The effect of simulation education based on flipped learning on academic engagement, motivation, and performance of first-year nursing students

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Research Article

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Abstract

**Background:** Nursing educators need to be prepared to adopt innovative, evidence-based approaches to education to improve student learning outcomes and prepare the workforce to better practice within complex health care systems. The present study aimed to determine the effect of simulation education based on flipped learning on performance, motivation in learning, and academic engagement of first-year undergraduate nursing students.

**Methods:** This study was conducted with a quasi-experimental design. Forty first-year undergraduate nursing students registered for the spring semester were selected by whole enumeration sampling. For the intervention group (n=22), the fundamental nursing skills course was taught to them using simulation education based on flipped learning. The control group (n=18) was taught in the same class using simulation-based education. Outcomes, including performance, learning motivation, and academic engagement, were measured using the nursing skills observation checklists, the Instructional Materials Motivation Scale, and the academic engagement questionnaire at the middle and end of the semester. Data were analyzed using mean, paired t-test, and ANCOVA analysis with Stata-17 software.

**Result:** There was no significant difference between the mean score performance and the total mean score of subscales of learning motivation and academic engagement in the middle and end of the semester in the two groups. Analysis of covariance (ANCOVA) showed no significant difference between the two groups in performance (P>0.05), learning motivation (P>0.05), and academic involvement (P>0.05).

**Conclusion:** It is recommended to use this method as well as traditional approaches, particularly to teach psychomotor skills to senior students who have higher self-regulation skills. There is still a need for further research using this approach to teach psychomotor skills, practical lessons and various outcomes.

**Background**

According to the statement from the World Health Organization, one of the main competencies of nursing instructors is facilitating active learning in the education process, ensuring learning outcomes, technological advancement, and individual experiential learning [1]. They must be prepared to adopt innovative, evidence-based teaching approaches that improve student learning outcomes and better prepare the future nursing workforce to practice in complex healthcare systems [2].

One such innovative pedagogical approach is blended or hybrid learning, which has steadily replaced traditional teaching methods as an advanced educational strategy [3]. One of these hybrid approaches is flipped classroom, with the help of which learning has been rapidly developed and recognized as an acceptable and active approach in education. The flipped classroom creates an ideal combination of online and face-to-face (F2F) learning called the "blended" classroom [4].
Simulation-Based Education (SBE) is often used to teach nursing skills. It integrates broad knowledge of a specialty field with practical abilities and actively encourages team members to cooperate in solving tasks [5]. However, the same approach is associated with limitations in problem-solving, developing clinical application ability, and increasing stress for nursing students. Consequently, a teaching-learning method is required as a new approach to overcome the limitations and problems of the SBE. To further improve the quality of nursing education in the evolving healthcare environment [6]. The International Nursing Association for Clinical Simulation and Learning (INACSL) emphasizes the importance of preparation activities before simulation to encourage participants to meet the simulation's objectives. Medical students are often unprepared for simulation sessions, which prevents them from achieving the desired learning outcomes [7]. Although professional simulation organizations support pre-simulation activities, more work needs to be done to motivate students to do preparatory work. It should be combined with the flipped learning model to improve the quality of nursing education [8]. However, this combination has not yet been quantitatively tested in well-designed studies [9].

SBE with the flipped classroom is a two-part teaching and learning process; Learning a practical topic using a video in a setting other than the classroom, and then in a simulation or F2F environment, learners engage in experiential learning through various sorts of simulations. During the debriefing phase of SBE, learners can react and reflect on their practice while they absorb and retain information. Simulation education based on flipped learning allows millennial students to adopt a self-directed learning style and address their need to access up-to-date information. This learning style is essential to millennials and their retention of data [10]. It also enables them to apply the concepts learned before clinical practice. This issue is vital to help learners bridge the gap between theory and clinical practice [11]. In recent years, many educators have used the flipped classroom approach to facilitate learning, address the various educational needs of students, and increase student engagement [12].

