognitive ability, and clinical performance among nursing students—An interventional study

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Abstract:

BACKGROUND: The emerging trend focuses on the need for an active agile method in the nursing curriculum. It helps to improve student engagement, the interaction between the students and teachers, higher-order thinking, teamwork, and practical skills. This study was done to assess the effectiveness of agile methodology on metacognitive ability and clinical performance among nursing students.

MATERIAL AND METHODS: In this interventional study, two groups of the pre–post design were adopted. Each college was considered a cluster. By using the chit method, the colleges (four) were randomly selected for the experimental and control groups. To avoid contamination, all the fourth-year students were included either in the experimental group (133) or the control groups (132), respectively. The pretest was conducted using a metacognitive awareness inventory (metacognitive ability (MA)) and an objective structured clinical examination (OSCE) tool (clinical performance (CP)) in the experimental and control groups. Leaders were selected using leader attribute inventory (leadership ability (LA) in the pretest and posttest 2 among the experimental and control groups before the agile teaching. By using agile methodology, the newborn course was taught for 21 days in the experimental group. To assess the effectiveness of agile methodology, the control group was not given any teaching. Posttests were conducted immediately and after 1 week to assess the MA and CP in the experimental and control groups. The control group had agile training for 10 days after the posttests to understand the newer agile methodology. The data were analyzed by using SPSS version 28. Descriptive and inferential statistics were used to assess the data for effectiveness.

RESULTS: The result showed that there is an improvement in the metacognitive ability (MA) score and clinical performance score over time in the experimental group ($P < 0.001$).

CONCLUSION: The study finding supports that incorporating agile methodology in education impacts the metacognitive ability and clinical performance among nursing students. However, the teacher must be familiar with the methodology while incorporating agile in teaching.

Keywords:

Agile methodology, clinical performance, metacognitive ability, nursing students

Introduction

Nursing is a challenging healthcare profession. Paradigm shift imports the revolutionary change in the current nursing education that emphasizes learner-centered, collaborative, and skill-based learning among nursing students.[1] The teaching and learning process is determined by the active participation and interaction of students in the classroom and clinical area. The nurse educator must incorporate innovative active learning strategies (ALS) into the curriculum

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to improve the knowledge, skills, and attitude, thus enhancing the competency of the nurses. ALS also promotes higher student engagement, collaboration, reflective practice, metacognitive skills, and core competencies such as teamwork, communication, professionalism, critical thinking, problem-solving, and leadership.[2-7]

ALS highly meliorates the metacognitive ability (MA). Awareness and ability in understanding and control (regulate) the cognitive process of thinking about one's thinking is called metacognition. It consists of knowledge on cognition and regulation on cognition.[8] Adopting metacognitive skills in learning improves the learner's performance significantly than other learners. Self-regulatory skills are necessary to understand the concept of metacognition. Various methods are used to measure MA including self-report inventory (type of questionnaire filled by the respondent only), questionnaires (set of questions filled by respondent or others), interviews, and computer-based tests.[9]

Studies reported that ALS paves the way for the development of clinical skills while applied in clinical learning. The ability in doing or performing the skills in a laboratory setup or hospital is called clinical performance. One of the widely used authentic, transparent, reliable methods of clinical performance evaluation is objective structured clinical examination (OSCE).[10] Structured, station-based exam integrates standardized patient, case scenario, uniform pattern of grading, etc.[11]

Contemporary education emphasizes ALS. Agile is an innovative, student-centered, and active learning method. Agile was coined by seventeen software developers to form the manifesto for agile software development which has four values, twelve principles, and methods.[12] The most popular agile methodology is scrum. Scrum is a framework that helps in managing the project and a term coined by Ken Schwaber and Jeff Sutherland in 2004. Scrum is widely used in the education system called eduScrum. It is a derivative of the scrum by Jeff Sutherland and Ken Schwaber in 2017. Scrum consists of three roles: product owner (PO)/outcome evaluator (OE)/facilitator, scrum master/team leader, and development team/student team. The scrum events or activities are a sprint, sprint planning, daily standup meeting, review, and retrospective meeting. The scrum artifacts/protocol are product backlog, sprint backlog, and increment. Scrum board/flip is the flip chart that shows the work assignment (quiz, specific skills, tasks, and demonstration) that the student should complete in the sprint (work schedule for a week) with the status of to do, progressing, or done. It represents transparency in the pattern of learning. The teacher can easily identify the tasks completed by the students.[12] The Burndown chart is the graphical representation of the remaining task (y-axis) and progress of the work (days of sprint) (x-axis).[12]

