

ORIGINAL ARTICLE

Quasi-experimental study on the effectiveness of a flipped classroom for teaching adult health nursing

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Abstract

Aim: The effectiveness of flipped learning as one of the teaching methods of active learning has been left unexamined in nursing majors, compared to the frequent attempts to uncover the effectiveness of it in other disciplines. The purpose of this study was to reveal the effectiveness of flipped learning pedagogy in an adult health nursing course, controlling for other variables.

Methods: The study applied a quasi-experimental approach, comparing pre- and post-test results in learning outcomes. Included in this analysis were the records of 81 junior nursing major students. The convenience sampling method was used to select the participants. Those in the experimental group were exposed to a flipped classroom experience that was given after the completion of their traditional class. The students' learning outcomes and the level of critical thinking skills were evaluated before and after the intervention of the flipped classroom.

Results: After the flipped classroom experience, the scores of the students' achievement in subject topics and critical thinking skills, specifically intellectual integrity and creativity, showed a greater level of increase than those of their controlled counterparts. This remained true even after controlling for previous academic performance and the level of creativity.

Conclusion: This study confirmed the effectiveness of the flipped classroom as a measure of active learning by applying a quantitative approach. But, regarding the significance of the initial contribution of flipped learning in the discipline of nursing science, carrying out a more authentic experimental study could justify the impact of flipped learning pedagogy.

Key words: academic performance, adult health nursing, creativity, critical thinking, flipped learning, intellectual integrity.

INTRODUCTION

Nursing professionals have been requested to be prepared enough to take care of challenging clients (Yuan *et al.*, 2011). Lately, the acuity of patients and their comorbidity and complications have increased, along with the severity of each illness (Betihavas, Bridgman, Kornhaber, & Cross, 2016; Everly, 2013; Martyn *et al.*,

2014; Sangestani & Khatiban, 2013; Yuan *et al.*, 2011). Consequently, there has been a call for higher education in nursing science to strengthen students' ability to integrate the relevant knowledge in complicated nursing situations (Sangestani & Khatiban; Yuan *et al.*). This would enable nursing students to transit smoothly from "theoretical" to "practical" nursing. Many nursing scholars have come to the conclusion that applying active learning strategies help students to foster competencies, such as problem-solving and critical thinking skills, that are critical for a successful nursing professional (Burke, 2017; Cater, Creedy, & Sidebotham, 2016; Cheng, Liou, Tsai, & Chang, 2014; Everly).

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Active learning has been studied frequently in an effort to find an effective pedagogy, regardless of the academic field (Cater *et al.*, 2016; Park & Park, 2016). Indeed, researchers from the discipline of educational technology (Bae, 2015; Han, Im, Han, & Park, 2015; Kim, Chun, & Choi, 2014; Mcknight *et al.*, 2016; Park, 2014; Seo & Rhee, 2015) and linguistics (Jung, 2015; Kim, 2015; Lee, 2015a) have demonstrated unceasing efforts to apply an innovative teaching strategy for their lectures. Likewise, researchers in the major of nursing education have vigilantly studied the effect of active learning methods (Betihavas *et al.*, 2016; Cheng *et al.*, 2014; Choi, Lindquist, & Song, 2014; Della Ratta, 2015; Everly, 2013; Kim, Song, & Kang, 2016; Martyn *et al.*, 2014; Sangestani & Khatiban, 2013; Yuan *et al.*, 2011). Among them are case-based learning (CBL) (Layne, 2010), team-based learning (TBL), and/or problem-based learning (PBL) (Betihavas *et al.*; Cheng *et al.*; Choi *et al.*; Kim *et al.*; Martyn *et al.*; Sangestani & Khatiban; Yuan *et al.*). However, there exists only a handful of attempts in nursing education to examine the effectiveness of the pedagogies drawing on hard data (Park & Park).