Studies that have been conducted to discover the effect of the flipped classroom on students’ academic engagement are almost rare. Busebaia and John (2020) assessed the impact of flipped learning on academic achievement and nursing students’ engagement in the pediatrics nursing course. The improvement in performance and scores of academic engagement in the flipped class were significant. Participants stated that they gained a deeper understanding of the concepts. They suggested that further empirical evidence is required for adapting flipped classrooms to other courses in the curricula to determine their suitability to a particular teaching content [13].

On the other hand, according to the evidence, web-based learning, online learning, and hybrid learning environments with technology are a part of the teaching and learning process that can provide the conditions to promote students’ metacognition, self-efficacy, and motivation [14]. There is also growing evidence that the flipped classroom model effectively motivates students to carry out preparatory activities. As a result, educators should be confident in accepting the flipped model of SBE. [15]. A systematic review showed that the flipped class improves knowledge level, skills, learner motivation, and self-directed learning. In addition, according to this systematic review, it is necessary to conduct empirical research with a robust methodology using evaluation criteria to sustain the efficiency of the flipped
classroom [16]. Gu and Sack (2021) found that SBE with flipped learning is the most effective training method to help nursing students improve their nursing skills and competencies, become self-aware and learn to be satisfied [6]. Kim and Jang's also reported the positive effects of simulation education based on flipped learning on the knowledge and competence of clinical practice, teamwork skills, and the level of satisfaction of students [5]. The teaching of clinical nursing skills is one of the critical components of the nursing education program for nursing students who learn the basic nursing skills in this course in the first year of study [3]. They should be able to use nursing principles and skills in providing care to patients so that they can apply the learned theoretical knowledge in practice [17, 18].

Despite the growing trend to use the flipped teaching model in health-related sciences, more research and evidence are needed in the curricula of practical courses and clinical nursing skills [19]. Most studies were concerned with academic performance and achievement and were mainly used for theoretical courses [20]. Flipped learning is an appropriate educational approach to provide nursing students with professional skills and competencies [5]. The researchers found that most students positively understood using the desired approach to enhance clinical knowledge and skills. They indicated that this was more practical than traditional teaching [21, 22]. Although some sources have demonstrated the benefits and positive impacts of flipped learning [23], others did not show significant differences between simulation based on flipped and traditional learning [24]. Therefore, further studies are required to evaluate this new approach. Consequently, the purpose of the present study was to determine the effect of simulation education based on flipped classrooms on learning motivation, academic engagement, and the performance of nursing students.

**Methods**

**Study design**

This research is a semi-experimental pre-test-post-test study with a control group.

**Participants and Setting**

This study was conducted in two nursing schools affiliated with Lorestan University of Medical Sciences (West Iran) in the second semester of 2021-2022. The target population was all first-semester undergraduate nursing students who had chosen the fundamental nursing skills course for the first time in the spring semester. The whole enumeration selected the samples based on study criteria. Because the sample size was determined based on available resources and when the course was offered, there was no control over the analysis's actual sample size and power. The inclusion criteria included studying in the first year of a nursing bachelor's degree, willingness to participate in the study, lack of previous familiarity with the flipped classroom, and enrollment in the fundamental nursing skills course. If the students did not want to continue the collaboration, they were excluded from the study. At the beginning of the study, only one group of nursing students was accepted in each college, so a group from Khorramabad Nursing colleges, including 22 undergraduate students as the experimental group and 18 first-semester nursing students from Aligudarz Nursing colleges were enrolled as the control group. The
selection of two groups from two separate colleges was aimed to prevent diffusion and imitation effects between groups.

**Tools**

Evaluation of this educational method's effectiveness was based on Kirkpatrick's model in two levels reaction and learning. At the model's first level, student motivation and academic engagement were evaluated with Instructional Materials Motivation Scale (IMMS) and Rio and Tseng's (2011) academic engagement scale, respectively. The next level of the model was the student's performance, which was assessed with an objective structured clinical evaluation (OSCE) and checklists related to each station. Four tools were used in this study as follows.

**The tool I: Questionnaire of demographic characteristics**

This tool was used to obtain data regarding (age, gender, economic status, living situation, high school grade-point average (GPA) scale ranging from 0 to 20, occupation, and parents' education level.

