THE EFFECT OF PROBLEM- BASED LEARNING STRATEGY ON NURSING STUDENT'S PROBLEM- SOLVING ABILITIES

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ABSTRACT

Background: Problem-Based Learning (PBL) empowers students to be more accountable in their learning process. Aim of the study: to assess the effect of PBL strategies on nursing student's problem solving (PS) abilities at the technical institute of nursing. Subjects and methods: A one group pre-test - post-test quasi-experimental design was carried out at Al-zahra Technical Institute of Nursing affiliated to Al Azhar University. The sample included all 83 nursing students enrolled in the fifth year during the academic year (2017/2018). Two tools were used in data collection, namely, a self-administered questionnaire to assess basic and applied knowledge of PBL and PS, also skills of problem-solving and an observation checklist for group performance in PBL. The researcher designed a PBL program and implemented it in 12 small group sessions. The effectiveness of the intervention was measured by an immediate post-test, and a 3-month follow-up assessment. Results: Students' age ranged between 19 and 20 years. Satisfactory total knowledge increased from 2.4% before the intervention to 100.0% after, and 94.0% at follow-up (p<0.001). None of the students had an adequate practice of PS before the intervention compared with 100.0% at the post- and follow-up phases (p<0.001). None of the students was able of PS by tutor evaluation before the intervention, compared with 49.4% at the post- and 100% at follow-up (p<0.001). Group performance scores had significant positive correlations with the knowledge and practice scores. In multivariate analysis, the study intervention was the main positive predictor of the knowledge, practice, and tutor evaluation scores. Conclusion: Implementing a PBL strategy for nursing students is effective in improving their PS abilities as well as their performance in BPL as evidenced by tutor evaluation. Hence, nurse educators must increasingly introduce this approach for their students. Recommendations: The study recommends more use of the PS education approach and PBL strategy in all nursing curricula; course planners need training in developing educational problems and identify the barriers to PBL implementation.

KEYWORDS: Problem-Based Learning, Strategy, Problem-Solving Abilities, Nursing Student

INTRODUCTION

Today's information community expects nursing graduates to be able to efficiently solve patients' problems and to confidently make a clinical decision *(Currey et al, 2015)*. Nursing education programs share the goal of preparing competent graduates who will successfully make the transition to the world of professional practice. One essential way to meet these demands engage in continuing professional education through best planned and managed learning process *(Al-*

Naggar and Bobryshev, 2012). Currently, nursing education is witnessing an emphasis on the development of self-directed learning and critical thinking through the application of innovative learning approaches as Problem-Based Learning (PBL) *(Demirel and Dagyar, 2016)*. In this approach, students are typically confronted with healthcare problems as stimuli for learning. A multi-stage process is used in small group tutorials to develop students reasoning skills, promote the learning of basic science, in a clinically useful way, develop independent learning skills, and motivate learning *(Gijselaers, 2015)*. It is a motivating, challenging, and enjoyable learning approach *(Ghosh and Sobek, 2015)*, and more than pedagogy, it is a curriculum *(Amoako-Sakyi and Amonoo-Kuofi, 2015)*. Students actively participate and use skills of inquiry and critical thinking as well as peer teaching and peer evaluation *(Csapo and Funke. 2017)*. Moreover, Problem Solving (PS) ability is considered a prerequisite to nurses' professional practice *(Ibrahim and Al-Shahrani, 2018)*. It is the production and attainment of the various potentially effective alternatives in order to cope with the problem and increasing the probability of choosing the most effective one among these alternatives. With the nurses and midwives using the problem-solving skills effectively, both the professionalization of the occupation will be contributed and the quality of the patient care will be improved *(Ancel, 2016)*. Nursing education must raise the PS skills of nurses through the application of the "nursing process" education as scientific PS *(Bayindir and Olgun, 2015)*. Therefore, nurse educators must use innovative teaching strategies such as PBL and PS.

