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Problem-based learning method in the context of a flipped classroom: Outcomes on pain management course acquisition

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Abstract

Introduction: A deep understanding of physiology, physiopathology, pharmacology, and the management of pain is crucial for nurse anaesthetists to ensure the well-being of their patients. Thus, the teaching strategies should enhance the transition from acquiring the fundamental pain phenomena, to developing translational and critical thinking. The aim of the study is to determine if the flipped classroom that is considered an active learning approach is most effective compared to the traditional method in teaching pain management and if it improves students' academic performance.

Methods: This study was quasi experimental, at a higher institute of nursing professions, among third-year anaesthesia resuscitation nursing students. participants were randomly allocated into either: the flipped classroom group where PBL was used (FG, n = 19), or the traditional lecture-based classroom group (TG, n = 19). The results and impact of the above approach were appreciated via the analysis of the summative assessment of the class group and from the questionnaire submitted to students.

Results: The present study revealed that in the midterm exam, the mean score of the flipped classroom group (14.0) which is significantly higher ($p < 0.01$) than the traditional lecture group (11.9). Moreover, the standard deviation of this latter is slightly higher (2.41) which indicates scores far from the average. Also, a significant difference between the averages of the two approaches in favor of flipped classroom Group was revealed ($p < 0.01$).

Conclusion: The assessment of student's grades and their appreciation of both teaching approaches showed a preference for the PBL.

Keywords: *Flipped Classroom, Nursing Education, Pain Management, Problem-Based Learning*

Practice Highlights

- Flipped classroom showed advantageous results on nursing students' grades.
- Flipped classroom endorsed positive results on course comprehension by nursing students.
- Flipped classroom has shown to effectively support content learning.

I. INTRODUCTION

Flipped classroom is a pedagogical approach defined as: "What was previously completed as homework is now finished in class, and what was previously completed in class is now completed at home" (Dong, 2016). Using this approach, traditional classroom time is spent on active learning strategies such as problem-based learning, games, or practice questions to allow teachers

to guide students in developing strategies. critical thinking (Dong, 2016). Flipped classrooms are used as the main teaching method in the courses of health professions such as nursing theory, statistics and pharmacology (Hanson, 2016; Immekus, 2019; Peisachovich et al., 2016). In fact, there is evidence that students' academic performance improved in midterm

exams while using flipped classroom approach (Geist et al., 2015).

Despite feeling that this method increased their knowledge, nursing students said they preferred traditional lectures to the use of a flipped classroom (Hanson, 2016). It is not uncommon for students to prefer lectures to the flipped classroom method, which may be related to how much work they feel they have to do or insecurity of exam preparation or both of them (Dong, 2016; Tune et al., 2013). The use of the flipped classroom in nursing was supported by evidence that showed lecturers were enthusiastic about this method. The most effective method for implementing and assessing this strategy in nursing education, though, is not consistently supported by the available data (Barranquero-Herbosa et al., 2022; Dong, 2016; Njie-Carr et al., 2017).

Contextual learning can encourage the growth of critical reasoning, which enables students to pick out the top nursing concerns for patients from a long list of problems, ultimately fostering the development of problem-based nursing analysis in line with Benner's model (Dong, 2016). Problem-based learning (PBL) uses problem scenarios to develop knowledge and understanding learning objectives (Wood, 2003). Among the strategies used in a flipped classroom, the PBL has been used in nursing education, in courses such as pharmacology, mental health nursing and critical care nursing (Alton, 2016; Gholami et al., 2016). Any teaching strategy that involves students in the learning process is considered to be an active learning strategy, which includes PBL (Peisachovich et al., 2016).

Despite the introduction of pain management in health professions education, pain is still undertreated. It affects 80%-90% of patients in medicine, surgery, and cancer units (Gerbershagen et al., 2009; Gianni et al., 2010). Previous research also highlighted that 43% to 51% of patients received inadequate or insufficient analgesic treatment and only 14% of patients who received analgesia benefit from reassessment (Deandrea et al., 2008; Manias et al., 2005). To effectively manage pain, nurses are crucial. Therefore, it is crucial that they receive effective training to ensure better pain management (Teike Lüthi et al., 2015).

In this direction, in order to encourage students' acquisition strategies, nursing science professors must implement effective teaching techniques. Training typically aims to increase knowledge, which is insufficient in this case; as a result, skills development is a top priority (Kerner et al., 2013). While prior research emphasised the value of nurse-patient interactions in

pain management, it undervalued the impact of nurses' scientific knowledge of pain mechanisms and pharmacology. It is interesting to note that a recent study highlighted the significance of the classroom setting and instructional methods in approaching pain management in a novel manner (Teike Lüthi et al., 2015).