Studies report that the agile scrum framework enhances the flexibility in the learning pattern, and improves communication between the students and faculty, leadership, teamwork, and time management. It provides an opportunity for using different types of evaluation methods in assessing student performance objectively.[13]

Studies related to active learning methods are sparse due to the time constraint and difficulty in implementation by the faculty to adopt the method in the classroom.[14] There is a need to implement active learning strategies such as agile methodology in nursing education to enhance the student's quality of learning through metacognitive skills and improve the clinical skills among future graduate nurses.

Material and Methods

Study design and setting

An interventional two group pre–post study [Figure 1] was conducted between August 2021 and May 2022 among fourth-year Bachelor of nursing students from four colleges affiliated with a health science university. Each college was considered a cluster. The cluster of colleges that were permitted to conduct the study was randomly allocated to an experimental or control group by using the chit method. To reduce the bias, the entire class of students was included either in the experimental group or the control group. The sample size was calculated using G power software version 3.1.

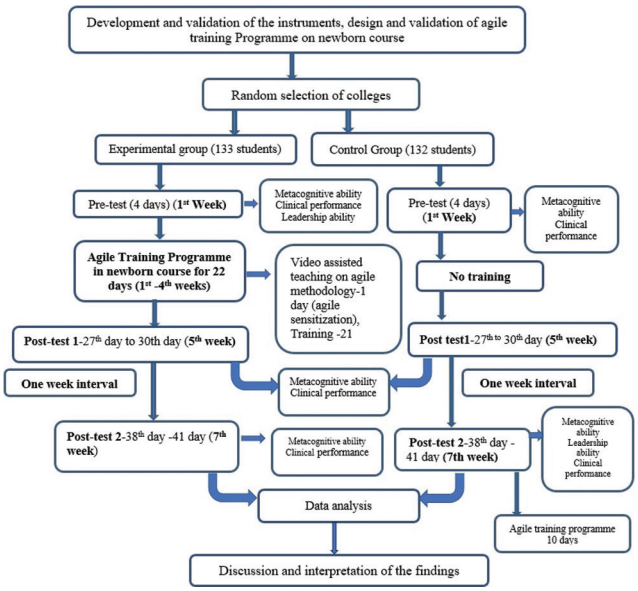

Figure 1: Study plan. Note: Cluster sampling was employed to select the students

Effect size f was computed as 0.29 based on the result of the pilot study (using the metacognitive ability score).

By fixing $\alpha = 0.05$, power at 0.80 correlation between the repeated observation as 0.5, no of groups = 2, no of measurements is 3, the minimum estimated sample size was 118, with the cluster effect 2 and 5% accounting attrition the sample size was fixed 247. Since the entire class of students were included in the study, the final samples were 265.

Four students from the experimental group were absent at the time of the pretest, and out of eleven students, five were absent at the time of the pretest and six were absent at the time of the posttest in the control group and were excluded from the study. Hence, the final experimental and control group students were 133 and 132, respectively.

Data collection tool and technique

The questionnaire on demographic profile, information about clinical training area, and OSCE tool to assess the clinical performance were developed by the researcher. Leader attribute inventory (LAI) by Jerome Moss, 1994, was used to select the team leader.[15] The reliability of the tool was assessed using Cronbach's alpha and was found to be 0.983. A short version of the 19-item metacognitive awareness inventory (MAI) by George Harrison, 2018, was used to assess the MA and Cronbach alpha was 0.787.[16] The tools were validated for the content by experts from the medical and nursing fields. A pilot study was conducted using 32 students (experimental group 16 and control group 16), respectively, to assess the flaw and feasibility.

Pilot study data were not included in the final study. The purpose of the study, objectives, and duration of the course was explained to the experimental and control group of students. The students were instructed to fill out the questionnaire for 30 min followed by an OSCE examination which was conducted with eight stations (one rest station) for 40 min in batches at the pediatric laboratory. Approximately, 30 students participated per day in OSCE. Each station was 5 min such as three unmanned stations (phototherapy, newborn screening, and radiant warmer), and four manned stations (performing immediate newborn care, administering Vit K injection, orogastric tube insertion for feeding, and performing newborn resuscitation) in the newborn course. The OSCE-trained observer was used to evaluate the students.

