

Effect of Virtual Flipped Classroom on Critical Care Nursing Students' Knowledge regarding Acute Respiratory Disorders and Learning Approach

Fayza Ahmed Abdou Mohammed Komsan¹, Rawhia Salah Dogham²

1. Assistant professor. Critical Care and Emergency Nursing Department, Faculty of Nursing, Assuit University, Assuit, Egypt - fayzaabdou2020@gmail.com
2. Assistant professor Nursing education department, Faculty of nursing, Alexandria University, Egypt - dr.rawhia@inaya.edu.sa

Abstract

Background: The virtual flipped classroom (VFC) is an integration of two concepts: the Flipped Classroom and Virtual Classroom. It empowers educator to instruct and guide students in applying the activities required to attain the best learning levels **Aim:** to evaluate the effect of virtual flipped classroom on critical care nursing students' knowledge regarding acute respiratory disorders and learning approach. **Design:** A quasi-experimental research design (pretest posttest research design) was used in this study. **Research hypothesis:** Critical care nursing students who undergo Virtual flipped classroom show improvement in post-test knowledge and have deep learning approach after application of virtual flipped classroom **Setting:** the study was conducted through online virtual class for critical care nursing students at Assuit Main University. **Subject:** Convenient sample of approximately fifty critical care nursing students. **Tools:** Two tools were used in the study knowledge assessment questionnaire and revised study process questionnaire. **Results:** A statistical significant differences between the nursing students pretest and posttest level of knowledge about acute respiratory disorders after application of virtual flipped classroom and highly statistical difference between pretest and posttest in relation to overall learning approach.. **Conclusion:** the majority of critical care nursing students have good level of knowledge after application of VFC. **Recommendation:** The VFC can also be integrated into the lessons depended on the context, nature of lessons, students' needs and characteristic

Keywords: virtual flipped classroom (VFC), acute respiratory disorders, learning approach, critical care nursing students

Introduction:

Changes in data and communication advances have also changed the qualifications and abilities expected from individuals in the current data age. Currently the challenge in nurse education is to make programs convenient, available and attractive to large number of students. E-Learning and blended learning have the potential to meet this challenge (Phillips C, O'Flaherty J 2019).

In today's classrooms, there are several ways in which the participant-educator has seen motivation integrated into teaching. Some educators utilize it for inquiry during class time as an online review, for virtual labs, or for research projects. They combine the utilize of innovation with their current classroom instruction strategies and pedagogical practices. This is known as blended learning. Additionally, some teacher have changed their teaching strategies through providing online lectures for students to watch at home in place of the teacher lecturing during the day and then using the face-to-face time in class for collaborative

activities or inquiry. This is known as the “flipped” classroom (**Whitlock j 2019**).

The flipped classroom, which is a new educational trend is anticipated to be commonly implemented in tertiary education in the next few years and is regarded as one of these alternatives (**Demiralay, R., & Karataş, S. 2019**). This educational trend, which is a new pedagogical approach, is a blended learning type where conventional face-to-face teaching is rearranged. This model gives a different teaching-learning process and viably utilizes innovation. Theoretical knowledge is instructed to students by implies of videos out-of-class study time and different activities and implementations are conducted in the class study time in this model ⁽⁴⁾. That's within the flipped classroom, students are educating at home and exposed to the assignment model at school (**Demiralay, R., & Karataş, S. 2019**).

The flipped classroom, which is an innovative learning model, is diverse from the conventional face-to-face learning strategy within the sense that students learn their lessons whenever and wherever they want before coming to school. The flipped approach has numerous advantages for students; it permits learning to be independently paced, adaptability of when and where electronic resources and materials are accessed, and real class time is utilized more successfully to engage students in dynamic discussion and interactive learning. The flipped approach allows students to practice lower order thinking skills (LOTs) such as remembering and understanding independently, and at their own pace. Class time can then be guided by mentors and peers, to give time to learning activities permitting students to create higher order thinking skills (HOTs) such as application, analysis, synthesis and evaluation (**Bergmann, J., & Sams, A. 2012**)

Virtual classroom (VC) is an electronic model in which students can collectively interface verbally and synchronously with their mentor subsequently diminishing the ‘transactional distance’ that has been detailed in association with learning in completely online courses (**O’Flaherty J & Laws T 2022**). Numerous studies report major benefits of

utilizing virtual classrooms such as giving immediate feedback, encouraging trade of different viewpoints, improving dynamic interactions among participants, strengthening social presence, fostering the exchange of emotional supports and providing verbal elements (**Kear, K., Chetwynd, F., Williams, J., & Web, H. 2022**).

The VFC is an integration of two concepts: the Flipped Classroom and Virtual Classroom. It empowers educator to instruct and guide students in applying the activities required to attain the best learning levels. Advances in technology and medicine mean that increasing numbers of severely ill patients are surviving with a corresponding need for intensive nursing care. Critical care nursing is the field of nursing with a focus on the most extreme care of the critically ill or unsteady patients following extensive injury, surgery or life-threatening diseases. Undergraduate critical care nursing course provide an opportunity for students to develop and create essential knowledge and skills in critical care, and exposure them to the role of the critical care nurse. Most of the nursing students consider critical care nursing course difficult (**Baran, E., & Correia, A. 2018**).