Flipped learning is defined as an inverted class and it is believed to be one of the effective active learning strategies. Unlike the researchers in other fields (Bae, 2015; Han *et al.*, 2015; Jung, 2015; Kim, 2015; Kim *et al.*, 2014; Lee, 2015b; Park, 2014; Mcknight *et al.*, 2016; Seo & Rhee, 2015), researchers in nursing education have dealt mainly with TBL and PBL (Betihavas *et al.*, 2016; Cheng *et al.*, 2014; Choi *et al.*, 2014; Kim *et al.*, 2016; Martyn *et al.*, 2014; Sangestani & Khatiban, 2013; Yuan *et al.*, 2011), but flipped learning has been left unexamined. In a flipped classroom, students are first exposed to new learning materials outside of class. Also, they are expected to take online lectures and work on reading assignments at home in order to be prepared for a class that requires students' active engagement in discussion, debates, and problem-solving (Bergmann & Sams, 2012; Brame, 2013). Different from the traditional class, there is no one-sided lecture in class. The lecturers take their roles as a facilitator in class, while the students are involved in different activities and tackling assigned projects. Flipped learning has been investigated mostly in a secondary education setting (Leo & Puzio, 2016; Pearson, 2012), not higher education.

Students are believed to foster competencies that are considered to be critical for future nursing professionals by applying active learning pedagogies and, indeed, some identified positive outcomes are acquired: critical thinking, higher achievement, and significantly higher

satisfaction (Bae, 2015; Choi & Kim, 2015; Jung, 2015; Kim, 2015; Kim *et al.*, 2014; Park & Park, 2016). A couple of studies applied TBL and PBL, mostly at a women's health class, to tease out a unique pedagogical contribution as an active learning strategy (Cheng *et al.*, 2014; Sangestani & Khatiban, 2013).

However, the attempt to examine flipped learning in the discipline of nursing science is rare, although studies in many other fields have proved the positive impact of it on learning outcomes (Choi & Kim, 2015; Jung, 2015; Kim *et al.*, 2015; Lee, 2015b). To the authors' knowledge, only one study that was done by Betihavas *et al.* (2016) dealt with the topic; however, they did not move further beyond a literature review and left the work of verifying the positive relationship between flipped learning and students' academic achievement. Given that a teaching method that is effective in a certain discipline would not necessarily be the case in another, the gap existing in the topic of flipped learning warrants an experimental research design. That being said, the purpose of this study was to investigate the effect of flipped learning that was applied in a course of adult health nursing by controlling for the covariates that are relevant to students' learning outcomes.

REVIEW OF THE LITERATURE

Critical thinking

One of the most frequently used study variables in regard to the positive outcomes of an active learning strategy is critical thinking (Burke, 2017; Park *et al.*, 2016). The AACN (2007) announced that critical thinking skills are one of the core values in nursing education because they help students to integrate nursing knowledge from both clinical experience and cognitive knowledge (Burke; Choi *et al.*, 2014). Recently, patients tend to have a more complicated comorbidity. Consequently, nursing professionals need to be equipped with critical thinking skills in order to prioritize nursing problems appropriately and to integrate the symptoms of what patients present so that proper nursing care can be delivered (Betihavas *et al.*, 2016; Burke). In the studies that have modeled critical thinking skills as a learning outcome variable, the active learning strategies, TBL and PBL, has been found to promote it (Betihavas *et al.*; Burke; Choi *et al.*; Martyn *et al.*, 2014). Betihavas *et al.* believed that flipped learning would increase the level of critical thinking skills among nursing students. However, an experimental study that examines the impact of flipped learning on critical thinking skills has not been

carried out for students in the discipline of nursing science. Hence, this is the motivating point of this study.

Academic achievement

Various studies that were carried out in academic fields other than nursing science have proved the effectiveness of flipped learning on students' academic achievement (Bae, 2015; Bates and Galloway, 2012; Frydenberg, 2013; Han *et al.*, 2015; Mason, Shuman, & Cook, 2013; Murphree, 2014; Stone, 2012). The studies reported that students who are exposed to flipped learning in higher education showed either equivalent or better academic performance, compared to their counterparts in a traditional class. However, the studies in the field of nursing science did not apply the same approach thus far.