**Tool II: IMMS**

IMMS was used to evaluate learning motivation. Keller designed it in 1987 [25] to measure students' motivation in specific situations such as lessons, courses, or teaching methods [26]. This tool has 36 items and four subscales, including attention (12 items), communication (9 items), confidence (9 items), and satisfaction (6 items). The IMMS is answered on a 5-point Likert scale. Ten items are reversed. In the reverse items, lower scores indicate higher motivational levels. The score is calculated for each subscale and the whole scale (total score). The minimum and maximum total scores are 36 and 180. A higher score indicates a higher motivation to learn. In a study, the instrument's internal consistency has been confirmed with Cronbach's alpha (0.95) [27]. In a study in Iran, the reliability of this tool was established with Cronbach's alpha (0.82) [28].

**Tool III: Questionnaire of academic engagement**

Reeve and Tseng's (2011) scale was used to evaluate students' academic engagement. This scale has 22 items and four components, including behavioral involvement (5 items), agent involvement (5 items), cognitive involvement (8 items), and emotional involvement (4 items). It is based on a five-point scale from always (5) to never (1). The range of scores for each subject is between 22 and 110. The reliability and validity of this tool were reported by Reeve and Tseng (2011) as high and acceptable [29]. In Iran, the reliability of the total scale instrument has been reached using Cronbach's alpha of 0.87. Cronbach's alpha of the subscales has been reported from 0.71 to 0.81 [30].

**Tool IV: Fundamentals of nursing skills observation checklists**

The learners' performance was also evaluated with a checklist. Checklists for each skill were developed after reviewing the literature, nursing textbooks, and logbook of the Faculty of Nursing, Lorestan
University. The validity of these checklists has been confirmed in a previous study [31].

The evaluator used the checklist to observe the learner's performance during the OSCE. Then evaluator would provide the learner with feedback based on objective findings. Each measurement checklist included items related to each fundamental nursing skill that measured skill accuracy using a 3-point Likert scale (0 = not performed, 1 = partially performed, 2 = fully performed).

**Data collection**

The data were collected remotely and by sending a link to the data collection tool through the WhatsApp messenger at two-time points: the end of the sixth session (pre-test) and the end of the twelfth session (post-test). Also, the student's performance at two-time points, including the mid-semester and end-semester tests, was measured by the observation method using a checklist.

**Fundamental nursing skills course**

The clinical course of Fundamental of Nursing is a 1/5 credit course offered in the 4-year undergraduate nursing curriculum in Iran in all first-semester nursing schools at the same time as its theory course. The content of this course includes 12 skills of 90 minutes of skill-based practical training, followed by 90 minutes of practice and repetition of skills after each session. The outline of this course is presented in Table 1.

**Intervention**

**Before the intervention**

In both groups, students were introduced to the general and specific goals, the outline and number of sessions, assignments, and tasks during the course, and at the end of it, the teaching method, course time (3 hours per week), and the method of formative and summative assessment. Also, the course plan is uploaded to the learning management system (LMS) of Iran Virtual University of Medical Sciences, which can be accessed at https://lumsnavid.vums.ac.ir. The learners can have permanent access to the course.

**SBE**

The students of both groups were taught six skills (Table 1) in the first six weeks of the academic semester by low-fidelity SBE. Skill Lab mannequins were used to teach this category of psychomotor skills. The instructor’s training was mainly in lecture format with a practical demonstration of the mannequin. If the students had questions, they would be asked during the training, and the instructor would give feedback. In this way, the instructor had an active role, and the student had a passive role. For the next six weeks, the control group students continued to receive training in the SBE method.

**Simulation education based on flipped learning**
The educational design of flipped classroom was based on the ADDIE model (Fig 1). Simulation education based on flipped learning for six other skills (Table 1) was conducted in the second six weeks of the academic semester for the experiment group in the form of a three-step process as follows;

1. **Pre-class activities**

The video and text content was pre-designed by the instructors. One week before the presentation of each psychomotor skill, its educational content was provided to the participants in the form of PowerPoint files and short videos through LMS. The content-sharing platform was the LMS of Iran Virtual University of Medical Sciences. Students could easily view the content uploaded in this system through their PC, computer, or mobile phone. Students studied educational content and videos at home. To ensure the viewing of the procedure video, the trainers reminded their expectations about the need to prepare before the class and watch the videos every session.