To engage students in critical care nursing course more effectively, viably the course dived into 4 parts which includes respiratory, cardiovascular, neurological and gastrointestinal diseases. The researcher provides the first part of course included critical care respiratory illness such as acute respiratory failure, acute respiratory distress syndrome (ARDS), pulmonary embolism and mechanical ventilation. The researchers conducted an online quiz (pretest) to evaluate the students’ fundamental knowledge of critical care nursing course first part. The results of the quiz indicated that the students had a significant low level of knowledge. The researchers arranged to deliver this content and make it accessible through utilize of a flipped classroom. To deal with the difficulties and problems related to the content, and to collaborate in solving problems in the critical care respiratory illness and mechanical ventilation, there was the clear need for a new learning environment that provides

interaction between the educator and the students and between the students themselves (Morten P,Fontain.2017).

Significant of study

Rapidly developing and changing information and communication technologies have influenced the society and individuals in many areas of life including business, communication, education and these technologies are of great importance in practices in these areas. with the increase in learning opportunities especially in the field of education, the need for integration into globalized learning environments has increased as well this learning environment was provided by the virtual classroom .As a result, the researchers integrated the concept of the Flipped Classroom with the concept of the Virtual Classroom to devise a new teaching model, the VFC and to evaluate the effect of virtual flipped classroom on acute respiratory disorders knowledge and learning approach among critical care nursing students.

Aim of this study to:

evaluate the effect of virtual flipped classroom on critical care nursing students' knowledge regarding acute respiratory disorders and learning approach

Research Hypothesis

- Critical care nursing students who undergo Virtual flipped classroom show improvement in post-test knowledge
- Critical care nursing students who undergo Virtual flipped classroom have deep learning approach after application of virtual flipped classroom

Subject And Method

Research design:

A quasi-experimental research design (pretest posttest research design) was used in this study

Setting

This study was conducted through online virtual class for critical care nursing students at Assuit Main University.

Subjects:

Convenient sample of approximately fifty critical care nursing students and they registered in the critical care nursing course were enrolled in this study during the period of data collection from September (2020) to December (2020).

Tools:

Two tools were used in the study:

Tool I: Knowledge assessment questionnaire: -

The knowledge assessment questionnaire was developed by the researcher after reviewing the related literature (Morten P,Fontain 2017, Miller J. 2017, Brunsell, E., & Horejsi, M. 2019). It is used to assess the baseline critical care nursing students' knowledge regarding critical care respiratory illness and mechanical ventilation. This tool consists of forty-five questions. These questions covering the theoretical aspects of critical care respiratory illness and mechanical ventilation in ICU which focus on categories namely:

Acute respiratory failure; which includes eleven multiple choice questions

Acute respiratory distress; which includes eleven multiple choice questions

Pulmonary embolism; which includes twelve multiple choice questions

Mechanical ventilation; which includes eleven multiple choice questions

The score of each question was assigned as follows:

Correct answer = score one

Incorrect answer = score zero

The cut point for "Good" is > 75% of the total score, "fair" is between 50% to less than 75% of the total score, and "poor" is less than 50 % of the total score.

- In addition to critical care nursing students' characteristics which include demographic data such as age, hours spent in study, hours of sleep at night and grade performance analysis of pervious semester (GPA)

Tool II: Revised Study Process Questionnaire (R-SPQ-2F) adopted from BiggsJ, Kember D &Leung & Tang, C. 2011. It used to assess nursing students' approaches to learning (SALs) during academic year 2019-2020. It consists of 20 items; ten of them are related to deep approach (DA) for learning and the other ten represented surface approach for learning (SA). It is the 5-point Likert scale ranged from A (never or only rarely true of me) to E (always or almost always true of me). The scoring system was used to generate scores for each of the following R-SPQ-2F main scales: deep SAL (DA); surface SAL (SA). The four subscales associated with these are: deep motive (DM); deep strategy (DS); surface motive (SM) and surface strategy (SS).

Method

Permission to conduct the study was obtained from the faculty of nursing after explanation of the aim of the study.

- "Knowledge Assessment Questionnaire" (Tool I) was developed by the researcher based on reviewing the related literature (Morten P,Fontain 2017, Miller J. 2017, Brunsell, E., & Horejsi, M. 2019).
- Revised Study Process Questionnaire (R-SPQ-2F) tool II
- All tools were tested for content validity by five experts in the fields of critical care and

emergency nursing, and nursing education and the necessary modification were done accordingly.

- A pilot study was conducted on five critical care nursing students to test all tools for the clarity, objectivity, feasibility, then necessary modifications were carried out and the results were excluded from the study.
- Tool I (Knowledge assessment questionnaire) was tested for reliability by using Cronbach's coefficient alpha ($r= 86\%$) which is acceptable

Data collection:

- The current study was carried out on **four phases**; assessment, preparation, implementation and evaluation phases.

I. Assessment phase:

- Assessment of the baseline critical care nursing students' knowledge was done using pretest "knowledge Assessment Questionnaire" (tool I)
- Assessment of critical care nursing students' learning approach was done using "Revised Study Process Questionnaire" (tool II).

Preparation phase:

- The content was developing for video lessons that covered four topics acute respiratory failure, acute respiratory distress syndrome, pulmonary embolism and mechanical ventilation after reviewing the related literature four video lessons have been produced with a total of 4 hours.

- Each lesson includes learning objectives, lesson content, and evaluation. Each video required the following four production stages: Planning, Recording, Editing and Publishing.

- Planning: this stage involved introducing the lesson objective for each topic, preparing the lesson content perfectly by

concentrating on clarity and removing fillers and repetitions, in addition to suggesting a suitable platform for publishing the videos online.