Students' academic performance

The proxy measure that taps the improvement of students' academic performance has been their grade from a college course, such as the mid-term and final grade (Geist, Larimore, Rawiszer, & Al Sager, 2015; Harrington, Bosch, Schoofs, Beel-Bates, & Anderson, 2015; Huang & Fang, 2013; Lee, 2015a). Some reported no statistical difference in the grades between the control and experimental groups (Geist *et al.*; Harrington *et al.*), while others identified a better grade for the students in a flipped classroom (Lee, 2015a; Missildine, Summers, & Gosselin, 2013). Lee reported that students with a low- or mid-level grade in the previous semester tended to show a stark increase in their academic performance after the implementation of flipped learning, compared to their counterpart high-performing students (Lee, 2015a). Similar to the report from Lee (2015a), Nieder, Stolfi, and Hudes (2005) reported that an active learning strategy, TBL, is evidently effective for the students that are academically weak. The sometimes conflicting and inconsistent findings on the effectiveness of the active learning strategy in disciplines other than nursing science provide a solid ground for the need of a similar study in nursing science; specifically, adult health nursing.

METHODS

Study design and sample

The participants of this study were 81 junior students from a nursing science major who were taking an adult health nursing course. This was a descriptive and quasi-

experimental study. In addition to a basic descriptive analysis, the study adopted a repeated-measures mean comparison as an analytic strategy, which means each participant was tested multiple times to see if there was any mean difference between the pre- and post-test scores. As a result of the ethical issue, the authors decided to compare the means from two different time points: the one after applying a traditional teaching method and the other after flipped learning.

It would have been desirable if the study had divided the selected participants into two separate classes, one for traditional pedagogy and the other for flipped learning. However, that would have caused an ethical issue by assigning a group of students to a classroom that potentially was more efficient than the traditional one, while the others were not. All the junior nursing students who registered for the adult health nursing course in 2015 were invited and those who agreed and signed the consent form were included in this study.

Instruments

The students' critical thinking skills were measured by a Critical Thinking Disposition Scale that was developed by Kwon *et al.* (2006). This is a self-administered instrument with 35 items that uses a five-point Likert scale. Theoretically, the total score ranges from 35 to 175, with a higher score indicating a higher degree of critical thinking skills and vice versa. The reliability of the instrument in the study by Kwon *et al.* was 0.89. The content validity was confirmed by five professionals that were recognized as an expert in the area. For the construct validity, the authors carried out a factor analysis: initially, 55 items were included in the analysis and 20 of them were excluded (Kwon *et al.*). The Cronbach's alpha of the measure was 0.83 in the current study.

The academic achievement of the students was measured by using a tool that was developed by the research team. Among the four research members, three were experts in adult health nursing and one in flipped learning. All of them confirmed the content validity of the tool that measured academic performance. This tool consists of 10 items with a four-point Likert Scale, ranging from 1 ("not at all") to 4 ("strongly agree"). The total score of the measure ranges from 10 to 40, with a lower score indicating a lower level of achievement and vice versa. The internal consistency of the measure was 0.86 for the study's sample. The authors also considered the students' preparedness of learning before they come to the class. The relevant items have the students answer whether they complete home assignments or not.

Procedures

An Institutional Review Board at the first author's university approved this study to be conducted. The data then were collected from March to June, 2015. The plan of research was advertised to the students ahead of time. Also, the principal investigator explained to the students the study's goals and procedures. Only the students who agreed to participate in this study were selected as participants.

First, the students were taught adult health nursing by applying a traditional lecture-oriented class for the first half of the semester. After that, the students were asked to answer the survey questionnaire that measured critical thinking skills and content knowledge. The second half of the semester applied the flipped learning method and the students were asked to respond to the same instruments. A notice was given to the students that they had the right to not answer the questionnaires or they could be dropped from this study. The principal investigator assured the students that dropping out of this study would not affect their grades at all.