Significant of the Study

The complexity of today's society is characterized by an infinite, dynamic and changing mass of information, these rapid changing labor market demanding a more flexible labor force that is directed toward a growing proportion of knowledge-intensive work in a team and lifelong learning. As a consequence, today's information community expects nursing graduates not only to have a specific knowledge base but also to be able to apply this knowledge to solve complex patients' problems in an efficient way and to further develop their ability to plan, communicate, teach, and make clinical decisions with confidence. Moreover, the core of nursing education is to help students to apply knowledge from nursing and other disciplines in making independence decisions and solve the problems in nursing practice situations. Problem-based learning addresses all of these, as students acquire problem-solving skills while critically analyzing problems posed to them in a collaborative setting.

Aim of the Study

The aim of this study was to investigate the effects of implementing a PBL strategy for technical institute nursing students on their PS abilities. The research hypothesis was that students' knowledge and practice will be improved after the implementation of the strategy.

SUBJECTS AND METHODS

Research Design and Setting

A one group pre-test – the post-test quasi-experimental design was used to carry out this study at *Al-zahra* Technical Institute of Nursing affiliated to Al Azhar University and located in Al zahra hospital. The main objective of the Institute is to prepare technical staff with a high level of scientific knowledge and skills to be applied in providing high-quality care to individuals, families, and communities through a 5-year nursing academic program.

Subjects

The study involved all 83 nursing students enrolled in the fifth year at the *setting* during the academic year (2017/2018). This sample size was large enough to demonstrate an improvement in students' PS knowledge and skills with a Relative Risk (RR) 1.5 from a baseline 50% at 95% level of confidence, 80% power, and accounting for an expected dropout rate of 15%.

Data Collection Tools

Two different tools were used in data collection, namely a self-administered questionnaire, and an observation checklist for group performance in PBL

Self-Administered Questionnaire

This tool was developed by the researcher based on *Lipe (2004)*, *Osman (2010)*, and *Ali (2015)*. It consisted of four parts. The first was for the collection of student's demographic data as well as some information about the academic achievement, problem-solving awareness, previous related study, and use in the study and personal life. The second part was for assessing student's PS applied knowledge and steps. It comprised 38 True/False items categorized into six dimensions: the study of the problem, solving the problem, psychological treatment of the problem, use of previous experience, dealing positively with the problem, and denial of the problem. Each correct response was scored 1 and the incorrect zero. The scores of the items were summed-up, and the total divided by the number of the items giving a mean score for each dimension and for the total scale. These scores were converted into percent scores, and means and standard deviations were computed. Student's knowledge was considered satisfactory if the percent score was 60% or higher and unsatisfactory if less than 60%. For the knowledge of the sequence of PS steps the student was asked to arrange the seven steps in the correct order. The knowledge was considered satisfactory if all steps were correctly arranged. The third part was a PBL knowledge questionnaire. It included 7 multiple choice questions covering PBL definition, effectiveness, teacher role, steps, process, benefits, and negative aspects, 3 True/False questions for the roles of the leader, recorder, and facilitator in PBL, one questions for PBL steps sequence arrangement, and one open-end question for the main skills learned in PBL. The scoring was the same as for the second part. The fourth part was for assessing the practice of PS skills by students through the use of a simulated case study based on *Osman (2010)* and *Ali (2015)*. The case study was followed by a list of 53 True/False questions covering the six steps of PS: problem identification, determination of the needed information, setting objectives based on information, setting a plan based on objectives, approach to the application of the plan, and setting success indicators. The scoring was the same as for the second part, but the ability to practice PS was considered adequate if the percent score was 60% or higher and inadequate if less than 60%.

Observation Checklist (Appendix 2)

This tool was developed by the researcher based on *Osman (2010)*, *Badrawy (2012)*, *Abdou (2013)*, and *Meshely (2016)*. It consists of two parts; part1 for individual student performance, and part2 for group performance. The first part was used by the tutor to evaluate individual student's application of PBL in the group session. It comprised of 47 items checked on 3-point Likert: "able; somewhat able; unable" categorized into five dimensions: application of knowledge, decision-making skills, self-directing learning, team-work, and communication skills. For scoring, the items checked able, somewhat able, and unable were checked 2, 1, and 0 respectively. The scores of the items were summed-up for each