2. **In-class activities**

This stage focused on peer activities and discussions with the instructor. During the flipped classroom session, students were divided into two groups. Each group consisted of 11 students and a clinical instructor. Classroom chairs were arranged in a circle for the students of each group. Two instructors taught the groups equally. In each group, before the start of each session, they explained a short introduction for 10 minutes about the general and specific goals of the lesson. Then, the students practiced and presented the video content and PDF files of fundamental nursing skills using mannequins with the participation of each other for 90 minutes. The teacher mostly listened. If needed, he would answer their questions and clarify the concepts. The teacher’s role was to provide feedback during the exercise. Students discussed the main points of the videos.

3. **Post-class activities**

Finally, after a 20-minute break, students repeated the same technique using a mannequin for another 90 minutes to consolidate the learning with peer and teacher feedback. Learners were asked to record critical points in the process (from their perspective).

**Data analysis**

Descriptive statistics were used to describe demographic data, including mean, standard deviation, frequency, and percentage. The Kolmogorov-Smirnov test was used to ensure the normality of data distribution. A paired t-test was used to compare students' mean performance scores, learning motivation, and academic engagement in the before and after measurements separately for each group. Also, the analysis of covariance (ANCOVA) test was used to compare the mean of quantitative variables in the next phase between two groups and adjust the effect of the previous step. The Chi-square test was used to examine the relationship between qualitative variables. All analyzes were performed using Stata 17 software. The significance level for all tests was 5 percent.
Results

None of the 40 students who chose the fundamental nursing skills course were excluded from the study. Demographic data of the experimental and control groups were analyzed using chi-square and two-tailed t-tests. The results showed no statistically significant difference between all demographic variables in both groups. Both groups were the same regarding age, gender, economic status, living situation, high school GPA, occupation, and education of parents (P > 0.05) (Table 2). None of the students mentioned a history of taking drugs, smoking, alcohol, or tobacco.

The mean score of students' performance (of 0-20 scores) in the experimental group in the first six weeks and the second six weeks after simulation education based on flipped learning was 14.52 ± 3.12, 15.52 ± 2.55, respectively. The student's performance in the control group was 15.38 ± 3.35 and 16.88 ± 1.77 in the first six weeks and the second six weeks, respectively. The paired t-test did not show a statistically significant difference between the two groups before and after measurements.

The mean total score of motivation in learning and its subscales in two groups in the first six weeks and the second six weeks are presented in Table 3. The paired t-test did not show any significant difference between the two groups in the total score of learning motivation and all sub-scales. Also, according to Table 4 and the paired t-test, there was no significant difference between the two groups regarding the total score of academic engagement and its subscales.

Also, the analysis of covariance (ANCOVA) test was used to compare the means of the performance (P>0.09), motivation in learning (P>0.48), and academic engagement (P>0.34) of students after the intervention between two groups and adjust the effect of the previous phase. It did not show any significant difference between the two groups.

Discussion

This study showed no difference between students' academic performance in the simulation approach based on the flipped classroom and SBE. Similarly, Wilson and Hobbs (2022) found that nursing students' validation scores using the flipped classroom approach in the fundamental nursing course were no different from in-person instruction [24]. The meta-analysis by Gillette et al. (2018) did not show a significant difference in academic performance test scores between the flipped and traditional classrooms [32]. Instructors and students identified challenges with this interactive learning strategy. Students should prepare for the flipped class. Some students resist being active in class and outside of it [33]. However, other studies have shown that the flipped learning approach has made significant progress in the academic performance of nursing students [5, 16, 34, 35].

These differences in outcomes may be attributed to the different processes, materials and environments used in the flipped learning model. The difference between these models in students' academic performance is due to the use of different materials in various lessons. The types of materials used and the learning environment can affect academic performance achievement. In addition, the instructors who
manage this process plan it in different ways and perform various classroom activities. These differences in activities may have produced mixed results.