- **Recording:** in this stage, a digital camera or screen capture software was used to produce the video lessons.
- **Editing:** this stage is crucial in making sure the video flows in a way that achieves the instructional goals. It can take a relatively long time. It aims at improving the videos lessons, and involves adding footage, effects, music or graphics, removing unwanted footage, titling, color correction, or sound mixing.
- **Publishing:** the final stage aims to publish video lessons securely to a video hosting online platform which will be easily viewed on the students' laptops and mobile devices.

Implementation phase:

- Implementation of VFC through four stages are dialogue with Self, dialogue with others, Observing and doing

1. First stage of VFC implementation, Dialogue with Self: the researcher planned the main purpose of this stage is to achieve self-learning of nursing students and to create independent thinkers. The main phases of this stage were the videos prepared and sent by the researcher. The critical care nursing students observed the videos about acute respiratory failure, ARDS, pulmonary embolism and mechanical ventilation in separate time before the class time then go and interact deeply into the subject. After watching the videos, the nursing students had dialogues with themselves before they produced the outcome of this stage, which was a reflection paper as well as answering questions that begin with "What". Some questions were prepared by the researcher, such as "What is the knowledge learned about acute respiratory failure and nursing care for this patient?" and "What is the role of this knowledge in the student's life?" Some other questions were prepared by the nursing students themselves, such as "What are the nursing student's notes about the acute respiratory

failure that has been learned?", "What are the difficulties faced during the learning?", and "What did the student learn about the acute respiratory failure?" the same questions apply for each subject (ARDS, pulmonary embolism and mechanical ventilation).

2. Second stage of VFC implementation, dialogue with others, the nursing students collaborated with them about the outcome of the previous stage and its content. It happened when the nursing students were engaged in dialogue sessions with classmates to build mutual understanding of the video content and to review the questions prepared by the whole group during the first stage, as well as the answers. This dialogue can be considered as "partial dialogue" as it might be limited to part of the student with the researcher. The nursing students also engaged in dialogue situations outside of class under the monitoring of the educator using some creative technologies such as emails, mobile apps, and live chatting. The main ideas of this stage were the questions and the answers that have been introduced by the students and recorded in the reflection paper during the dialogue sessions. The outcomes and feedback of these dialogue sessions, i.e. the questions with no accurate answers, were considered as the outcomes of the stage. Any unanswered questions should be presented to the researcher for improved learning.

3. The third stage of implementation of VFC, observing, this stage aimed to provide nursing students with experiences through observing the activities performed by the researcher or the learners during the virtual classroom. Initially, the researcher presented an introduction to the topic, which had been sent previously to the nursing students and also presented an introductory video or a final product created based on his before expectation of the difficult elements in the content. After that, the nursing students discussed their unanswered questions, which were considered as inputs for this stage. The students then send their notes about the videos and shared their thoughts with the researcher and classmates virtually using the chat window or through the microphone. Finally, the researcher started

answering in a practical way the students' questions. The answers given by the researcher were the outcomes of the observing stage.

4. The final stage of implementation of VFC, doing, the main important point of this stage took place in the virtual classroom. It aimed to provide student experiences-by-doing through direct, purposeful experiences, which are what the students can learn by doing them. This way of teaching was done through assignments to solve real-world problems and these assignments were the inputs for this stage. The researcher introduced the activities during the virtual classroom to make the students apply what they have learned in the flipped classroom (the videos) and what they have observed in the virtual classroom. The activities done by the students to solve the assignments were considered as the outcome of the stage.

IV. The Evaluation phase: -

- Reassessment of nursing students' knowledge was done using the posttest "knowledge Assessment Questionnaire" (tool I) immediately after finishing the first part of critical care course to measure the effect of virtual flipped classroom on the nursing students' knowledge

- Reassessment of nursing students' learning approach was done using the "students' learning approach" (tool II) immediately after finishing the first part of critical care course to measure the effect of virtual flipped classroom on the nursing students' learning approach.

Statistical analysis of the data

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp) Qualitative data were described using number and percent. Quantitative data were described mean, standard deviation. Significance of the obtained results was judged at the 5% level.

The used tests were

1 - Marginal Homogeneity Test

Used to analyze the significance between the different stages

2 - Paired t-test

For normally distributed quantitative variables, to compare between two periods

Ethical considerations:

- The researcher explained to the critical care nursing students the objectives of the study orally, additionally to the written explanations on the covering letter of questionnaire
- Critical care nursing students were assured about the confidentiality of the data collected and the right to refuse to participate in the study

Results

The aim of this study is to determine the effect of virtual flipped classroom on critical care nursing students' knowledge regarding acute respiratory disorders and learning approach

To fulfill this aim the current study results presented in the following order:

Part I: studied critical care nursing students' characteristics

Table (1): shows the distribution of the studied critical care nursing students according to their characteristics. This table indicates that (82%) of studied nursing students aged between 21 to less than 24 years old and half of them (52%) spend 3 to 4 hours to study the critical care course. Moreover, more than half (54%) of nursing students is sleeping more than 7 hours at night. Two third of them (70%) have 4 grade performance analysis (GPA)

Part II: studied critical care nursing students' level of knowledge.