category and for the total scale, and the total divided by the number of the items giving a mean score. These scores were converted into percent scores, and means and standard deviations were computed. The students was considered able to apply PBL if the percent score was 60% or higher and unable if less than 60%. The second part was used by the researcher to evaluate group performance during PBL sessions. It involved eight statements covering members' participation, listening to others, encouraging each other, task assignment, trust and cooperation, and accepting criticism. The statements were checked on a Likert-type rating scale "Major Difficulty, Needs Improvement, Good, Very Good, and Excellent. The items checked from "Major Difficulty" to "Excellent" were checked from 0 to 4 respectively. The scores of the items were summed-up and the total divided by the number of the items giving a mean score. It was converted into a percent score, and means and standard deviations were computed. The group performance was considered adequate if the percent score was 60% or higher and inadequate if less than 60%. The tools were face and content validated by a jury group consisting of five experts in the field of nursing administration from the Faculties of Nursing at Ain-shams and Cairo Universities. Modifications and rephrasing were done based on their opinions. A pilot study was conducted on eight students. These students were included in the main study sample since no major changes were done in the tools. The reliability of the tutor evaluation checklist was evaluated and had Cronbach's Alpha coefficient 0.701.

Field Work

The fieldwork of this study was performed in the period from February to August 2018 through assessment, planning, implementation, and evaluation phases.

Assessment Phase

Permissions were secured, and the finalized tools were handed to participating students for pre-testing their knowledge and skills in PS, and their knowledge about PBL. They were asked to fill the forms in the presence of the researcher. These constituted the baseline pre-test data.

Planning Phase

The researcher developed the content of the training program based on the pertinent literature, and guided by the results of the assessment phase. It consisted of two main parts. The first theoretical part covered knowledge, while the second part was practical in the form of giving scenarios for students about major managerial skills such as applying principles and skills of effective communication and applying time management process and strategies for optimal use of time. The researcher developed five scenarios covering the topics of communication, time management, leadership, team building, and decision-making to be used to apply PS skills following its six steps. This phase also involved training of the staff who will help in the implementation of the PBL sessions as tutors. These consisted of five demonstrators from Al-Zahra Technical Institute of Nursing. The training was administered in five 4-hour duration sessions.

Implementation Phase

The designed program was implemented through 13 sessions. The total duration of the sessions was 18 hours, 8 hours for theory, and 10 hours of practices. The teaching methods included lectures, group discussion, and practice sessions included role-play, group activities, and brainstorming. The teaching media included power-point, data-show, whiteboard, and handouts. The students were then randomly divided into 10 groups. In the first week, each group member was assigned to one of the following roles; a leader, a recorder, facilitator. The leader was responsible for designing tasks

to develop the learning outcomes appropriate to the target learner group. The recorder was responsible for recording the research responsibilities delegated to members during the first meeting. The facilitator was responsible for keeping the discussion going and ensuring that all members participate in team discussions. Each group was mentored by an assistant tutor trained in PBL. Additionally, the researcher acted as a floating facilitator for all groups.

Evaluation Phase

A post-test was done at the end of the program implementation using the same pre-test tools. Additionally, the application of the PBL process by the nursing students was evaluated by the researcher using the related forms for the individual student and group performance. A follow-up assessment was undertaken three months after implementing the program using the same evaluation tools and procedures.

Administrative and Ethical Considerations

The Ethics Committee of the Al-Zahra Technical Institute of Nursing, Al-Azhar University, approved the study proposal. Official permissions to conduct the study were secured from pertinent authorities. All participants gave their written consent to participate in the study. They were informed about the study purpose and about their rights to refuse or withdraw at any time without giving reasons. Confidentiality of any obtained information was ascertained.

Statistical Analysis

Data entry and statistical analysis were done using SPSS 20.0 statistical software package. Cronbach alpha coefficient was calculated to assess the reliability of the developed scale through its internal consistency. Qualitative categorical variables were compared using the chi-square test. Spearman rank correlation was used for assessment of the inter-relationships among quantitative variables and ranked ones. In order to identify the independent predictors of the knowledge and practice scores, multiple linear regression analysis was used and analysis of variance for the full regression models was done. Statistical significance was considered at p-value <0.05.