During the second half of this study period (flipped classroom), the students had to complete outside class activities before they came to a class: sometimes, they had to do reading assignments (preview of the textbook and other reading materials), watch video clips, animations (usually illness scenarios), or live demonstrations of procedures or nursing care. When they came to class, they had to complete a diagnostic test: it could be either individual or group tests. In addition to this, the students frequently were asked to participate in group discussions and presentations: the total amount of participants was broken down into seven groups and each group consisted of five-to-six students; thus, small-group discussions and activities were possible. A short wrapping-up lecture was given by the instructor at the end of in-class activities. Every other week, they would do a post-test at the end of the class activity (Table 1).

Data analyses

The data were analyzed by using STATA v. 13.0 (StataCorp, 2013). Descriptive statistics were used to analyze the students' demographic characteristics and the scale of dependent variables accordingly. To compare the scores of the students' achievement and the level of critical thinking before and after the implementation of flipped learning, the paired sample *t*-test was applied. A factor analysis was used to construct the variable of critical thinking, drawing on the relevant survey items. At the last stage, a regression

analysis was done to find out whether the flipped learning pedagogy survived as a statistically significant variable after controlling for the other relevant variables that were associated with the students' academic performance. A G*Power (v. 3.0.10; Heinrich-Heine University Dusseldorf, Germany) analysis was used to estimate the study's sample size: two-tailed, effect size of 0.27, alpha error probability of 0.05, and a study power of 0.8 were computed to estimate the sample size.

RESULTS

Demographic characteristics

The mean age of the study's participants was 22.1 years, with a standard deviation of 0.89. There were 71 female students, while nine male students participated. As a result of the nature of the nursing major, not many male nursing students were found at the college of nursing. The participants' grade point averages (GPAs) were normally distributed, as described in Table 2 (skewness: -0.26; kurtosis: 0.24). With regard to the students' competency in English, half of them answered as middle (58%) and 40.7% as low. The students that were involved previously in discussion in class were 45.7%, which means that 54.3% of them have not experienced it in the class (see Table 2).

Effect of flipped learning on the students' critical thinking and achievement

The mean score of critical thinking that was measured after the traditional class was 114.827, while the one after flipped learning was applied was 117.80. Likewise, the average score of the students' academic achievement that was measured after the traditional class was 24.12, while the one that was measured after the implementation of flipped learning was 25.63. The mean difference in critical thinking and the students' achievement that were measured on completion of the traditional and flipped learning revealed a statistically significant difference: $P = 0.003$ ($t = 3.114$) ($t = 3.114$) for the mean difference of critical thinking and $P = 0.005$ ($t = 3.114$) ($t = 2.892$) for the mean difference of the students' academic achievement (see Table 3).

Factor analysis of critical thinking

In order to confirm the construct validity, a confirmatory factor analysis (CFA) was done for the measure of critical

Table 1 The processes of the experimental study

	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10
Advertisement of the study to recruit participants and sample selection	↑									
Survey was done to secure homogeneity of students		↑								
Traditional classes: control group was taught in a traditional way			↑							
Survey was done to measure students' critical thinking skill and academic achievement				↑						
Pretest of each class was done; reading assignments; watch video clips					↑					
Flipped classes: experimental group was taught by applying flipped learning (discussion, brain storms, case study on scenarios, etc.)						↑				
Brief lectures were given by lecturers and posttests of each class were done							↑			
Survey was done on critical thinking skill and academic achievement								↑		
Data cleaning and analysis were done									↑	

During classes: group (5–6 students) discussion, presentation, and activities (i.e., Team Based Learning, Case Based Learning).
After each class: posttest; a short wrapping up lecture given by lecturers.

