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Effectiveness of Problem-based Learning (PBL) on Maritime Courses in a Blended Learning Modality

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ABSTRACT: This study aimed to determine the effectiveness of problem-based learning (PBL) on identified courses in improving the performance of maritime students. This study utilized pretest-posttest non-equivalent group design. Respondents were 480 BSMT students gathered using a match group design. Instrument used was a 45-item researcher-made multiple-choice test that has undergone content validity and reliability testing. Statistical tools used were mean and standard deviation for descriptive data analysis, Mann-Whitney test and Wilcoxon-Signed ranks for inferential data analysis, and Cohen's d effect size, to determine the effectiveness of PBL. Results showed that the experimental and control group pretest performance before the intervention is described as poor and fair, while excellent and very good thereafter. No significant difference in the pretest scores of experimental and control groups. No significant differences in the posttest scores of experimental and control groups in NGEC 9, NAV 5, and SEAM 6, while there were significant differences in the posttest scores of experimental and control groups in NAV 2, NAV 4, and NAV 7. Significant differences were noted in the pretest and posttest scores of the experimental and control groups in all identified courses. The mean gain score of the experimental group in all identified courses is higher than the control group. No significant difference in the mean gains of experimental and control groups, for NGEC 9, NAV 5, and for SEAM 6 but significantly different was noted in NAV 2, NAV 4, and NAV 7. Based on the effect size results, PBL is highly effective on NAV 2 and NAV 7 compared to the traditional method. These results confirm how effective the PBL approach is as a teaching style in all identified courses. PBL approach is highly recommended for all maritime courses.

1 INTRODUCTION

Maritime education is always a pillar in producing competent seafarers [1] [2]. Theoretical immersion is extremely essential in the upbringing a competent and holistic ship crew. Akl [3] expressed that education in higher education requires teaching finesse and tact in learning progression as the world treads globalization. This also puts pressure on the educational structures and deliverance in the pressing matter of producing intellectual and skillful graduates [4].

Traditional lecture-based instruction predominantly follows the old-age concept of pedagogy. Since the traditional approach dominates most academic environments, students lack active learning as instructions only provide a one-way teacher-student information feed [5]. However, in producing competent graduates, this method can no longer accommodate such demands [6]. Cognitive-centered education is now the eye of many higher education practices as it can sufficiently scaffold cognitive prowess [7]. Also, this method significantly reduces the burden on the educators, as presented by Arseven et al. [8].

Problem-based learning (PBL) is vastly applied to broad fields of discipline and instructional concepts promoting cognitive scaffolding and developing critical problem-solving attributes. Thru real-life problem contexts, PBL provides an efficient teaching and learning approach considering long-term knowledge retention and application [9]. PBL's approach revolves around activity engagement in meaningful problems. Students are given collaborative problem-solving undertakings in an attempt to form their own mental learning models, as well as their self-directed habits through practice and reflection. PBL's model includes a broad objective of strengthening critical-thinking abilities, talents in investigation, problem-solving, and ability to learn independently [10] [11] [12].

Problem-based learning can simply be defined as a teaching method where problems are presented in context [13] for the students to emulate and learn. PBL's process of education requires the following: a problem to be encountered, problem – solving, learning needs identification, self-study, application, and summarizing what has been learned [9] [14] [15] According to Prosser and Sze [16], PBL is effective in long-term retention of course content and short-term regarding elaboration of new information. The use of PBL demonstrates its potential for learning through the integration of maritime students' cognitive, behavioral and social dimensions, fostering closer integration with the context of professional activity [17].

The integration of PBL in blended learning is widely observed after the COVID-19 pandemic. According to the study of Yennita and Zukmadini [18], the application of PBL on blended learning can improve the critical thinking skills of students. This is supported by the study of Zamroni et al. [19]. Essentially, blended learning promotes higher order thinking which is largely harnessed in this modern globalization [20] [21].

This study was conducted to provide instructors with practical direction for more effective instruction inside the classroom. The results of this study may move school administrators to provide in-service seminars, workshops, and trainings for their teachers for them to learn the PBL approach model in teaching. The students will certainly be benefited by the results of this study since these will inform them about the need to adjust to new instructional modes which may lead to better learning of their course. Lastly, the PBL approach had been used at JBLFMU, thus, this study will validate previous results.