On the other hand, the students in this study (who were in the first semester) had never experienced the simulation method and the flipped classroom in their learning history. These students needed more time to get used to the new approach, which may have affected the results of the present study. Changing the traditional teaching method suddenly undermines their learning results because of insufficient preparation of students with the new teaching method [36]. Therefore, such methods that allow students to take more active roles and positively affect the learning outcome should be included in future educational programs to enable students to transition from passive to interactive learning methods.

A systematic review found that flipped classrooms may only be suitable for certain subjects, teachers or learners. Choosing a flipped learning course is a critical decision and requires careful assessment of learner expectations and needs prior to designing a flipped course. However, if instructors carefully consider content, materials, presentation, and designs, they can create a flipped classroom course that helps students develop higher-order conceptual and thinking skills, and can produce better results. [37].

Our study showed that the construct of learning motivation in the flipped simulation strategy did not increase significantly compared to the simulation classroom conventionally. However, more motivation is needed in the flipped classroom to participate in discussions and complete extracurricular activities. Some students prefer something other than the flipped classroom over the traditional classroom, possibly because of the effort and participation required in active learning [38]. This issue is that even though the students in Luo and Hugh's study preferred the flipped classroom to the traditional classrooms, the student's motivation and academic involvement in solving the problem were successfully improved [39]. On the other hand, the results of a meta-analysis of 271 studies have identified challenges for students and teachers. Students' challenges included a need for more motivation to watch pre-recorded videos. For teachers, the challenges included the need for more preparation, difficulty controlling students' pre-class activities, and technical challenges involving technological problems and internet access [40]. Meanwhile, the most important challenge for teachers was the motivation of students to watch pre-recorded video lectures or to study content outside the classroom. [41].

A positive element of the flipped classroom approach is the use of active learning methods that provide many learning opportunities in the classroom. Another positive factor is the increase in interaction between students and instructors. However, a negative factor is that students tend to explain more passively. Probably because students sometimes need help to acquire lower-level skills during out-of-class activities when the structures are new or difficult to understand [42].

The results of this study did not show a difference in the levels of academic engagement between the two approaches. This finding is consistent with the study of Subramaniam and Muniandi, who studied the academic engagement levels of computer science students using the flipped classroom approach.
The results indicated that the students in the experimental group (flipped classroom) were very involved. However, compared to the didactic class, there was little difference in academic involvement in the flipped classroom [43]. A literature review suggests that participants in the flipped classroom are more active and engaged than in traditional education. They show more behavioral and emotional involvement. As a result, they prepare themselves to participate in class activities, ask questions, and problem-solve with their peers. The main reason for students' academic engagement was their pre-learning activities in and out of class [11, 12, 43, 44]

On the other hand, changing education can cause confusion and stress among students and teachers. Teachers are very comfortable with traditional education as information holders, but they must work hard to change their classes to teach students independent learning. At the same time, some students who have been very comfortable with conventional instruction may need to be more enthusiastically engaged in independent study, especially outside of classroom hours. They are not ready to learn independently outside the classroom without instructor guidance because the content usually presented through lectures is distributed as homework for students to master before attending the classroom [41]. However, nursing instructors and students can use these methods. In addition, instructors can develop programs (especially programs that activate students) to identify and use appropriate educational strategies that match students' learning styles.

The present study had limitations. The study's sample size was small, so it is recommended to conduct further studies with a larger sample size as a clinical trial with a more extended period in the future. The flipped approach was part of the nursing skills course. The short intervention period of the flipped classroom method in this study limited the time needed for students to comfortably adapt and get used to an entirely new way of learning, which may have hindered the possible effects of the method on learning skills. Furthermore, the academic engagement in this study was done using self-report, while future studies should investigate how to objectively evaluate the competence of the essential skills of nursing students. Also, considering the importance of metacognitive skills and comprehensive self-direction, it is recommended that higher-year students be used.