Part II: studied critical care nursing students' level of knowledge before and after

application of virtual flipped classroom about critical care respiratory illness

Table (2): demonstrates distribution of the studied critical care nursing students' level of knowledge before and after application of virtual flipped classroom about critical care respiratory illness. It was found that the majority of nursing students had poor level of knowledge regarding mechanical ventilation, acute respiratory failure and pulmonary embolism (92 %, 86%,90% respectively). More than two third of them (78%) had poor level of knowledge regarding acute respiratory distress syndrome

From this table, it can be noted that the majority of nursing students had good level of knowledge regarding mechanical ventilation and acute respiratory failure after application of virtual flipped class room (88%, 94% respectively) and more than two third of them had good level of knowledge regarding acute respiratory distress syndrome and pulmonary embolism after application of virtual flipped classroom (72%, 82% respectively). The same table revealed that statistically significant differences between the nursing students pretest and posttest level of knowledge after application of virtual flipped classroom

Table (3) presents the mean score percentage of the studied critical care nursing students' level of knowledge before and after application of virtual flipped classroom. It was observed the highest total mean nursing student knowledge score after application of virtual flipped classroom(87.42+6.30)

Part III: studied critical care nursing students' learning approach

Table (4): illustrates mean score percentage of studied critical care nursing students' learning approach before and after application of virtual flipped classroom. It was observed that there was highly statistical difference between pre and post in relation to

overall learning approach. There was significance difference between pre and posttest in relation to deep learning approach which include deep motivation and deep strategy. While there was significance difference between pre and posttest in relation to superficial learning approach that include surface and superficial learning approach.

Part IV: Relationships

Table (6): describes relationship between the studied nursing students' level of knowledge before application of virtual flipped classroom and their characteristics. It was observed that there are statistical significant differences between nursing student's level of knowledge regarding pulmonary embolism and GPA, their age (P (0.029), (0.015) respectively). Moreover, no statistically significant differences between the nursing students' level of knowledge regarding mechanical ventilation, acute respiratory failure and ARDS before application of virtual flipped classroom and their demographic data

Table (7): illustrates relationship between the studied nursing students' level of knowledge after application of virtual flipped classroom and their characteristics. It was found that there are statistically significant differences between the nursing students' level of knowledge regarding acute respiratory failure and their age (P= 0.001). The same table noted that statistically significant differences between nursing student's level of knowledge regarding ARDS and hours spent for studying (P=0.019). Moreover, statistically significant differences between students' overall knowledge and sleep hours at night, GPA (P= 0.039, 0.013 respectively)

Table (8): show relationship between the studied nursing students' level of learning approach after application of virtual flipped classroom and their characteristics. It was found that a statistically significant differences between students' overall learning approach and sleep hours at night.

Table (1): Distribution of studied students according to their demographic characteristics (n = 50)

| Demographic characteristics | No. | % |
|---------------------------------|-------------|------|
| Age | | |
| 17 – 20 | 6 | 12.0 |
| 21 – 24 | 41 | 82.0 |
| 25 – 28 | 3 | 6.0 |
| Hours spent for studying | | |
| Less than 2 hours | 5 | 10.0 |
| 3 – 4 hours | 26 | 52.0 |
| 5- 6 hours | 10 | 20.0 |
| More than 7 hours | 9 | 18.0 |
| Hours of sleep / night | | |
| Less than 2 hours | 0 | 0.0 |
| 3 – 4 hours | 4 | 8.0 |
| 5- 6 hours | 19 | 38.0 |
| More than 7 hours | 27 | 54.0 |
| GPA | | |
| 2.5 - <3 | 2 | 4.0 |
| 3 - <3.5 | 6 | 12.0 |
| 3.5 - <4 | 7 | 14.0 |
| 4+ | 35 | 70.0 |
| Min. – Max. | 2.79 – 5.0 | |
| Mean ± SD. | 4.24 ± 0.65 | |

Table (2): Comparison between before and after application of virtual flipped class room according to levels of knowledge questionnaire about respiratory diseases (n = 50)

| Knowledge questionnaire about respiratory diseases | Pre | | Post | | MH | p |
|--|-----|------|------|------|--------|---------|
| | No. | % | No. | % | | |
| MV | | | | | | |
| Poor (<50%) | 46 | 92.0 | 0 | 0.0 | | |
| Fair (50%-75%) | 4 | 8.0 | 6 | 12.0 | 99.0* | <0.001* |
| Good (>75%) | 0 | 0.0 | 44 | 88.0 | | |
| Acute respiratory failure | | | | | | |
| Poor (<50%) | 43 | 86.0 | 0 | 0.0 | | |
| Fair (50%-75%) | 7 | 14.0 | 3 | 6.0 | 102.0* | <0.001* |
| Good (>75%) | 0 | 0.0 | 47 | 94.0 | | |
| ARDS | | | | | | |
| Poor (<50%) | 39 | 78.0 | 0 | 0.0 | | |
| Fair (50%-75%) | 11 | 22.0 | 14 | 28.0 | 96.50* | <0.001* |
| Good (>75%) | 0 | 0.0 | 36 | 72.0 | | |
| Pulmonary embolism | | | | | | |
| Poor (<50%) | 45 | 90.0 | 2 | 4.0 | | |
| Fair (50%-75%) | 5 | 10.0 | 7 | 14.0 | 95.0* | <0.001* |
| Good (>75%) | 0 | 0.0 | 41 | 82.0 | | |
| Overall Knowledge | | | | | | |
| Poor (<50%) | 46 | 92.0 | 0 | 0.0 | | |
| Fair (50%-75%) | 4 | 8.0 | 2 | 4.0 | 101.0* | <0.001* |
| Good (>75%) | 0 | 0.0 | 48 | 96.0 | | |