This study was anchored to the Theory of Constructivism [22] [23] [24] [25], wherein it strongly suggests an established link between the new information and the existing ones each individual during the process. The individual information is not piled on and individual establishes the basis of information by adding his own comment. Teachers play vital role in this approach where the learner serves as the core. With this approach, teachers do not directly transfer the information to the students; but they guide and help learners to reach the information and to construct it [26]. According to Ayaz and Şekerci [27] a teaching and learning environment dominated by the constructivist approach is different from a teaching and learning environment dominated by the traditional approach. With this learning approach, discourse, interests and needs of learners are essentially paid attention thru certain uncertainties and collaborative learning efforts. Constructivism is related to the present study because students will be exposed to PBL in a blended learning modality to improve performance in maritime professional courses [28].

Generally, this study aimed to determine the effectiveness of PBL on identified courses using blended learning modality in improving the students' performance during the second semester of school-year 2022-2023.

2 MATERIALS AND METHODS

2.1 *Research Design*

This study utilized the quasi-experimental specifically the pretest-posttest non-equivalent group design. In the pretest-posttest nonequivalent group design there is a treatment group that is given a pretest, receives a treatment, and then is given a posttest. But at the same time, there is a nonequivalent control group that is given a pretest, does not receive the treatment, and then is given a posttest [29]. This design covered the effectiveness of PBL in blended learning modality in improving maritime students' performance on General Education and Maritime Professional courses. Also, it utilized an instruction-related treatment or intervention in one student group but no such treatment in another comparable group, that is, the experimental group incorporated the PBL while the control group utilized with the traditional method which is lecture-discussion. Both groups are under the blended learning modality as mitigation for post-COVID 19 responses among BSMT students. The intervention lasted for four months.

2.2 *Participants*

Table 1 shows the 480 participants composed of 40 students per section who were bonafide students of the institution. The participants were two comparable sections taking the same course. The selection utilized match-group design using General Weighted Average (GWA) in the first semester of school-year 2022-2023. Thus, there were 12 sections, each with two courses for each year level who participated in the study. The identified courses were chosen because of their problem-solving attributes. Similarly, the chosen subjects are vital in honing a future officer.

2.3 *Instrument*

Each of six instruments was a 45-item researcher-made multiple-choice tests which contain topics covering prelims to finals. The instruments had underwent content validity from experts and reliability-testing using the Kuder-Richardson (KR) 20. The Table of Specifications (TOS) was created to assist in the construction of the instrument prior to reliability testing. There was a total of five professional and one general education courses covered in the study. Each year level is composed of 160 students with 40 students in the experimental and 40 in the control groups in both general education and professional courses. The list is shown in Table 1.

Table 1. Year Level, Identified Courses, Number of Section and Students, Reliability Coefficients, and Descriptive Title

1 Year/Level
2 Course
3 Number of Section
4 Number of Students
5 Reliability Coefficient
6 Descriptive Title

1	2	3	4	5	6
First	NGEC 4	2	80	0.94	Mathematics in the Modern World
	Nav 2	2	80	0.92	Terrestrial and Coastal Navigation 1
Second	Nav 4	2	80	0.88	Celestial Navigation
	Nav 5	2	80	0.91	Operational Use of RADAR/ARPA
Third	Seam 6	2	80	0.87	Advanced Trim and Stability
	Nav 7	2	80	0.89	Voyage Planning

2.4 *Data Collection*

The data were obtained using a cognitive achievement, researcher-made multiple-choice test for each course. Each course test was validated by a panel of experts for appropriateness and correctness of the instrument.

Tossing of coins was used to determine which groups was the experimental or control groups. The head was assigned as experimental group and the tail as the control group.

Pretest was conducted during first-class session. For experimental groups, they had undergone PBL wherein they had given the opportunities to do problem solving in a collaborative setting, create mental models for learning, and form self-directed learning habits through practice and reflection. On the other hand, for control groups, traditional method had applied using lecture-discussion for four months. Posttest was done after four months of using the blended learning modality to assess the effectiveness of the intervention.