**Conclusion**

Simulation-based on flipped learning in the fundamental nursing skills course compared to conventional simulation did not show any difference in academic performance, learning motivation, and academic engagement of students. It is recommended to use this method as well as traditional approaches, particularly to teach psychomotor skills to senior students who have higher self-regulation skills. There is still a need for further research using this approach to teach psychomotor skills, practical lessons and various outcomes.

**Abbreviations**

F2F: Face-to-face
Declarations

Ethics approval and consent to participate

The Ethics Committee of Lorestan University of Medical Sciences IR. LUMS approved this study (no.REC.1401.200). Ethical principles were followed, and the Declaration of Helsinki conducted the study. Students entered this study voluntarily. Their written informed consent to participate in the study was also obtained before the start of data collection. The students could refuse to participate or withdraw from the study without notice. Their non-participation in the study did not affect the final evaluation of their academic performance in the clinical skills nursing course.

Consent for publication

Not applicable

Availability of data and materials

The datasets generated and/or analyzed during the current study are not publicly available due to confidentiality but are available from the corresponding author upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

SH, SB and MF were responsible for the study conception/design. SH and SB performed the data collection. YM analyzed and interpreted the participant's data. SH, SB, MF, SK, and RH, were significant contributors to writing the manuscript. All authors read and approved the final manuscript.

Acknowledgments
The authors' gratitude goes to the students who significantly contributed to this study with their participation.

References


Tables

Table 1. Content of the fundamentals nursing course

<table>
<thead>
<tr>
<th>Sessions</th>
<th>Contents of SBE</th>
<th>Sessions</th>
<th>Contents of simulation education based on flipped learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Medical and surgical hand washing</td>
<td>7</td>
<td>Dry and sterile dressing</td>
</tr>
<tr>
<td>2</td>
<td>Wearing a gown, mask and sterile gloves</td>
<td>8</td>
<td>Placement of nasogastric tube and gavage</td>
</tr>
<tr>
<td>3</td>
<td>Control and recording of vital signs</td>
<td>9</td>
<td>Principles of administering injectable drugs</td>
</tr>
<tr>
<td>4</td>
<td>Principles of prescribing non-injectable drugs</td>
<td>10</td>
<td>Oxygen therapy</td>
</tr>
<tr>
<td>5</td>
<td>Fluid therapy</td>
<td>11</td>
<td>Nasopharyngeal suction</td>
</tr>
<tr>
<td>6</td>
<td>Urinary catheterization</td>
<td>12</td>
<td>Enema</td>
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Table 2. Demographics of the participants (N=40)
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Experimental</th>
<th>Control</th>
<th>P value</th>
<th>$\chi^2$</th>
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<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
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<tr>
<td>Gender</td>
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<tr>
<td>Female</td>
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<td>9 (50)</td>
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<td>Good</td>
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<tr>
<td>Average</td>
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<td>17 (95)</td>
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<td>Living status</td>
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<td>With family</td>
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<td>8 (45)</td>
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<td>Dormitory</td>
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<td>10 (55)</td>
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<td>Father's level of education</td>
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<tr>
<td>Diploma</td>
<td>5 (23)</td>
<td>3 (17)</td>
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<td>High school</td>
<td>14 (64)</td>
<td>12 (66)</td>
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<tr>
<td>Higher than diploma</td>
<td>3 (13)</td>
<td>3 (17)</td>
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<tr>
<td>Father's job</td>
<td></td>
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<td></td>
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<tr>
<td>Employee</td>
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<td>6 (34)</td>
<td>0.91</td>
<td>0.01</td>
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<td>freelance job</td>
<td>15 (68)</td>
<td>12 (66)</td>
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<tr>
<td>Mother's education level</td>
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<td>Higher than diploma</td>
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<tr>
<td>Mother's job</td>
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<tr>
<td>Employee</td>
<td>3 (14)</td>
<td>3 (17)</td>
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<td>20.27 (2.63)</td>
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<td>GPA</td>
<td>18.50 (0.99)</td>
<td>18.46 (1.04)</td>
<td>0.89</td>
<td>t = 0.13</td>
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Table 3. Comparisons of the total and subscales scores of IMMS between two groups