RESULTS AND DISCUSSIONS

The study sample consisted of 83 nursing students whose age ranged between 19 and 20 years as shown in Table 1. The great majority were singles (92.8%). Their median GPA (Grade Point Average) was 88.0 and ranged between 60 and 99. Only 3 (3.6%) of them reported having had a previous academic failure. Table 2 shows that nursing students' knowledge of Problem Solving (PS) was low in the pre-intervention phase. Statistically significant improvements were revealed at the post and follow-up phases of the intervention ($p<0.001$). Thus, only 13.3% of the nursing students had satisfactory knowledge of applied PS before the intervention. This increased to 97.6% at the post-intervention phase and slightly declined to 84.3% at the follow-up phase ($p<0.001$). In total, only 2 (2.4%) of the nursing students had total satisfactory knowledge before the intervention. Statistically significant improvements were demonstrated at the post-intervention reaching 100.0% ($p<0.001$). A very slight decline was found at the follow-up phase (94.0%), but the level was still significantly higher compared with the pre-intervention level ($p<0.001$). Concerning the practice of problem-solving using problem-based learning among the nursing students in the study sample, Table 3 shows high deficiency at the pre-intervention phase. The percentages of adequate practice ranged between 1.2% for defining objectives and 32.5% for plan application. Statistically significant improvements were revealed at the post and follow-up phases of the intervention ($p<0.001$) in all areas of practice, reaching 100.0% adequacy in most of them. In total, none of the nursing students had an

adequate practice of PS before the intervention compared with 100.0% at both post-intervention and follow-up phases. The improvements were statistically significant (p<0.001).

As regards tutor evaluation of the practice of nursing students, Table 4 indicates that none of them was found to be able to apply knowledge, demonstrate decision-making skills, self-learning, or teamwork before the intervention. At the post-intervention phase, there were slight but statistically significant improvements in all areas (p<0.001). The improvements continued through the follow-up phase reaching 100% in almost all steps, with statistically significant differences (p<0.001). In total, none of the nursing students in the study sample was considered able of problem-solving by tutor evaluation before the intervention. This rose to 49.4% at the post-intervention phase and reached 100% at the follow-up phase. These improvements were statistically significant (p<0.001). Table 5 demonstrates a statistically significant strong positive correlation between nursing students' scores of knowledge and practice (r=0.907). Meanwhile, moderate positive correlations were revealed between the scores of tutor evaluation and students' practice and knowledge scores. As displayed in Table 6, nursing students' practice scores had a statistically significant weak positive correlation with their GPA (r=0.184). In multivariate analysis (Table 7), the study intervention was identified as the main statistically significant independent positive predictor of nursing students' knowledge score, in addition to their GPA. Conversely, their previous academic failure was a negative predictor. The model explains 79% of the variation in the knowledge score. As for nursing students' practice score, the study intervention was its main statistically, significant independent positive predictor, in addition to their knowledge score, GPA, and previous academic failure. The model explains 94% of the variation in the practice score. Concerning the score of tutor evaluation of nursing students' practice, the table indicates that the study intervention was its only statistically significant independent positive predictor. It explains 80% of the variation in this score.

FIGURES AND TABLES

Table 1: Personal Characteristics of Nursing Students in the Study Sample (N= 83)

Items	Frequency	Percent
Age:		
19	51	61.4
20	32	38.6
Range	19.0-20.0	
Mean ± SD	19.4±0.5	
Median	19.0	
Marital status:		
Single	77	92.8
Married	6	7.2
GPA (%):		
<75	7	8.4
75-	16	19.3
85+	60	72.3
Range	60.0-99.0	
Mean ± SD	86.4±8.4	
Median	88.0	
Previous academic failure:		
No	80	96.4
Yes	3	3.6

Table 2: Knowledge of Problem Solving (Ps) and Problem –Based Learning (PBL) Among Nursing Students throughout the Intervention Phase