After the pretest, the experimental group students received an agile training program in the newborn course. The first step was the selection of team leaders (based on LAI score and willingness) and student team formation. A mixed ability student team was formed based on, CP score, and previous year academic performance score. The student team consisted of seven members. Agile methodology was taught using video-assisted teaching, and team leader training through role play. Each team had one team leader. The team leader was held responsible for motivating, communicating, and removing the impediments in the learning process and conducting daily, review and retrospective meetings.

The product owner/outcome evaluator/faculty outlined the course with a list of topics (product backlog). The course was 21 days divided into three sprints (set the time to complete the task) with 7 days duration. The student's opinion was considered while selecting the topics for each week. Prerecorded videos and materials for selected topics were sent to the students through electronic mediums. In the sprint planning meeting, the subdivision of topics/tasks with the time duration for completion (sprint backlog), assignment for the week, and type of evaluation methods were discussed. This was carried out on day 1. The sprint started with a daily meeting to monitor the learning process for 15 min by the team leader and was communicated to the outcome evaluator. The students started reading the material and watched the videos from 2nd day to 5th day. On the 3rd day, the faculty demonstrated the procedure for the chosen topic for every sprint, and doubts were clarified during the session. Daily, students spent 1–2 hours completing the task individually and as a team. The outcome evaluator regularly monitored students' progress through the team leaders. On the 6th day, the students were highly motivated by the team leader for completing the task, submitting the assignment, and getting ready for the demonstration/quiz. On the 7th day, the students demonstrated the procedure team wise including the team leader and participated in the quiz. The outcome evaluator was offered feedback about the lacking of particular skills while demonstrating. This is called a review meeting. Followed by student team and team leader discussed the topic selection for the completed sprint, time duration, problem faced during the task completion and solution used for solving the problems, and recommendations for the next sprint. This is called a retrospective meeting helps to improve the learning in the next sprint. The consequent sprint cycle was continued for the next 2 weeks with the above mentioned process and the course was successful with the active agile learners. Details are given in Figure 2. The control group students have not received any training initially. After posttest 2, 10 days of agile training were offered for understanding the agile methodology with one sprint [Figure 2].