MH: Marginal Homogeneity Test

p: p value for comparing between pre and post

*: Statistically significant at $p \leq 0.05$

Table (3): Comparison between before and after application of virtual flipped class room according to scores of knowledge questionnaire about respiratory diseases (n = 50)

| Knowledge questionnaire about respiratory diseases | before Mean ± SD. | after Mean ± SD. | t | p |
|--|----------------------|---------------------|---------|---------|
| MV | | | | |
| Total score | 3.82 ± 1.84 | 9.80 ± 1.01 | 25.108* | <0.001* |
| Percent score | 34.73 ± 16.70 | 89.09 ± 9.18 | | |
| Acute respiratory failure | | | | |
| Total score | 3.44 ± 2.04 | 10.96 ± 1.05 | 28.848* | <0.001* |
| Percent score | 28.67 ± 17.02 | 91.33 ± 8.74 | | |
| ARDS | | | | |
| Total score | 3.06 ± 1.67 | 8.22 ± 1.27 | 20.804* | <0.001* |
| Percent score | 30.60 ± 16.71 | 82.20 ± 12.66 | | |
| Pulmonary embolism | | | | |
| Total score | 3.62 ± 1.82 | 10.36 ± 1.74 | 21.032* | <0.001* |
| Percent score | 30.17 ± 15.14 | 86.33 ± 14.46 | | |
| Overall Knowledge | | | | |
| Total score | 13.94 ± 5.32 | 39.34 ± 2.83 | 34.896* | <0.001* |
| Percent score | 30.98 ± 11.82 | 87.42 ± 6.30 | | |

t: Paired t-test

p: p value for comparing between pre and post

*: Statistically significant at $p \leq 0.05$ **Table (4): Comparison between before and after application of virtual flipped class room according to scores of learning approach scale**

| Learning approach scale | before Mean ± SD. | after Mean ± SD. | t | p |
|--|----------------------|---------------------|---------|---------|
| Deep learning approach | | | | |
| Total score | 28.28 ± 6.72 | 39.22 ± 2.31 | 13.061* | <0.001* |
| Percent score | 45.70 ± 16.79 | 73.05 ± 5.77 | | |
| Deep motivation DM | | | | |
| Total score | 14.61 ± 4.02 | 19.22 ± 1.74 | 8.424* | <0.001* |
| Percent score | 48.20 ± 20.12 | 71.10 ± 8.71 | | |
| DS deep strategy | | | | |
| Total score | 13.64 ± 3.15 | 20.0 ± 1.32 | 15.190* | <0.001* |
| Percent score | 43.20 ± 15.74 | 75.0 ± 6.62 | | |
| Surface / superficial learning approach | | | | |
| Total score | 36.42 ± 4.60 | 42.82 ± 3.26 | 10.703* | <0.001* |
| Percent score | 66.05 ± 11.51 | 82.05 ± 8.14 | | |
| SM | | | | |
| Total score | 18.22 ± 3.22 | 22.58 ± 1.75 | 9.835* | <0.001* |
| Percent score | 66.10 ± 16.11 | 87.90 ± 8.75 | | |
| SS learning approach | | | | |
| Total score | 18.20 ± 2.61 | 20.24 ± 2.43 | 5.208* | <0.001* |
| Percent score | 66.0 ± 13.05 | 76.20 ± 12.15 | | |
| Overall learning approach | | | | |
| Total score | 64.70 ± 7.12 | 82.04 ± 3.98 | 17.336* | <0.001* |
| Percent score | 55.88 ± 8.90 | 77.55 ± 4.98 | | |

t: Paired t-test

p: p value for comparing between pre and post

*: Statistically significant at $p \leq 0.05$

Table (5): Relation between mean score of knowledge about respiratory diseases and demographic data in before application of virtual flipped class room