Knowledge	Phases						X^2 (P-Value) Pre-Post	X^2 (P-Value) Pre-FU
	Pre (n=83)		Post (n=83)		FU (n=83)			
	No.	%	No.	%	No.	%		
Applied PS:								
Satisfactory	11	13.3	81	97.6	70	84.3	119.48	83.93
Unsatisfactory	72	86.7	2	2.4	13	15.7	(<0.001*)	(<0.001*)
Steps arrangement:								
Satisfactory	2	2.4	83	100.0	83	100.0	158.19	158.19
Unsatisfactory	81	97.6	0	0.0	0	0.0	(<0.001*)	(<0.001*)
PBL:								
Satisfactory	3	3.6	83	100.0	63	75.9	154.42	90.55
Unsatisfactory	80	96.4	0	0.0	20	24.1	(<0.001*)	(<0.001*)
Total knowledge:								
Satisfactory	2	2.4	83	100.0	78	94.0	158.19	139.36
Unsatisfactory	81	97.6	0	0.0	5	6.0	(<0.001*)	(<0.001*)

(*) Statistically significant at p<0.05

Table 3: Skills of Problem-Solving among Nursing Students throughout the Intervention Phases

Problem Solving Skills	Phases						X^2 (P-Value) Pre-Post	X^2 (P-Value) Pre-Fu
	Pre (n=83)		Post (n=83)		FU (n=83)			
	No.	%	No.	%	No.	%		
Problem identification:								
Adequate	14	16.9	83	100.0	83	100.0	118.08	118.08
Inadequate	69	83.1	0	0.0	0	0.0	(<0.001*)	(<0.001*)
Information needed:								
Adequate	2	2.4	82	98.8	83	100.0	154.24	158.19
Inadequate	81	97.6	1	1.2	0	0.0	(<0.001*)	(<0.001*)
Defining objectives:								
Adequate	1	1.2	83	100.0	83	100.0	162.05	162.05
Inadequate	82	98.8	0	0.0	0	0.0	(<0.001*)	(<0.001*)
Problem solving plan:								
Adequate	12	14.5	83	100.0	82	98.8	124.06	120.18
Inadequate	71	85.5	0	0.0	1	1.2	(<0.001*)	(<0.001*)
Plan application:								
Adequate	27	32.5	83	100.0	83	100.0	84.51	84.51
Inadequate	56	67.5	0	0.0	0	0.0	(<0.001*)	(<0.001*)
Indicators of success;								
Adequate	6	7.2	83	100.0	83	100.0	143.62	143.62
Inadequate	77	92.8	0	0.0	0	0.0	(<0.001*)	(<0.001*)
Total practice:								
Adequate	0	0.0	83	100.0	83	100.0	166.00	166.00
Inadequate	83	100.0	0	0.0	0	0.0	(<0.001*)	(<0.001*)

(*) Statistically significant at p<0.05

**Table 4: Tutor Evaluation of the Skill of Problem-Solving Among Nursing Students throughout
the Intervention Phases**

Problem Solving Skills	Phases						X^2 (P-Value) Pre-Post	X^2 (P-Value) Pre-Fu
	Pre (n=83)		Post (n=83)		FU (n=83)			
	No.	%	No.	%	No.	%		
Application of knowledge:								
Able	0	0.0	25	30.1	83	100.0	29.43	166.00
Unable	83	100.0	58	69.9	0	0.0	(<0.001*)	(<0.001*)
Decision-making skills:								
Able	0	0.0	46	55.4	83	100.0	63.63	166.00
Unable	83	100.0	37	44.6	0	0.0	(<0.001*)	(<0.001*)
Self-learning:								
Able	0	0.0	43	51.8	83	100.0	58.03	166.00
Unable	83	100.0	40	48.2	0	0.0	(<0.001*)	(<0.001*)
Teamwork:								
Able	0	0.0	59	71.1	83	100.0	91.53	166.00
Unable	83	100.0	24	28.9	0	0.0	(<0.001*)	(<0.001*)
Communication skills:								
Able	4	4.8	53	63.9	82	98.8	64.15	146.79
Unable	79	95.2	30	36.1	1	1.2	(<0.001*)	(<0.001*)
Total evaluation:								
Able	0	0.0	41	49.4	83	100.0	0.00	65.56
Unable	83	100.0	42	50.6	0	0.0	(1.00)	(<0.001*)