However, a need for a rigorous evaluation of learning strategies is crucial for best practices in nursing education (Barranquero-Herbosa et al., 2022; Njie-Carr et al., 2017). The present study provides an assessment of PBL as a model of applied learning in a flipped classroom of anesthesia nursing students in the context of a pain management course.

The main purpose of the study was to determine if the flipped classroom is more effective than traditional learning in teaching pain management by assessing students' academic performance and determine their perceptions about the flipped classroom approach. In that capacity, the research questions of the study are:

1. Is there a significant difference in students' academic performance between the traditional and flipped classroom approaches on declarative knowledge?
2. Is there a significant difference in students' academic performance between the traditional and flipped classroom approaches on conditional knowledge?
3. What are anesthesia and resuscitation nursing students' perceptions of PBL impact on the acquisition and application of pain management knowledge?
4. What are anesthesia and resuscitation nursing students' perceptions of PBL as a model for learning in pain management?

II. METHODS

A. Research Design and Samples

This study is quasi experimental, and was conducted from September at a higher institute of nursing professions. The participants are third-year anaesthesia resuscitation nursing students. Participation in the study was voluntary and anonymous. Oral consent of all participants was obtained. These participants were randomly allocated into either: The flipped classroom group where PBL was used (FG, n = 19), or the traditional lecture-based classroom group (TG, n = 19). Both classroom groups had the same professor.

B. Curriculum Description

The "pain management" course (50h) is taught during the third year of nursing studies in the institute. It is composed of three parts: the pathophysiology of pain; the evaluation of pain, and the pain management.

C. Problem Based Learning on Flipped Classroom Approach

The problem-based template was designed by the professor who teaches the course, by using small groups of 5 to 6 students. The students were the facilitators of the discussion; they meet in group work to discuss a case for an hour. The objective is to identify the type of pain or to choose the best pain assessment tool for the case. The group must then suggest a drug treatment protocol and design appropriate nursing interventions. The role of the professor was to provide immediate and specific feedback during the discussion.

All cases were written by the professor. The objectives were the acquisition of knowledge and the development of clinical reasoning. Each case contained 300 words and included key patient data. Each of these cases included information that could be analysed to provide priority elements to the discussed case.

D. Data Collection and Statistical Analyses

The results and impact of the above approach were extracted via an analysis of the summative assessment of the class group and from the questionnaire submitted to students.

1) Summative assessment (exam):

Students in both groups went through two exams: midterm exam (ME) which took place in the middle of the course in the 6th week in order to assess the students' declarative knowledge, and a final exam (FE) which took place at the end of the course, to assess conditional knowledge. The tests were graded from zero to twenty. The final score (FS) was obtained by the following equation:

$$FS=(ME+FE)/2$$

2) Questionnaire:

At the end of the course, the FG students were asked to fill out an anonymous questionnaire divided into two sections. The questions were developed in the first

section of the questionnaire to determine students' perceptions of knowledge acquisition. Elements evoked in the questionnaire were created with a language that demonstrates perceived ability and related to self-efficacy (Tune et al., 2013). The second set of items was created to determine students' perceptions of the cases used in the course. The statements began, for example, with "Participating in the group discussions made me more confident for...". Likert scale was used to measure the responses. The scale is presented as follows:

1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, and 5 = Strongly agree.

3) Statistical analyses:

Data analysis was performed using MS Excel (21), background variables of the study participants were calculated, and the results are presented as frequency distribution, percentages, mean, and standard deviation, statistical significance when $p < 0.05$.

III. RESULTS

The data that support the findings of this RCT study are openly available at

<https://doi.org/10.6084/m9.figshare.22639279>

(Merrou et al., 2023).

A. Demographics

The number of participants in the study was 38 students, 19 per group. Female students represented 79% of the study participants, whereas 21% were male.

B. Students' Grades

Based on the data obtained, statistical analysis was done to analyse the influence of the teaching approach and the type of examination on learners' results. The obtained findings have been presented in Tables 1 and 2. They indicate the average performance of learners in both exams: midterm (ME) and final exam (FE) where conditional knowledge is measured for both teaching approaches.

| Type of exam | Teaching approach | M | Sd | Inf born | Sup born | P value |
|--------------|-------------------|------|------|----------|----------|---------|
| ME | TG | 11.9 | 2.41 | 7.38 | 16.1 | <0.01 |
| | FG | 14.0 | 1.94 | 9.0 | 16.5 | |
| FE | TG | 11.9 | 3.28 | 6.09 | 16 | <0.01 |
| | FG | 14.1 | 1.96 | 10 | 16 | |

Table 1. Descriptive statistics by exam type for each teaching approach.