| Demographic data | Knowledge about respiratory diseases before application of virtual flipped class room | | | | |
|---------------------------------|---|---------------------------|-------------------|--------------------|-------------------|
| | MV | Acute respiratory failure | ARDS | Pulmonary embolism | Overall Knowledge |
| | Mean \pm SD. | Mean \pm SD. | Mean \pm SD. | Mean \pm SD. | Mean \pm SD. |
| Age | | | | | |
| 17 – 20 | 43.94 \pm 23.99 | 16.67 \pm 12.91 | 25.00 \pm 20.74 | 15.28 \pm 14.35 | 24.81 \pm 17.01 |
| 21 – 24 | 32.82 \pm 15.73 | 31.10 \pm 16.77 | 31.46 \pm 16.82 | 32.52 \pm 14.65 | 31.98 \pm 11.26 |
| 25 – 28 | 42.42 \pm 5.25 | 19.44 \pm 19.25 | 30.00 \pm 0.00 | 27.78 \pm 4.81 | 29.63 \pm 5.13 |
| F (p) | 1.532(0.227) | 2.494(0.093) | 0.384(0.683) | 3.830*(0.029*) | 0.981(0.383) |
| Hours spent for studying | | | | | |
| Less than 2 hours | 36.36 \pm 6.43 | 33.33 \pm 5.89 | 26.00 \pm 15.17 | 26.67 \pm 3.73 | 30.67 \pm 2.90 |
| 3 – 4 hours | 36.36 \pm 19.07 | 25.00 \pm 12.69 | 30.77 \pm 18.09 | 31.09 \pm 15.19 | 30.68 \pm 10.98 |
| 5- 6 hours | 28.18 \pm 17.90 | 28.33 \pm 20.49 | 34.00 \pm 17.76 | 37.50 \pm 18.53 | 32.00 \pm 14.71 |
| More than 7 hours | 36.36 \pm 11.13 | 37.04 \pm 25.38 | 28.89 \pm 13.64 | 21.30 \pm 11.11 | 30.86 \pm 15.17 |
| F (p) | 0.625(0.602) | 1.276(0.294) | 0.284(0.837) | 2.058(0.119) | 0.030(0.993) |
| Hours of sleep / night | | | | | |
| 3 – 4 hours | 29.55 \pm 13.64 | 18.75 \pm 17.18 | 35.00 \pm 19.15 | 20.83 \pm 4.81 | 25.56 \pm 5.29 |
| 5- 6 hours | 35.89 \pm 15.59 | 25.00 \pm 16.90 | 24.21 \pm 16.44 | 26.75 \pm 18.13 | 27.95 \pm 13.03 |
| More than 7 hours | 34.68 \pm 18.19 | 32.72 \pm 16.49 | 34.44 \pm 15.77 | 33.95 \pm 12.85 | 33.91 \pm 11.07 |
| F (p) | 0.231(0.795) | 1.958(0.152) | 2.367(0.105) | 2.186(0.124) | 1.945(0.154) |
| GPA | | | | | |
| 2.5 - <3 | 36.36 \pm 0.0 | 41.67 \pm 0.0 | 20.00 \pm 0.0 | 16.67 \pm 0.0 | 28.89 \pm 0.0 |
| 3 - <3.5 | 34.85 \pm 21.06 | 18.06 \pm 11.08 | 25.00 \pm 20.74 | 19.44 \pm 12.55 | 24.07 \pm 13.94 |
| 3.5 - <4 | 31.17 \pm 7.15 | 22.62 \pm 17.16 | 18.57 \pm 9.00 | 21.43 \pm 6.56 | 23.49 \pm 5.57 |
| 4+ | 35.32 \pm 18.02 | 30.95 \pm 17.45 | 34.57 \pm 16.33 | 34.52 \pm 15.28 | 33.78 \pm 11.79 |
| F (p) | 0.120(0.948) | 1.749(0.170) | 2.591(0.064) | 3.847*(0.015*) | 2.504(0.071) |

F: F for ANOVA test,

*: Statistically significant at $p \leq 0.05$

Table (6): Relationship between mean score of knowledge about respiratory diseases and demographic data after application of virtual flipped class room

| Demographic data | Knowledge about respiratory diseases after application of virtual flipped class room | | | | |
|---------------------------------|--|---------------------------|----------------|--------------------|--------------------|
| | MV | Acute respiratory failure | ARDS | Pulmonary embolism | Overall, Knowledge |
| | Mean ±SD. | Mean ±SD. | Mean ±SD. | Mean ±SD. | Mean ±SD. |
| Age | | | | | |
| 17 – 20 | 93.94±4.69 | 79.17±11.49 | 93.33±8.16 | 87.50±11.49 | 88.15±6.23 |
| 21 – 24 | 88.25±9.59 | 93.09±7.19 | 80.73±12.92 | 85.77±15.39 | 87.21±6.57 |
| 25 – 28 | 90.91±9.09 | 91.67±0.00 | 80.00±0.00 | 91.67±0.00 | 88.89±2.22 |
| F (p) | 1.071(0.351) | 8.738*(0.001*) | 2.838(0.069) | 0.247(0.782) | 0.140(0.870) |
| Hours spent for studying | | | | | |
| Less than 2 hours | 89.09±9.96 | 88.33±4.56 | 82.00±10.95 | 81.67±6.97 | 85.33±5.58 |
| 3 – 4 hours | 88.11±9.19 | 93.27±7.08 | 77.69±13.66 | 87.18±18.89 | 86.92±6.98 |
| 5- 6 hours | 86.36±9.82 | 90.00±6.57 | 85.00±10.80 | 88.33±8.05 | 87.56±5.15 |
| More than 7 hours | 94.95±6.60 | 88.89±15.02 | 92.22±4.41 | 84.26±6.51 | 89.88±5.89 |
| F (p) | 1.681(0.184) | 0.929(0.434) | 3.650*(0.019*) | 0.315(0.814) | 0.682(0.568) |
| Hours of sleep / night | | | | | |
| 3 – 4 hours | 86.36±11.74 | 89.58±7.98 | 92.50±9.57 | 89.58±4.17 | 89.44±4.21 |
| 5- 6 hours | 86.12±7.02 | 89.04±10.78 | 78.42±13.85 | 83.77±21.06 | 84.56±6.77 |
| More than 7 hours | 91.58±9.74 | 93.21±6.95 | 83.33±11.44 | 87.65±8.76 | 89.14±5.59 |
| F (p) | 2.274(0.114) | 1.380(0.262) | 2.408(0.101) | 0.501(0.609) | 3.491*(0.039*) |
| GPA | | | | | |
| 2.5 - <3 | 81.82±0.0 | 91.67±0.0 | 70.00±0.0 | 91.67±0.0 | 84.44±0.0 |
| 3 - <3.5 | 89.39±6.84 | 79.17±12.64 | 86.67±17.51 | 76.39±27.60 | 82.59±10.18 |
| 3.5 - <4 | 85.71±8.87 | 88.10±6.56 | 78.57±12.15 | 79.76±4.45 | 83.17±3.60 |
| 4+ | 90.13±9.70 | 94.05±6.57 | 82.86±12.02 | 89.05±12.26 | 89.27±5.27 |
| F (p) | 0.879(0.459) | 7.407* (<0.001*) | 1.097(0.360) | 2.054(0.119) | 4.021* (0.013*) |