Table 2 Descriptive analysis of the participants ($n = 81$)

SexN (%)		Age (years) Mean	Accumulated GPA		Previous AHI grade		English level		Discussion experience	
Male	Female		Score	N (%)	Grade	N (%)	Level	N (%)	Yes	No
9 (11.1)	71 (88.9)	22.1	<2.5	5 (6.2)	A	14 (17.3)	High	1 (1.2)	37 (45.7)	44 (54.3)
			>2.5	19 (23.5)	B	33 (40.7)	Middle	47 (58)		
			<3.0	37 (45.7)	C	33 (40.7)	Low	33 (40.7)		
			>3.0	20 (24.7)	D	1 (1.2)	–	–		
			<3.5	–	–	–	–	–		
			>3.5	–	–	–	–	–		

AHI, adult health and illness; GPA, grade point average.

Table 3 Effect of flipped learning on academic achievement and critical thinking

Variable	Means		MD	SD	SE	95% CI		<i>t</i> -Value	<i>P</i> -value
	Pre	Post							
Academic achievement	24.123	25.630	1.506	4.354	0.484	2.469	0.554	3.114	0.003
Critical thinking	114.827	117.803	2.975	9.260	1.029	5.023	0.928	2.892	0.005

CI, confidence interval; MD, mean difference; Pre and Post, students' critical thinking skills and academic achievement scores before and after the implementation of flipped learning; SD, standard deviation; SE, standard error.

thinking skills. The authors extracted two constructs that constituted the critical thinking skills from the CFA (refer to Fig. 1 and Table 4 for the scree plot and uniqueness, respectively), “intellectual integrity” and “creativity.” Considering the result of the CFA, the two relevant subscales, intellectual integrity and creativity, were created and analyzed in order to see if these subscales changed after the implementation of flipped learning. According to the results of the analysis, the intellectual integrity and creativity were significantly improved after the implementation of flipped learning; the average scores of intellectual integrity and creativity that were measured before and after flipped learning were 3.418 and 3.532 for

intellectual integrity, respectively ($P < 0.01$) and 2.956 and 3.069 for creativity, respectively ($P < 0.05$) (see Table 5).

Variables affecting the students' academic achievement after flipped learning

The final stage of the analysis attempted to explain the variables that were associated with the students' academic achievement by conducting a regression analysis. The level of the students' academic achievement, the dependent variable of the regression model, was measured after the implementation of flipped learning. The independent variables that were modeled in this study were previous academic achievement (immediate previous-term GPA), demographic characteristics (sex and age), personal characteristics (intellectual integrity, creativity), class preparation and participation, and students' proficiency level of English.

First, the regression model explained 20% of all the variance that existed in the dependent variable of academic achievement ($R^2 = 0.203$). Looking at the specific predictors, the students' academic achievement was found to be significantly associated with the level of students' previous achievement, as measured by the cumulated GPA at $P < 0.05$. The score of creativity also showed a positive association with the dependent variable ($P < 0.01$). The students' demographic variables were found to not be associated with their academic achievement: $P = 0.468$ for the variable of male

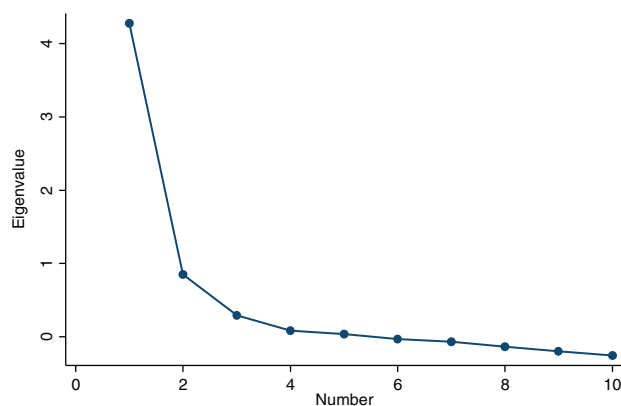
**Figure 1** Scree plot of the Eigenvalues after the factor.