Statistical analysis

Data were coded and entered into the Microsoft excel

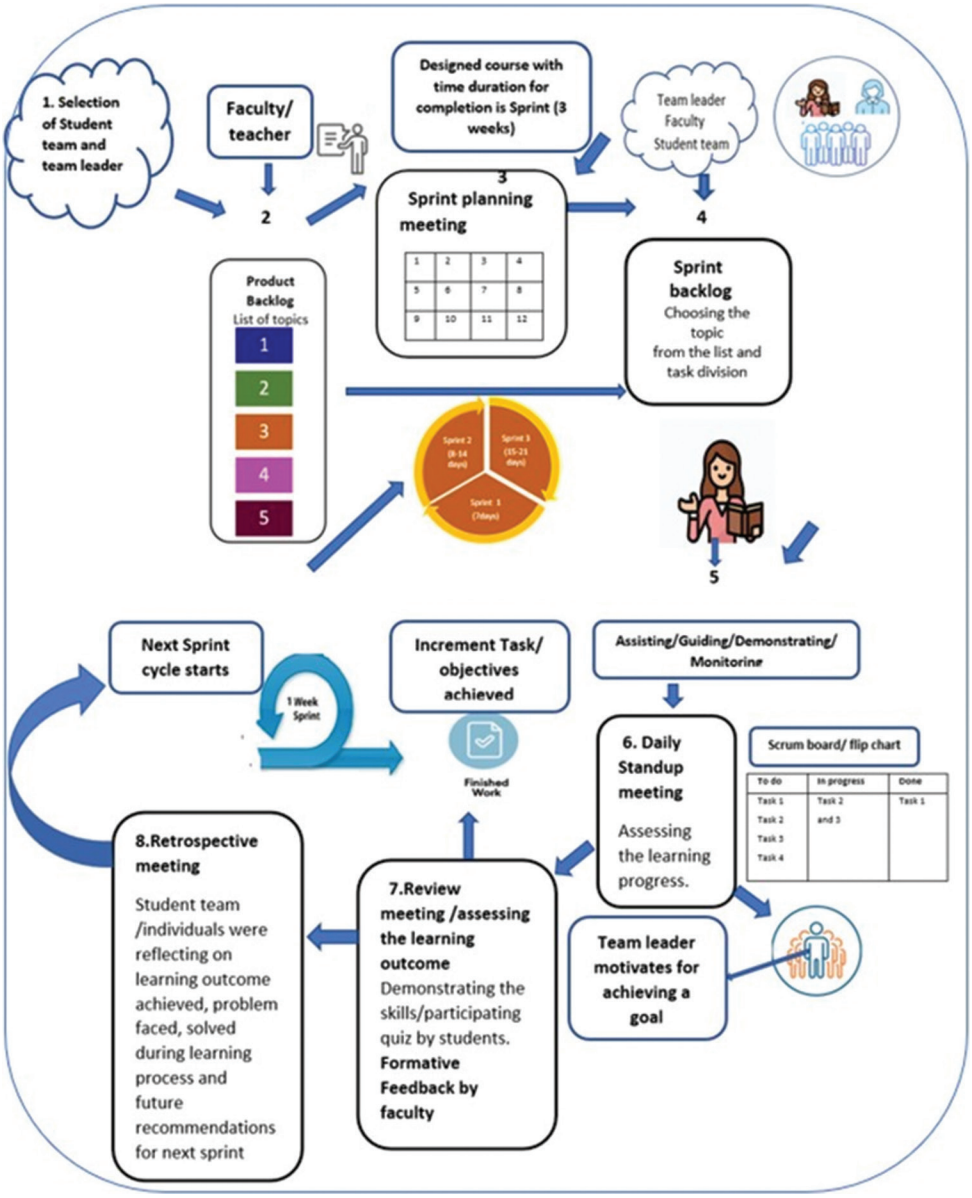

Figure 2: Scrum framework

spreadsheet. The analysis was carried out using IBM SPSS version 28 for windows. Independent Samples t tests and Chi-square tests were used to compare the demographic variables between the groups. The mean score of pre and two posttests was compared and analyzed using repeated measures ANOVA, and the Bonferroni *post hoc* test was used to compare the different time points.

Ethical consideration

Ethical clearance was obtained by the Institutional Ethical clearance for Human Subjects Research. Administrative permission was obtained from the principals of the college of nursing. Fourth-year students were included in the study after obtaining written informed consent.

Result

Demographic characteristics

The study was conducted to evaluate the effectiveness of agile methodology among fourth-year nursing students. The demographic data showed the participant's mean age, sex, and scholastic performance in the previous year and information about the clinical training area. The mean age of the experimental and control group of students was 20.95 ± 0.54 years and 20.95 ± 0.56 years, respectively. The majority of the participants were females in both groups. The mean score of scholastic performance of the experimental and control group of students was 65.5 ± 7.41 and 65.67 ± 7.49. Statistically, there is no significant difference between the age and scholastic performance among the experimental and

control group of students, respectively. There was no difference in the clinical training area between the groups [Table 1].

Both the group of students were posted in the specialist hospital which is governed by Govt with a bed capacity >300, less than five members with 8 hours of posting in the clinical area, and replied that the hospital was facilitated for their training. Hence, the study groups were homogenous and comparable.

In metacognitive ability, the knowledge on cognition (t = −1.490; P = 0.137), regulation on cognition (t = 0.052; P = 0.959), overall metacognitive ability (t = −0.799; P = 0.425), and clinical performance were not statistically significant between the groups at baseline before the intervention program [Table 1].

Comparison of metacognitive ability and clinical performance between the experimental and control groups

The result of repeated measures ANOVA indicates that there is a significant change in MA and CP scores from pre to posttest: F_a = 1693, (P < 0.001) and F_a = 3492.53, (P < 0.001). The change was significantly different in the two groups: F_b = 3408.45 (P < 0.001) and F_b = 14215.95 (P < 0.001) [Table 2]. However, in the experimental group, the mean score of MA score and CP score at baseline was 42.65 which increased to 86.01 [Figure 3] and 12.96 which increased to 57. 02 respectively [Figure 4]. However, in the control group the difference was less.