According to Table 1, it is noted that in the midterm exam (ME), the mean score is significantly higher

($p < 0.01$) in the FG (14.0) compared to the TG (11.9), also, with this latter, there is a slightly high standard

deviation of 2.41 which indicates scores far from the average. FG, on the other hand, dressed a lower standard deviation (1.94) which indicates that the scores are more grouped around the mean (14.0). The application of the PBL on flipped classroom approach has, as it appears, improved the grades and reduced the gap between them.

For the final exam, with the traditional approach, the dispersion increased (Sd=3.28). On the other hand, PBL approach has improved student outcomes and widened the gap between them compared to TG ($p < 0.01$). Figure 1 highlights the dispersion of the continuous and final control data (before for the traditional approach and after for PBL).

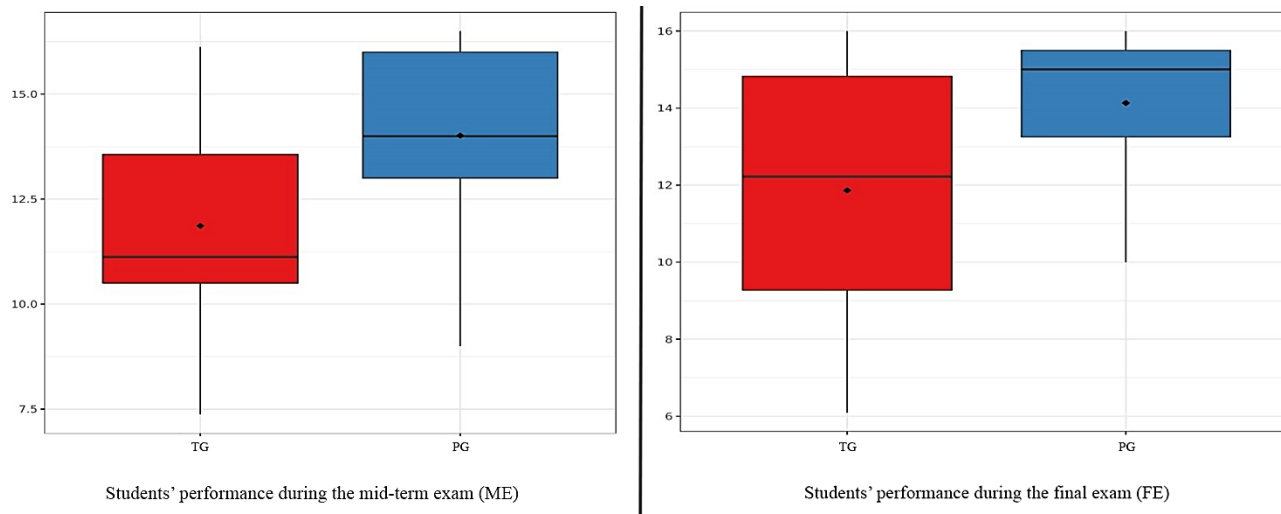


Figure 1. Students' performance during the midterm exam (ME) and final exam (FE)

The ME grades were improved using PBL. As the number of compared participants is limited, a nonparametric test was carried out (Paired Mann-Whitney test) which revealed that the average grade of MEs is significantly different ($p < 0.01$), between the traditional approach and the PBL. Similarly, an improvement in FE grades is observed when using the PBL approach. This approach allowed an improvement

in the means as well as the dispersion. This leads us to state that the teaching approach based on case studies in the context of a flipped classroom (PBL), may improve both declarative and conditional knowledge on students' outcomes.

Table 2 provides the overall averages of the grades for FG and TG regarding both approaches.

| Teaching approach | N | M | Standard deviation | Δ mean | p |
|-------------------|----|------|--------------------|---------------|------|
| TG | 19 | 11.9 | 3.30 | 2.21 | 0.01 |
| FG | 19 | 14.1 | 1.95 | | |

Table 2: Descriptive statistics by teaching approach for the different types of controls.

From Table 2, there is a difference between the averages of the two approaches in favor of FG ($p < 0.01$). This means that students who have taken the PBL approach had increased grades compared to those who have taken the traditional approach. To check if these differences are significant, a Paired Mann-Whitney test was used. This one demonstrated that the average rank of the grades is

significantly different between the two studied approaches ($p = 0.01$).