Table 4 Uniqueness of the two factors from the academic achievement measure

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Uniqueness
Achieve_1	0.830	–	–	–	–	0.296
Achieve_2	0.822	–	–	–	–	0.290
Achieve_3	0.746	–	–	–	–	0.369
Achieve_4	0.527	–	–	–	–	0.601
Achieve_5	0.719	–	–	–	–	0.423
Achieve_6	0.720	–	–	–	–	0.437
Achieve_7	0.645	–	–	–	–	0.487
Achieve_8	0.713	–	–	–	–	0.387
Achieve_9	–	0.591	–	–	–	0.580
Achieve_10	–	0.574	–	–	–	0.580

Table 5 Effect of flipped learning on intellectual integrity and creativity ($n = 81$)

Variable	Means		MD	SD	SE	95% CI		<i>t</i> -Value	<i>P</i> -value
	Pre	Post							
Intellectual integrity	3.418	3.532	0.114	0.045	0.043	0.025	0.203	2.555	0.006
Creativity	2.956	3.069	0.114	0.508	0.056	0.001	0.226	2.013	0.024

CI, confidence interval; Creativity, the measure of creativity before and after the implementation of flipped learning; MD, mean difference; Pre and Post, the measure of intellectual integrity before and after the implementation of flipped learning; SD, standard deviation; SE, standard error.

Table 6 Variables affecting the students' achievement after flipped learning

Achievement	SE	<i>t</i> -Value	<i>P</i> -value	β	95% CI	
GPA	0.047	2.170	0.033	0.231	0.008	0.008
Sex	0.170	–0.730	0.468	–0.101	0.464	0.464
Age	0.060	1.750	0.084	0.239	0.015	0.015
Int. integ.	0.097	0.790	0.431	0.086	0.116	0.116
Creativity	0.065	3.010	0.004	0.319	0.066	0.066
Class prep.	0.038	–0.240	0.811	–0.025	0.084	0.084
Diss. exp.	0.871	–0.669	0.506	–0.075	–2.316	1.151
English level	0.840	–1.122	0.265	–0.125	–2.616	0.730

Probability > *F*-value = 0.0085; $R^2 = 0.203$.

CI, confidence interval; Class prep., class preparation and participation; Diss. exp., discussion experience; GPA, grade point average; Int. integ., intellectual integrity; SE, standard error.

and $P = 0.084$ for age. The other predictors were found to not be related to the dependent variable (see Table 6).

DISCUSSION

The study tried to fill the gap that exists in the extant body of literature in the discipline of nursing science and the result of the analysis identified a positive impact of flipped learning on students' cognitive skill and academic performance. The relationship between flipped learning and academic performance has been broadly examined in other academic fields, but not in nursing science (Choi & Kim, 2015; Kim, 2015; Lee, 2015a; Mason *et al.*, 2013). This study disclosed that the

academic performance of the students, in terms of both the content knowledge and cognitive skills, increased after they experienced a flipped classroom. This was especially true for the students with high GPAs and cognitive skills. However, there exist studies that have reported a contradicting finding: those students with a low level (50% increase in the students' achievement) to mid-level (25% increase in the students' achievement) GPA saw a greater degree of growth in their academic achievement (Lee, 2015a; Nieder *et al.*, 2005). It is difficult to pinpoint one definite reason for the inconsistent results, which serves as a good rationale to repeat the current study.

In the discipline of nursing science, critical thinking has been a main interest as the outcome of higher education and many studies have tried to examine the effect

of an innovative pedagogy in an effort to foster the skill. Now, there is ample evidence that an active learning approach is positively associated with critical thinking skills (Burke, 2017; Choi *et al.*, 2014; Layne *et al.*, 2010; Martyn *et al.*, 2014; Van Vliet, Winnips, & Brouwer, 2015). Yet, most of them tried to examine the effectiveness of PBL, TBL (Choi *et al.*; Martyn *et al.*; Van Vliet *et al.*), and CBL (Layne *et al.*, 2010), but left flipped learning to be studied in the discipline of nursing science. The result of the current study revealed that flipped learning that was applied in an adult health nursing course, among the different active learning pedagogies, was a statistically significant predictor that contributed to promoting critical thinking skills.