The *post hoc* pairwise comparison showed that there is a difference in MA scores and CP scores from pre to posttest 1 (P < 0.001), and pre to posttest 2 (P < 0.001). There was no significant difference between posttest 1 and posttest 2, indicating that the knowledge of applying MA for learning and clinical knowledge and skills was retained after 1 week. So, the agile

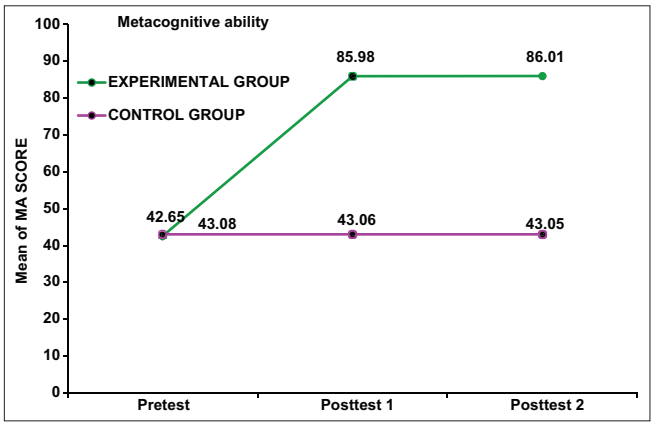

Figure 3: Profile plots of metacognitive ability score at various time points with group comparison. Note: MA -metacognivie ability

Table 1: Demographic characteristics of nursing students at baseline

Demographic characteristics	Mean±SD range or *n* (%)		*t* or χ^2	*P*
	Experimental group (*n*=133)	Control group (*n*=132)		
Age	20.95±0.54	20.95±0.56	0.118	0.906
Sex				
Female	121 (91.0)	120((90.9)	0.000	0.985
Male	12 (9.0)	12 (9.1)	0.000	0.985
Scholastic performance	65.5±7.41	65.67±7.49	−0.186	0.852
Knowledge on cognition (KC)	18.34±2.24	18.79±2.68	−1.490	0.137
Regulation of cognition (RC)	24.32±2.472	24.30±3.761	0.052	0.959
Total score of Metacognitive ability (KC and RC total)	42.65±3.30	43.08±5.217	−0.799	0.425
Clinical performance score	12.96±3.079	13.091±3.442	−0.339	0.735

Frequency (*n*) with percentage in parenthesis (%), SD: Standard deviation, *t*: Independent sample *t*-test, χ^2: Chi-square test

Table 2: Comparing the pretest and posttest scores of metacognitive ability and clinical performance between the experimental and control groups over the time period *n*=265 (133+132)

Variables	Group	Mean±SD			Time F_a (*P*)	Group F_b (*P*)	Bonferroni *post hoc* comparison *P*
		Pretest	Posttest 1	Posttest 2			
Knowledge on cognition (KC) score	E	18.34±2.24	35.95±2.07	35.99±3.08			
	C	18.79±2.66	18.86±1.91	18.87±4.65	884.61 (<0.001)	2552.72 (<0.001)	<0.001
Regulation on cognition (RC) score	E	24.32±2.472	50.02±3.13	50.02±2.93			
	C	24.30±3.761	24.20±3.83	23.17±5.39	1445.67 (<0.001)	2809.42 (<0.001)	<0.001
Metacognitive ability score	E	42.65±3.33	85.98±4.389	86.01±5.36			
	C	43.08±3.217	43.06±4.382	43.05±9.334	1693 (<0.001)	3408.45 (<0.001)	<0.001
Clinical performance Score	E	12.96±3.079	57.07±1.631	57.102±1.56			
	C	13.091±3.443	13.080±4.751	13.098±4.93	3492.53 (<0.001)	14215.95 (<0.001)	<0.001

E: Experimental group, C: Control group, SD: Standard deviation, repeated measures ANOVA shows the F_a: Change over time and F_b: Between the group, Bonferroni post hoc comparison of pretest with posttest 1 and 2, **P* significant at <0.05 level of significance

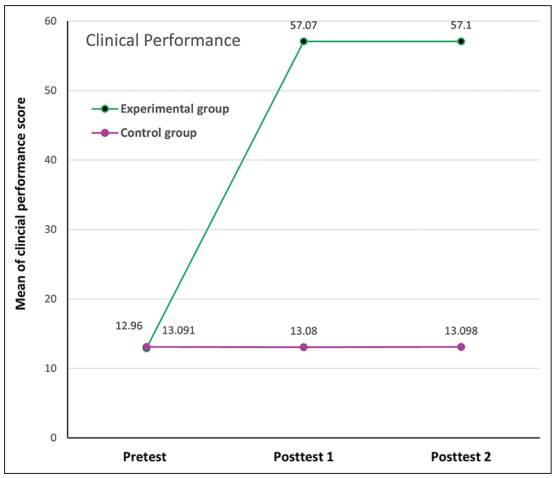

Figure 4: Profile plots of clinical performance mean score at various time points with group comparison

methodology was effective in improving metacognitive ability, and clinical performance among the nursing students.