A qualified instructor taught both groups at the span of four months. There were a total of six instructors who facilitated the groups and were assigned in every year level on their designated course.

2.5 *Data Analysis*

The statistical tools used in this study were the following: Mean was used to determine the students' performance in the pretest and posttest. The mean scale, descriptive rating, and indicators for interpreting the pretest and posttest scores is shown in Table 2. Standard deviation was used to determine the level of students' homogeneity in their course performance.

Mann-Whitney test was used to determine the significant differences in the pretests and posttests between two groups in all courses and for the significant difference in the mean gain of the pretest and posttest of the experimental and control groups set at .05 level of significance.

Wilcoxon-Signed ranks test was used to determine the significant differences in the pretest and posttest of within each of the groups in all courses set at .05 level of significance.

Cohen's d effect size was used to determine the effectiveness of problem-based learning approach in terms of students' performance professional courses. This is done by using the means and standard deviation in the posttest among the experimental and the control groups.

Table 2. Mean Scale, Descriptive Rating, and Indicators in Interpreting the Students' Level of Competencies

Mean Scale	Descriptive Rating	Indicators
36.04 – 45.0	Excellent	Students have mastered all the competencies
27.03 – 36.03	Very Good	Students have mastered most of the competencies
18.02 – 27.02	Good	Students have mastered at the average competencies
9.01 – 18.01	Fair	Students have mastered few competencies
1.0 – 9.0	Poor	Students have mastered very few competencies

3 RESULTS AND DISCUSSION

Table 3 shows the pretest mean score performances of the experimental and control groups in NGEC 9 and NAV 2 courses. Both the experimental and the control groups' pretest mean score performances before the intervention is described as fair indicating that they have mastered few competencies.

It also shows the pretest mean score performances of the experimental and control groups in NAV 4, NAV 5, SEAM 6, and NAV 7 course. Both the experimental and the control groups' pretest mean score performances before the intervention is described as poor indicating that they have mastered very few competencies.

Table 3 Pretest Mean Score Performances of the Experimental and Control Groups

Mean Scale	Descriptive Rating	Indicators	Descriptive Rating	SD
NGEC 9	Experimental	15.20	Fair	5.13
	Control	15.70	Fair	3.70
NAV 2	Experimental	11.13	Fair	2.40
	Control	10.75	Fair	2.16
NAV 4	Experimental	8.50	Poor	2.01
	Control	8.43	Poor	1.92
NAV 5	Experimental	7.95	Poor	1.32
	Control	7.60	Poor	1.39
SEAM 6	Experimental	8.98	Poor	1.17
	Control	9.08	Fair	1.33
NAV 7	Experimental	6.57	Poor	2.16
	Control	6.85	Poor	1.70

Table 4 shows the posttest mean score performances of the experimental and control groups in NGEC 9, NAV 2, NAV 4, and NAV 5 courses. Both the experimental and the control groups' posttest mean score performances after the intervention is described as very good indicating that they have mastered most of the competencies.

It also shows the posttest mean score performances of the experimental and control groups in SEAM 6 and NAV 7 courses. Both the experimental and the control groups' posttest mean score performances after the intervention is described as excellent indicating that they have mastered all the competencies but the control group for NAV 7 on the other hand is just very good.

Table 4. Posttest Mean Score Performances of the Experimental and Control Groups

Identified Course	Group	Mean	Descriptive Rating	SD
NGEC 9	Experimental	35.53	Very Good	2.03
	Control	35.23	Very Good	2.71
NAV 2	Experimental	36.53	Very Good	2.02
	Control	30.02	Very Good	2.30
NAV 4	Experimental	33.41	Very Good	3.12
	Control	31.35	Very Good	2.37
NAV 5	Experimental	34.37	Very Good	2.69
	Control	35.43	Very Good	2.65
SEAM 6	Experimental	41.18	Excellent	1.65
	Control	40.45	Excellent	2.26
NAV 7	Experimental	36.48	Excellent	2.71
	Control	32.05	Very Good	2.99

Table 5 shows that there are no significant differences on the pretest mean score performances between the experimental and control groups, for NGEC 9, U = 791.00, p = .931; for NAV 2, U = 740.00, p = .560; for NAV 4, U = 791.50, p = .934; for NAV 5, U = 685.50, p = .254; for SEAM 6, U = 740.00, p = .542; and for NAV 7, U = 788.50, p = .911. This means that both groups possess the same knowledge in all identified courses before the intervention. Thus, the homogeneity of the groups is well established before the treatment 30].