<table>
<thead>
<tr>
<th>Variables</th>
<th>Experimental Mean(SD)</th>
<th>Control Mean(SD)</th>
<th>Paired t-test (P value)</th>
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<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
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</tr>
<tr>
<td>Attention</td>
<td>39.95 (4.79)</td>
<td>40.66 (4.57)</td>
<td>0.55(0.58)</td>
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<td>39.31 (4.23)</td>
<td>40.33 (3.75)</td>
<td>0.8(0.24)</td>
</tr>
<tr>
<td>Relevance</td>
<td>Pre</td>
<td>32.54 (4.13)</td>
<td>(0.41)0.82</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>31.59 (5.09)</td>
<td>0.91(0.11)</td>
</tr>
<tr>
<td>Confidence</td>
<td>Pre</td>
<td>30.77 (4.80)</td>
<td>0.47(0.64)</td>
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<tr>
<td></td>
<td>Post</td>
<td>30 (6.78)</td>
<td>0.76(0.3)</td>
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<tr>
<td>Satisfaction</td>
<td>Pre</td>
<td>22.22 (4.01)</td>
<td>0.35(0.72)</td>
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<tr>
<td></td>
<td>Post</td>
<td>21.72 (5.62)</td>
<td>0.83(0.2)</td>
</tr>
<tr>
<td>Total IMMS</td>
<td>Pre</td>
<td>125.5 (14.68)</td>
<td>0.6(0.51)</td>
</tr>
<tr>
<td></td>
<td>post</td>
<td>122.63 (18.29)</td>
<td>0.79(0.2)</td>
</tr>
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Table 4. Comparisons of the total and subscales scores of engagement between two groups
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<tr>
<th>Variables</th>
<th>Experimental Mean(SD)</th>
<th>Control Mean(SD)</th>
<th>Paired t-test (P value)</th>
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<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td></td>
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<td>Agentic</td>
<td>16.5 (5.8)</td>
<td>16.68 (3.77)</td>
<td>-0.12(0.90)</td>
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<td>16.44(3.9)</td>
<td>17.05 (3.63)</td>
<td>-0.52(0.6)</td>
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<td>Behavioral</td>
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<td>20.77 (3.19)</td>
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<td>19.09 (3.30)</td>
<td>20.61 (3.36)</td>
<td>0.17(0.86)</td>
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<td>Emotional</td>
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<td>16.88 (2.58)</td>
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<td>15.13 (3.12)</td>
<td>16.22 (2.31)</td>
<td>0.98(0.33)</td>
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<tr>
<td>Cognitive</td>
<td>30.59 (4.7)</td>
<td>31(3.59)</td>
<td>0.47(0.64)</td>
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<td>28.27 (4.91)</td>
<td>30.55 (4.73)</td>
<td>0.76(0.3)</td>
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<tr>
<td>Total engagement</td>
<td>83.04 (13.61)</td>
<td>85.11(11.55)</td>
<td>1.02(0.31)</td>
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<td>79.18 (12.85)</td>
<td>84.44 (12.06)</td>
<td>0.18(0.85)</td>
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</tbody>
</table>

**Figures**
Figure 1

The educational design of flipped classroom based on the ADDIE model

Analysis
- Analysis feasibility for FC pedagogy
- Determining the list of learners' tasks based on the curriculum and selecting important tasks
- Determining the training setting

Design
- Identify courses for the implementation of the flipped classroom
- Definition of practical procedures
- Lesson planning
- Instructors selection and evaluation tools
- Selection of different software programs to record, edit and publish video

Development
- Producing materials (maximum 10 minutes)
- Develop tools of evaluate effectiveness

Implementation
- Dividing students into two groups of 11 people
- The students practiced and explained the video content and PDF files of fundamental nursing skills using mannequins with the participation of each other for 90 minutes
- The role of the instructors was to provide feedback to student
- Repetition of fundamental nursing skills using simulators and mannequins for another 90 minutes to consolidate learning

Evaluation
- Provide feedback to students by peers and instructors to consolidate learning
- Outcomes including performance, learning motivation and academic engagement were measured using the nursing skills observation checklists, IMMS and academic engagement questionnaire at the middle and end of the semester.