The mean score and the standard deviation for each question in the questionnaire was determined. Average responses to the 12 items that referred to acquisition and application of knowledge related to the pain management ranged from 3.8 to 4.5 (See Table 3).

| Statements | Average score (Sd) |
|---|--------------------|
| 1. I am confident in my ability to read a case and select the patient's key factors that may impact their care. | 4.3 (0.7) |
| 2. I am confident in my ability to identify the presence of pain in a given patient. | 4.1 (0.6) |
| 3. I feel confident in determining the type of pain from the etiology involved. | 4.2 (0.6) |
| 4. I feel confident in determining the type of pain from the descriptive semiology used by a patient. | 4.2 (0.7) |
| 5. I am confident in my ability to choose the right pain assessment test for a given patient. | 4.5 (0.5) |
| 6. I am confident in my ability to use pain assessment tests with a given patient. | 4.3 (0.6) |
| 7. I am confident in my ability to understand the mechanism of action of an analgesic according to its pharmacological class. | 4.1 (0.6) |
| 8. I feel confident in my ability to relate the therapeutic benefit of a drug to its mechanism of action. | 4.1 (0.5) |
| 9. I am confident in my ability to determine the oxidative, supra-additive, or sub-additive effects of painkillers. | 4.1 (0.8) |
| 10. I feel more sensitive to the importance of pain management. | 4 (0.7) |
| 11. I feel better prepared at the clinic after participating in clinical case discussions as part of the flipped classroom. | 4.1 (0.5) |
| 12. I feel better prepared to act as an advocate for my patient's interests to ensure comfort. | 3.8 (0.8) |

Table 3. Acquisition and application of knowledge

The statement "I feel better prepared to act as an advocate for my patient's interests to ensure comfort" received a

response rate of 3.8. This statement has the least satisfaction rate compared to all statements in the corresponding section.

| Statements | Average score (Sd) | P value |
|--|--------------------|---------|
| 1. The cases were relevant and interesting. | 4.7 (0.4) | |
| 2. I was nervous at the beginning of the module, but I gained confidence in myself as the course progressed. | 4.3 (0.8) | |
| 3. Participating in the group discussions made me more confident in analysing key pain-related data. | 4.1 (0.9) | Ns* |
| 4. I find that discussions have helped me learn more effectively than lectures. | 4.5 (0.6) | |
| 5. I found that the group discussions helped my learning more effectively than the manual (handout). | 4.6 (0.7) | |
| 6. I would recommend case-based seminar discussions as a tool for other courses. | 4 (0.9) | |

*mean comparison of each item

Table 4. Perception of LPLs as a teaching/learning model

Average responses to the six questionnaire items that referred to cases as a learning model ranged from 4 to 4.7. None of the average responses differed significantly ($p>0.05$) from the other responses in this section of the questionnaire. The average response to the question "Were the cases relevant and interesting?" was 4.7, which was higher than all other answers. The statement "I would recommend the PBL format (no lectures, only case studies with assigned readings) as a tool for other courses" has a response average of 4, which is lower than all other responses in the corresponding category.

IV. DISCUSSION

Nursing students must grasp intricate concepts of basic physiology, pathophysiology, pharmacology, and more. Employing effective teaching methods with active learning can foster critical thinking abilities and uphold patient safety in complex care scenarios (Dong, 2016; Forsgren et al., 2014; Wood, 2003). Nowadays, nursing education has embraced the use of the flipped classroom as it offers a rich learning environment (Dong, 2016;

Hanson, 2016; Immekus, 2019; Missildine et al., 2013; Ndosi & Newell, 2009; Peisachovich et al., 2016; Wood, 2003). Problem-based learning (PBL) is a frequently employed active learning approach in flipped classroom scenarios (Dong, 2016; Geist et al., 2015). PBL has been demonstrated to enhance the capacity of nursing students to evaluate patient information and arrive at more contemplative clinical judgments (Forsgren et al., 2014; Njie-Carr et al., 2017). When nursing students engage in discussions within small groups, they open themselves up to a wealth of interactive learning opportunities that are guided by their professor. This active learning situation is far more advantageous than the traditional lecture format as it promotes critical thinking skills and fosters independent learning. By participating in small group discussions, nursing students are able to delve deeper into the subject matter, ask questions, and engage in meaningful dialogue with their peers and instructor. This type of collaborative learning environment encourages students to take ownership of their education and empowers them to become more confident and

competent healthcare professionals. Therefore, it is crucial that nursing programs prioritise small group discussions as a key component of their curriculum (Bailey, 2017; Carvalho et al., 2017; Kong et al., 2014; Teike Lüthi et al., 2015; Wood, 2003). High-level thinking and independent learning are enhanced with the use of interactive small groups (Alton, 2016; Gholami et al., 2016). We note from a review of the literature that a limited number of studies have examined the use of PBL in nursing (Bailey, 2017; Forsgren et al., 2014).