(*) Statistically significant at p<0.05

Table 5: Correlation Matrix of Students' Knowledge, Skill, and Evaluation Scores

Scores	Spearman's Rank Correlation Coefficient		
	Knowledge	Practice	Tutor Evaluation
Knowledge			
Practice	.907**		
Tutor evaluation	.431**	.451**	

(**) Statistically significant at p<0.01

Table 6: Correlation between Student's knowledge, Skills and Evaluation Scores and their Characteristics

	Spearman's Rank Correlation Coefficient		
	Knowledge	Practice	Tutor Evaluation
Age	.003	-.010	-.041
GPA	.121	.184**	-.027
Computer skills	-.011	.043	.008

(**) Statistically significant at p<0.01

Table 7: Best Fitting Multiple Linear Regression Model for the Total Knowledge and Skills and Evaluation Scores

	Unstandardized Coefficients		Standardized Coefficients	T-Test	P-Value	95% Confidence Interval For B	
	B	Std. Error				Lower	Upper
Knowledge Score							
Constant	11.99	7.29		1.644	0.101	-2.37	26.36
Intervention	42.44	1.42	0.88	29.991	<0.001	39.66	45.23
GPA	0.30	0.08	0.11	3.595	<0.001	0.13	0.46
Previous failure	-8.63	3.71	-0.07	-2.327	0.021	-15.93	-1.33
r-square=0.79 Model ANOVA: F=307.99, p<0.001 Variables entered and excluded: age, marital status, previous experience, computer skills, PBL awareness							
Skills Score							
Constant	14.37	3.48		4.123	<0.001	7.50	21.23
Intervention	30.02	1.45	0.67	20.661	<0.001	27.16	32.88
GPA	0.21	0.04	0.08	5.284	<0.001	0.13	0.29
Previous failure	4.33	1.78	0.04	2.431	0.016	0.82	7.83
Knowledge score	0.30	0.03	0.33	9.939	<0.001	0.24	0.36
r-square=0.94 Model ANOVA: F=1054.24, p<0.001 Variables entered and excluded: age, marital status, previous experience, computer skills, PBL awareness							
Tutor Evaluation Score							
Constant	11.05	1.00		11.043	<0.001	9.08	13.02
Intervention	38.83	1.23	0.90	31.680	<0.001	36.42	41.25
r-square=0.80 Model ANOVA: F=1003.61, p<0.001 Variables entered and excluded: age, marital status, previous failure, GPA, previous experience, computer skills, PBL awareness							

DISCUSSIONS

The current study results demonstrated significant improvements in these students' basic and applied knowledge of PBL and PS skills. The effect of the intervention was confirmed through multivariate analysis, which leads to acceptance of the set research hypotheses. According to the present study results, nursing students' knowledge of PS was deficient at the pre-intervention phase. This is expected given the traditional educational system in schools in Egypt. After the implementation of the intervention, significant improvements were shown in nursing students' total knowledge of PS and PBL at the post-intervention and follow-up phases in all the areas of knowledge. The findings indicate the direct positive effect of the study intervention, as well as its long-term effect. This was confirmed in multivariate analysis, and the positive effect might be explained by its focus on applied knowledge so that attendants realize the importance of the applied content to close the gap between theory and practice. In agreement with this, *Ibrahim et al (2018)* demonstrated significant improvements in Sudanese medical students' knowledge following the implementation of PBL sessions.

The present study results identified the influence of certain academic characteristics of the nursing students on their total knowledge scores of PS and PBL. Thus, the negative effect of the previous history of academic failures and the positive effect of GPA was confirmed in multivariate analysis. The findings are plausible and are explained by the reciprocal relationship between problem-solving and academic achievement. This, a student with high academic

achievement is expected to learn and get more benefit from the intervention. On the other hand, a student with better PS and PBL knowledge is expected to have better academic performance and achievement. In line with this, *Ghazivakili et al (2014)* in a study in Iran found a significant relation between PS skills and students' academic achievements.