F: F for ANOVA test, *: Statistically significant at $p \leq 0.05$

Table (7): Relationship between mean score percentage of learning approach scale and demographic data before application of virtual flipped class room

| Demographic data | Learning approach scale before application of virtual flipped class room | | |
|---------------------------------|--|---|---------------------------|
| | Deep learning approach | Surface / superficial learning approach | Overall learning approach |
| | Mean ±SD. | Mean ±SD. | Mean ±SD. |
| Age | | | |
| 17 – 20 | 53.33 ± 14.72 | 69.58 ± 13.27 | 61.46 ± 10.20 |
| 21 – 24 | 43.96 ± 17.24 | 65.00 ± 11.52 | 54.48 ± 8.47 |
| 25 – 28 | 54.17 ± 8.78 | 73.33 ± 2.89 | 63.75 ± 4.51 |
| F (p) | 1.232(0.301) | 1.057(0.356) | 3.102(0.054) |
| Hours spent for studying | | | |
| Less than 2 hours | 53.50 ± 18.42 | 54.50 ± 5.12 | 54.00 ± 8.40 |
| 3 – 4 hours | 47.40 ± 15.83 | 67.88 ± 10.55 | 57.64 ± 8.16 |
| 5- 6 hours | 45.00 ± 16.41 | 66.50 ± 13.60 | 55.75 ± 11.74 |
| More than 7 hours | 37.22 ± 18.47 | 66.67 ± 12.12 | 51.94 ± 7.53 |
| F (p) | 1.237(0.307) | 2.034(0.122) | 1.002(0.400) |
| Hours of sleep / night | | | |
| 3 – 4 hours | 48.13 ± 17.96 | 71.25 ± 13.62 | 59.69 ± 14.84 |
| 5- 6 hours | 48.55 ± 14.42 | 63.68 ± 13.08 | 56.12 ± 9.75 |
| More than 7 hours | 43.33 ± 18.37 | 66.94 ± 10.03 | 55.14 ± 7.43 |
| F (p) | 0.574(0.567) | 0.887(0.419) | 0.456(0.637) |
| GPA | | | |
| 2.5 - <3 | 57.50 ± 3.54 | 57.50 ± 24.75 | 57.50 ± 10.61 |
| 3 - <3.5 | 50.83 ± 14.11 | 61.67 ± 14.97 | 56.25 ± 9.71 |
| 3.5 - <4 | 40.36 ± 21.96 | 57.86 ± 11.50 | 49.11 ± 9.03 |
| 4+ | 45.21 ± 16.51 | 68.93 ± 9.30 | 57.07 ± 8.46 |
| F (p) | 0.751(0.528) | 2.864* (0.047*) | 1.649(0.191) |

F: F for ANOVA test, *: Statistically significant at $p \leq 0.05$

Table (8): Relationship between mean score percentage of learning approach scale and demographic data after application of virtual flipped class room

| Demographic data | Learning approach scale after application of virtual flipped class room | | |
|---------------------------------|---|---|---|
| | Deep learning approach Mean \pm SD. | Surface / superficial learning approach Mean \pm SD. | Overall learning approach Mean \pm SD. |
| Age | | | |
| 17 – 20 | 74.17 \pm 5.85 | 82.08 \pm 5.34 | 78.13 \pm 4.45 |
| 21 – 24 | 73.11 \pm 5.94 | 82.01 \pm 8.74 | 77.56 \pm 5.21 |
| 25 – 28 | 70.00 \pm 2.50 | 82.50 \pm 5.00 | 76.25 \pm 3.31 |
| F (p) | 0.524(0.595) | 0.005(0.995) | 0.137(0.872) |
| Hours spent for studying | | | |
| Less than 2 hours | 74.00 \pm 3.79 | 79.00 \pm 9.45 | 76.50 \pm 2.98 |
| 3 – 4 hours | 73.56 \pm 5.30 | 82.79 \pm 6.68 | 78.17 \pm 3.32 |
| 5- 6 hours | 71.75 \pm 8.34 | 82.50 \pm 10.93 | 77.13 \pm 8.50 |
| More than 7 hours | 72.50 \pm 5.15 | 81.11 \pm 8.85 | 76.81 \pm 5.38 |
| F (p) | 0.296(0.828) | 0.341(0.796) | 0.288(0.834) |
| Hours of sleep / night | | | |
| 3 – 4 hours | 73.75 \pm 4.33 | 91.25 \pm 4.33 | 82.50 \pm 4.33 |
| 5- 6 hours | 73.68 \pm 5.61 | 83.16 \pm 7.30 | 78.42 \pm 4.64 |
| More than 7 hours | 72.50 \pm 6.16 | 79.91 \pm 8.19 | 76.20 \pm 4.85 |
| F (p) | 0.259(0.773) | 4.136*(0.022*) | 3.597* (0.035*) |
| GPA | | | |
| 2.5 - <3 | 77.50 \pm 3.54 | 83.75 \pm 8.84 | 80.63 \pm 6.19 |
| 3 - <3.5 | 72.92 \pm 5.79 | 79.58 \pm 4.31 | 76.25 \pm 3.45 |
| 3.5 - <4 | 72.86 \pm 4.19 | 80.00 \pm 8.78 | 76.43 \pm 5.37 |
| 4+ | 72.86 \pm 6.19 | 82.79 \pm 8.61 | 77.82 \pm 5.16 |
| F (p) | 0.399(0.755) | 0.440(0.725) | 0.528(0.666) |

F: F for ANOVA test,

*: Statistically significant at $p \leq 0.05$

Discussion

The educational processes are in constant change; active methodologies take in hand a relevant role by making students the central character of their learning. The VFC is aimed to personalization of the learning processes that improve their academic achievement (Colomo-Magaña, E., Soto-Varela, R., Ruiz-Palmero, J., & Gómez-García, M. (2020).