The current study revealed that regardless of the nature of the exam, student learning outcomes significantly improved with the flipped classroom method. Furthermore, the students participating in this study consider this method as a useful model to improve their learning and be more engaging. In fact, active learning allows effective knowledge acquisition (Arrue et al., 2017) and the development of critical thinking skills on nursing students as well as the improvement of metacognitive skills (Bailey, 2017; Carvalho et al., 2017; Domínguez, 2012). Furthermore, the students participating in this study consider this method as a useful model to improve their learning and be more engaging (Schlairet et al., 2014). Consequently, alternating between lectures and PBL approach may be a better option for health science courses (Alexandre & Wright, 2013). Greater confidence is demonstrated in acquiring and applying knowledge (practice) related to pain management.

Participation in this approach was considered a positive learning strategy, regardless of course content, the flipped classroom has shown to effectively support content learning (Hanson, 2016). When students were asked to consider whether it helped them learn more effectively than lectures, a higher response was obtained, and the response was very positive. This conclusion is in line with one from a study conducted in Portugal, which found that using this method in a second-year pathophysiology course led to higher levels of student satisfaction (Marques & Correia, 2017). Although some discomfort may be reported students are uncertain about the content and will attend classes on the assumption that it will help them understand exactly what they need to do and what they hope to achieve. This result confirms that student satisfaction does not always accurately reflect their learning (Dong, 2016). Further evaluation of this strategy and other learning tools is needed to establish best practices in nursing education (Barranquero-Herbosa et al., 2022; Njie-Carr et al., 2017).

A. Limitations

The small number of participants may affect the validity of the study. The results of this study cannot be

generalised because participants belonged to one track only, so they are not representative to all nursing students. In addition, the small sample size of the study participants and the small number of available academic levels covered by the study.

B. Implications for Teaching and Future Research

Future studies could be considered to compare different learning strategies (e.g., games, medication card design, and practice problems) to determine the best practices for active learning strategies that support learning in a professional education setting and support flipped classroom learnings in nursing education.

V. CONCLUSION

Nursing education is about the development of professional skills; hence it is important to adopt active teaching strategies that promote critical thinking and knowledge transfer. However, the time constraint often pushes teachers to adopt the magistral lectures, the traditional form of knowledge delivery which mostly lacks the element of interactivity which is an issue recognised among many researchers worldwide.

The flipped classroom, in our case, is a solution to the time management problem. It allowed us to free up time in class which was beneficial to give space for interactive activities and active animation techniques such as case studies. In addition, in this study, we were able to compare the impact of the flipped classroom with the traditional model on two groups of students enrolled to the same course: pain management. The comparison results were mainly based on the acquisition of knowledge by students. We also measured students' satisfaction with the proposed model as well as their sense of self-efficacy.

Students' grades were clearly in favour of the PBL model in the flipped classroom. The students were also mostly satisfied with the proposed model and confirmed the development of their sense of self-efficacy regarding the pain management course.

Our perspective is the improvement of our teaching which, in our opinion, must be constantly corrected and enriched to face new conditions and situations. In this direction, the present study could constitute a roadmap for further in-depth studies to bring more to the PBL-based teaching model in the flipped classroom.

Notes on Contributors

Soumia Merrou is involved in the conceptualisation, methodology, data curation, writing and original draft preparation.

Abdellah Idrissi Jouicha helped in the methodology, participated in data curation and software, helped in writing – reviewing and editing.

Baslam Abdelmounaim participated in writing the original draft preparation, performed statistical analyses, helped in reviewing and editing corrections.

Zakaria Ouhaz was involved in visualisation, participated in data collection, helped writing and reviewed the manuscript.

Ahmed Rhassane El Adib was central to the conceptualisation and methodology, validated the design study, and supervised work progress. All authors have read and approved the final manuscript.

Ethical Approval

Participation in the study was voluntary and anonymous. Oral consent of all participants was obtained and the research was approved by the Institutional Ethical committee (CCBE-FSA Ref. No: ER-CS-10/2022-000).

Data Availability

The data that support the findings of this study are openly available in Figshare repository, <https://doi.org/10.6084/m9.figshare.21385446>.

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Declaration of Interest

The authors declare that they have no conflict of interest.

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