Another objective of the present study was to assess the effect of the implementation of the intervention program on nursing students' practice of PS using the PBL process. The results demonstrate that the majority of the students were having a deficient practice of PS before the intervention. In agreement with this, *Abdollahi et al (2018)* found poor PS knowledge and skills among Malaysian university students.

However, the implementation of the present study intervention led to significant improvements in nursing students' practice of the PS process. Such improvement could be attributed to the effect of the intervention as evidenced by the multivariate analysis, which identified it as the main positive predictor of the practice score. This success is undoubtedly due to program content which was tailored to fit students' needs, and the process of the intervention, which entailed true hands-on training on the PS process using the PBL approach. In congruence with this, *Currey et al (2015)* in a study in Australia demonstrated statistically significant improvements in nursing students' PS knowledge and skills following the implementation of an educational intervention. Similar findings were also reported by *Breen (2018)* in a study carried out on nuclear medicine technologists in the United States.

Another important reason for the effectiveness of the present study intervention was the motivation and enthusiasm of the students to learn in small groups using interactions to reach to solve the problems. This helped them to acquire important communication and leadership skills while learning. They also learned to work together reach to a common goal to solve the problem. In congruence with this, *Chakravarthi and Vijayan (2010)*, in a study in Malaysia, showed that the PBL process enhanced students' self-directed learning as they become more responsible for identifying and tracking their learning goals. On the same line, *Yadav et al (2018)* in Nepal demonstrated that PBL increased students' feeling of own accountability for their learning, and fostered the skills of reasoning, active participation, group interaction, as well as teamwork. Similar to the knowledge scores, the current study results showed that nursing students' scores of practice were influenced positively by their GPA and negatively by previous academic failure. The reasons underlying these influences are the same as previously explained regarding the knowledge scores. An additional factor was the previous use of PS in the study, which had a positive influence on the practice score as expected. In congruence with this, *Trunzo et al (2014)* in a study in the United States revealed that the PS skill was a statistically significant positive predictor of students' academic achievement.

The multivariate analysis of the present study has also revealed a very strong positive correlation between nursing students' scores of knowledge and practice. Moreover, the knowledge score was identified as a significant independent predictor of the practice score. This indicates the importance of acquiring basic theoretical knowledge in improving their practice. The success of the intervention was actually due to linking knowledge to practice so that students while acquiring theoretical knowledge were aware of and able to apply it in their practice. In line with this, the importance of linking knowledge to practice has been highlighted by *Phillips and Neumeier (2018)* in a study in Canada.

Additionally, the implementation of the present study involved a process of evaluation of the application of the PBL process by individual nursing students within the small groups. This was done by the tutor who was trained in this process and using a checklist student's abilities in the application of knowledge, decision-making skills, self-directing

learning, teamwork, and communication skills. Based on this, none of the nursing students was found to be able to PS before the intervention. This is certainly due to their lack of knowledge and of training in PBL and PS. Moreover, in the initial stage of the PBL process, group members are not familiar with each other and the subject to be discussed is not yet fully understood. Therefore, students are reluctant to engage in oral interaction at the start and had to overcome such psychological barriers. Such barriers need further research as pointed by *Wang et al (2016)* in China.

The current study intervention led to a significant improvement in nursing students' scores of practice as assessed by their tutor immediately at the post-intervention phase. This continued to increase at the follow-up phase. Such improvement is attributed to the effect of the intervention, which was identified as the only independent statistically significant positive predictor of the tutor's score of evaluation of the students' ability to practice PS. The implementation of the intervention helped students to work in groups, to be open-minded to others' viewpoints, translate learning needs in learning goals, and to be able to observe and to be role model for others.

CONCLUSION AND RECOMMENDATIONS

Implementing a PBL strategy for nursing students is effective in improving their PS abilities as well as their performance in PBL as evidenced by tutor evaluation. The study recommends more use of the PS educational approach and PBL strategy in all nursing curricula. Course planners need training in developing educational problems. Staff should be trained to be efficient PBL class tutors. Continuing assessment of the application of PBL process should be done. Further studies are proposed to identify the barriers to PBL implementation and to compare students' outcomes in PBL and other traditional learning approaches.

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