Table 5. Mann-Whitney Test Result on the Pretest Mean Score Performances between the Experimental and Control Groups

Identified Course	Compared Group	U	W	Z	Asymp. Sig. (2-tailed)
NGEC 9	Experimental Control	791.00ns	1611.00	-.087	.931
NAV 2	Experimental Control	740.00ns	1560	-.583	.560
NAV 4	Experimental Control	791.50ns	1611.50	-.083	.934
NAV 5	Experimental Control	685.50ns	1505.50	-1.141	.254
SEAM 6	Experimental Control	740.00ns	1560	-.610	.542
NAV 7	Experimental Control	788.50ns	1608.50	-.112	.911

Note. ns means not significant at .05 level of probability.

Table 6 shows that there are no significant differences on the posttest mean score performances between the experimental and control groups, for NGEC 9, U = 716.50, p = .414; for NAV 5, U = 637.50, p = .115; and for SEAM 6, U = 686.50, p = .267. This means that both groups possess the same performance in NGEC 9, NAV 5, and SEAM 6 after the intervention. This can be inferred that both methods are similarly effective [31].

It also shows that there are significant differences on the posttest mean score performances between the experimental and control groups, for NAV 2, U = 28.00, p = .000; for NAV 4, U = 206.50, p = .000; and for NAV 7, U = 194.50, p = .000. This means that the experimental group performed significantly better after the intervention. The research results support the findings of Sadhasivam, et al. [32] and Alrahlah [14], who found that students' posttest scores improved significantly when compared to their pretest scores.

Table 6. Mann-Whitney Test Result on the Posttest Mean Score Performances between the Experimental and Control Groups

Identified Course	Compared Group	U	W	Z	Asymp. Sig. (2-tailed)
NGEC 9	Experimental Control	716.50ns	1536.50	-.816	.414
NAV 2	Experimental Control	28.00*	848.00	-7.464	.000
NAV 4	Experimental Control	206.50*	1026.50	-5.753	.000
NAV 5	Experimental Control	637.50ns	1457.50	-1.576	.115
SEAM 6	Experimental Control	686.50ns	1506.50	-1.110	.267
NAV 7	Experimental Control	194.50*	1014.50	-5.852	.000

Note. ns means not significant at .05 level of probability while asterisk (*) means significant at .05 level of probability.

Table 7 reveals that there are significant differences in the pretest and posttest mean score performances of the experimental groups in all identified courses. This means that the experimental groups' mean score performances after the intervention are significantly better than before the intervention. This is supported by the study of Oderinu et al.[33], where PBL provides higher ability for intellectual stimulation.

Table 7. Wilcoxon-Signed Ranks Test Result on the Pretest and Posttest Mean Score Performances of the Experimental Group

Identified Course	Compared Test	Z	Asymp. Sig. (2-tailed)
NGEC 9	Pretest Posttest	-5.52*	.000
NAV 2	Pretest Posttest	-5.32*	.000
NAV 4	Pretest Posttest	-5.52*	.000
NAV 5	Pretest Posttest	-5.52*	.000
SEAM 6	Pretest Posttest	-5.53*	.000
NAV 7	Pretest Posttest	-5.53*	.000

Note. Asterisk (*) means significant at .05 level of probability.

Table 8 reveals that there are significant differences in the pretest and posttest mean score performances of the control groups in all identified courses. This simply shows that the control groups' mean score posttest performances are significantly better than their pretest performance. Evident to its effectivity, control group showed promise in elevating student knowledge [34].

Table 8. Wilcoxon-Signed Ranks Test Result on the Pretest and Posttest Mean Score Performances of the Control Group

Identified Course	Compared Test	Z	Asymp. Sig. (2-tailed)
NGEC 9	Pretest Posttest	-5.52*	.000
NAV 2	Pretest Posttest	-5.52*	.000
NAV 4	Pretest Posttest	-5.52*	.000
NAV 5	Pretest Posttest	-5.52*	.000
SEAM 6	Pretest Posttest	-5.54*	.000
NAV 7	Pretest Posttest	-5.53*	.000

Note. Asterisk (*) means significant at .05 level of probability.