Reviewing the activities that the students have gone through during the semester, the students' academic achievement is scored. As an illustration, a group discussion on a clinical scenario does not require one definite answer. Rather, it is opened to several possibilities that require more innovative and groundbreaking answers. Therefore, theoretically, a group of students that provides more creative answers will receive a higher grade than the others. All the different activities in the class will allow the students to sharpen their cognitive skill of creativity, which is associated, in turn, with a higher academic achievement, which other extant studies also have identified (Burke, 2017; Choi *et al.*, 2014; Layne *et al.*, 2010; Martyn *et al.*, 2014; Van Vliet *et al.*, 2015). The results of this study provide the nursing science discipline with a good reason to diversify the nursing science education in terms of applying effective pedagogies. Traditionally, nursing education has been greatly dependent on lecturing to deliver nursing knowledge due to many practical reasons (Ilic & Maloney, 2014). Indeed, combining different teaching methods can be burdensome for faculty members in the field because of a limited amount of time in delivering such a wide breadth of content. However, an increasing number of studies, including the current study, has reported the benefits of applying various teaching methods, rather than solely depending on the traditional teaching method, lecturing (Bodine & Miller, 2017; Cooper, 2016). Some of the components of an active teaching strategy were used in the current study and the result of this study disclosed a positive impact on learning outcomes by small-group discussion, a preview of the learning content via video clips and reading materials, brainstorming, and case studies on a given scenario (Bodine & Miller; Cooper). This might suggest the need for a serious conversation on reconsidering the overall structure or curriculum of nursing education.

Limitations of the current study and future directions

Although the current study has its unique contribution to the field of nursing science, some limitations need to be clearly stated. First, the analytic method that was applied in this study, repeated-measures mean comparison, is a method that can be questioned regarding the natural growth in a cognitive skill. As stated previously, the current study could not form a true experimental study because of the ethical issue. The lecturer could not force a group of students into a traditional class that could be potentially less effective than a flipped counterpart. A future study would be able to apply a different analytic strategy, such as difference in difference, that is free from the concern for the natural growth issue. However, it does not mean that the result from a repeated-measures mean comparison is not scientific. In spite of its obvious limitations, it has been used widely to examine a statistically significant increase in cognitive skills in psychometrics (StataCorp, 2015, p. 2750). In that regards, the current study could serve as a good starting point for further research as it has identified a positive contribution to learning outcomes.

In addition, a possible bias in the sample selection needs to be mentioned. The participants of this study were recruited from a university that was located in a city of a local province and the sample size was relatively small. Therefore, a further study needs to be done to generalize the findings of the current study with a larger sample and randomized controlled trial.

Also, there was no measurement tool that was available to measure the concept of "academic achievement." For future study, a concept analysis on academic achievement should be done after delivering nursing education by applying flipped learning. Developing a reliable measure of academic achievement requires psychometric testing and the newly developed tool would serve as a solid ground for future studies.

CONCLUSION

This study was the first experimental study that examines the effectiveness of flipped learning that is applied in an adult health course in the discipline of nursing science. As in other academic fields, the current study found that flipped learning increased the students' academic achievement and cognitive skills. A simple repeated-measures *t*-test and regression analysis uncovered that academic achievement and critical thinking

skills were changed after the implementation of flipped learning and that the change was within the boundary of statistical significance. Future studies with a sufficiently large number of participants from random sampling could be conducted by applying a more rigorous analytic strategy, such as difference in difference, to sort out a unique contribution of flipped learning to students' learning outcomes. Although there are the existence of some limitations, this study fills the gaps that exist in the extant body of literature regarding flipped learning.

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CONFLICTS OF INTEREST

No conflict of interest has been declared by the authors.

AUTHOR CONTRIBUTIONS

Study design, E. O. P., and J. P.; data collection, E. O. P.; data analysis, J. P.; and manuscript preparation, E. O. P., and J. P.

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