On the level of knowledge, the results of this study showed that there was statistically significant difference in the knowledge scores before and after the application of virtual flipped classroom. It was observed that the highest total mean nursing knowledge score after use of virtual flipped classroom. These results are consistent with the study of (Zhu Li , Cao N, Ren Ch, Chu X, Zhou H (2020) That indicated that the VFC mode produced a significantly higher theoretical scores than the lecture-based learning mode . Joseph M, Roach E, Natarajan J, Karkada

S& Cayaban A. (2021).The findings also parallel the results shown by both Everly, M. C(2013) and Hawks 2022), that the VFC pedagogy improved both student learning and satisfaction.

The current study showed that there was statistically significance difference between pre and post studied sample in relation to respiratory diseases knowledge questionnaire concerning mechanical ventilator; acute respiratory failure; acute respiratory disease syndrome and pulmonary embolism. This can be interpreted by selected intentional content according to the instructive purposes followed, where it is

the teacher's task to specify what will be worked on autonomously by the students and what will be practically implemented in the classroom Colomo-Magaña, E., Soto-Varela, R., Ruiz-Palmero, J., & Gómez-García, M. (2020). This result may be related to VFC helps students to be more engaged in their own

learning by collaborative problem solving with the teacher and the other students. In addition, Students received immediate feedback on material from their teacher instead of attempting the work at home and failing to complete the work due to missed information. Moreover, **Nolan and Washington (2022)** noted that many students in a flipped classroom revealed an improvement in behaviour and retention of material (**Nolan A & Washington S, 2022**). This can be interpreted by the VFC characterized by flexibility; positive culture of learning for students; the work of teachers goes beyond the didactic and pedagogical transmission of knowledge, which is key for the changes, adaptations, innovations, or challenges which necessary to improve the training work and by supporting their decisions in a reflective and self-critical process of their work **Colomo-Magaña, E., Soto-Varela, R., Ruiz-Palmero, J., & Gómez-García, M. (2020)**.

Concerning learning approach, the results of this study illustrated that there are significant differences between pre and post-test regarding to overall learning approach. This result is consistent with the study of **Dehghanzadeh (2019)** which showed that the flipped classroom method significantly increased the deep approach and its subscales, including deep motive and deep strategy, while not affecting the superficial approach and its sub-scales **Dehghanzadeh (2019)**. Also, by assessing learners' study approaches, it is possible to identify the various educational methods that affect deep learning. These findings can be related to the instructors in VFC provide the conditions for deep and meaningful learning through educational methods that enable learners to work and think at different cognitive levels **Roca, J., Reguant, M., & Canet, O. (2016)**. The VFC method also emphasis on active learning and learner-centeredness as well as the use of class time on the application of the learned concepts allows for deep learning **Mikkelsen, T. R. (2020) & Lacher, L. L., & Lewis, M. C. (2019)**.

In relation to students' demographic characteristics the results of the current study revealed that, statistically significant differences between students' overall knowledge and sleep

hours at night, GPA after the implementation of the flipped classroom method. This finding similar to study **Zeek, M. L., Savoie, M. J., Song, M., Kennemur, L. M., Qian, J., Jungnickel, P. W., & Westrick, S. C. (2015)**, who found that a majority of student pharmacists had suboptimal durations of sleep, defined as fewer than 7 hours. Adequate sleep the night prior to an examination was positively associated with student course grades and semester GPAs. Additional, comparison between the classical lecture format, and the flipped classroom strategy, it was found that there was improved Omani nursing students' performance in and satisfaction with an anatomy and physiology course. These results show that the flipped classroom is an important teaching strategy in nursing education **Joseph M,Roach E, Natarajan J,Karkada S& Cayaban A. (2021)**.

In interpreting this finding, it can be supported by constructivist perspective on learning that deep learning approach, meaning that, for developing capacities of understanding, critical interpreting, skills to solve real-life situations, it must be emphasized more practical side of activities with students, to create the conditions necessary for them to learn how to learn, valuing the experience by analysing concrete examples, by putting in situation, by encouraging the formulation of hypotheses, solutions, value judgments **Ecaterina Sarah. (2014)**. In addition, the deep learning approach can be effective due to VFC helps learns to perform tasks directly from text, sound, or images **Magnimind (2020)**.

Conclusion

It was concluded that the VFC is an effective teaching and learning method that produce more interest in nursing education. This study results support the use of VFC for improve students' learning approach and their knowledge in critical care nursing course.

Recommendations

- The effects of the preparation periods prior to the class study time and lengths of videos could be investigated.

- Training programs could be applied in the flipped classroom in one semester or academic year to reveal its far-reaching effects. Long periods can be important to observe changes in variables, particularly “academic achievement”.

- The flipped classroom can be integrated into the lessons depended on the context, nature of lessons, students’ needs and characteristic.

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