Discussion

Introducing agile methodology in the nursing curriculum optimizes the learning pattern and improves the practical skills among nursing students. One of the popular agile methods is scrum which has been widely used by the computer science curriculum for the development of software and to enforce teamwork. It has been adopted in various domains such as education, business, industry, military, science banking, public sector, etc.[17] Agile education fosters constructivist competencies like critical thinking about metacognition and reflection, collaboration, autonomy in knowledge generation and construction, mind mapping, examining different solutions, and various sources of knowledge used and managed.[18]

The current study was conducted to find the effectiveness of agile methodology on metacognitive ability and clinical performance among fourth-year students. The metacognitive ability and clinical performance scores were improved significantly after the agile training program in the newborn course than the control group of students. The metacognitive ability includes metacognitive knowledge (what to do, how to do it, where and when to do it), monitoring (assess the learning—achieved the goal or not, and identifying the potential problems), and controlling (within the set time the outcome achieved). In this study, the agile scrum framework enhanced the metacognitive knowledge by planning their daily activities and set the goals for individual and group work (sprint planning) appropriately with the guidance of the outcome evaluator. Monitoring was achieved through self-reflection of work progress and planning in daily meetings, feedback by stakeholders and outcome evaluators in review meetings, and team reflection about the strength and weaknesses in the learning pattern, problems faced, and modification of the plan in the retrospective meeting. Finally, the metacognitive control strategies were emphasized by time management. Every day, the students spent one and a half an hour to two hours completing the task. In this context, the agile methodology also promoted self-regulated learning, i.e., the set goals are achieved over time.

The active learning strategies promote metacognitive ability in classrooms and clinical setups among healthcare professionals.[19] In this study, an active agile learning method was incorporated with pre-planned activities, self-reflection, case scenarios, videos, questioning and feedback, a scaffolding method, group activities, and quizzes. The study result shows that the agile students had higher metacognitive ability than the control group students. This study result was consistent with the previous study showing that the quizzes, and reflection at the end of each simulation, pre-class material, mini-lectures, interactive session, and collaborative learning enhances metacognition.[19-23]

Studies stated that active learning strategies improved the students' performance at various discipline such as science, technology, engineering and mathematics (STEM) course.[24]

In our study, the clinical performance skills score was high in agile students than in the control group students. This result was consistent with the previous study showed that agile improves the experimental students' technical and non-technical skills more than control groups in undergraduate software engineering.[25] The studies stated that the agile scrum framework promotes hands-on experience.[26]

The study findings showed that the agile students completed the task within a period of time.[27] The study done by Kroop reported that the students' practical skills were improved in computer science students after learning agile methodology.[28]

Studies also stated that the clinical competency score was improved in specific and general nursing performance after the active learning program, especially reflective activities, situation-based case studies, standardized patient, and high-fidelity simulation.[29] Studies indicate that effective use of active learning strategy in class and clinical learning areas helped to improve clinical competency in a safe environment.[4,29]

Conclusion

Agile is an active learning method. The agile methodology

was used in nursing education to bring changes in planning, monitoring, and controlling one's learning pattern within the set duration and improve practical competency through collaboration, continuous feedback, and team meetings. The team leader has a unique role, and does not have any control over the student team; however, she/he motivates the students continuously and is responsible for conveying team progress to the outcome evaluator daily. AGILE reduces the stress among the students; hence, the students were learning in a team and individually too. However, the study had limitations in that the metacognitive ability was assessed by a self-assessment tool and the clinical performance was assessed in the laboratory setup only. Finally, the flexible agile method promotes the students to become lifelong active learners and competent enough to practice as future registered nurses.

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Conflicts of interest

There are no conflicts of interest.

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