Table 9 presents the mean gains of the experimental and control groups. It shows that the mean gains of most identified courses is higher in the experimental group than the control group. It can be inferred that the experimental group showed significantly better performance as compared to the control group. This was also inferred by the study of Delucci [35], where knowledge is already present however, the one with a better intervention can effectively widen the gap. However, in NAV 5, the mean gain in the control group is higher than the experimental group. It can be gleaned that the control group is as effective as the experimental group. Given the established fact that PBL is effective on other subjects, it is inferred that the most effective instruction is interchangeable. Furthermore, the subject requires simulation and immediate support [36].

Table 9. Mean Gains of the Experimental and Control Groups

Identified Course	Compared Group	Pretest	Posttest	Mean Gain
NGEC 9	Experimental	15.20	35.53	20.33
	Control	15.70	35.23	19.53
NAV 2	Experimental	11.13	36.53	25.40
	Control	10.75	30.02	19.27
NAV 4	Experimental	8.50	33.41	24.91
	Control	8.43	31.35	22.92
NAV 5	Experimental	7.95	34.37	26.42
	Control	7.60	35.43	27.83
SEAM 6	Experimental	8.98	41.18	32.20
	Control	9.08	40.45	31.37
NAV 7	Experimental	6.58	36.48	29.90
	Control	6.85	32.05	25.20

Table 10 shows that there are no significant differences in the mean gains of the experimental and the control groups for NGEC 9, U = 737.50, p = .546; for NAV 5, U = 608.50, p = .063; and for SEAM 6, U = 663.50, p = .182. This suggests that both intervention is effective in delivering instructions across three subjects. According to Sniegocki [37], Nav 5 (Operational use of RADAR/ARPA) requires systematic and closely guided instruction. The NGEC 9 and Seam 5 on the other hand, focuses on achievement rather than application as attested in the study Laurens et al. [38]. Mustaffa et al. [39] largely disproves these results as NGEC 9 and SEAM 5 shares the same roots. Nevertheless, traditional instruction is as effective as the PBL as shown by the results.

While there are significant differences in the mean gains of the experimental and control groups for NAV 2, U = 150.00, p = .000; for NAV 4, U = 146.50, p = .000; and for NAV 7, U = 226.50, p = .000. This means that one of the groups perform better than the other groups in NAV 2, NAV 4, and NAV 7 after the intervention. The experimental group having the PBL approach is significantly better as compared to the control group as shown on the mean gains. It can be inferred that the intervention which is the PBL approach is effective than the traditional method. Since PBL focuses on student-centered education, the application across three subjects denote appropriate approach in scaffolding student cognition and critical thinking [40] [41].

Table 10. Mann-Whitney Test in the Mean Gains of the Experimental and the Control Groups

Identified Course	Compared Group	U	W	Z	Asymp. Sig. (2-tailed)
NGEC 9	Experimental Control	737.50ns	1557.50	-.604	.546
NAV 2	Experimental Control	150.00*	970.00	-6.280	.000
NAV 4	Experimental Control	146.50*	966.50	-6.308	.000
NAV 5	Experimental Control	608.00ns	1428.00	-1.857	.063
SEAM 6	Experimental Control	663.00ns	1483.00	-1.335	.182
NAV 7	Experimental Control	226.50*	1046.50	-5.546	.000

Note. ns means not significant at .05 level of probability while asterisk (*) means significant at .05 level of probability.

The effectiveness of the PBL in terms of students' performance in NGEC 9 is quantified using the Cohen's d effect size. The value of the effect size is 0.2. This means that the effect size is small and the intervention is slightly effective compared to the traditional method which is lecture-discussion. NAV 2 is 3.01. This means that the effect size is very large and the intervention is very effective compared to lecture-discussion. This means that the effect size was very large and the intervention was more than a 100% effective [42]. NAV 4 is 0.7. This means that the effect size is medium and the intervention is moderately effective compared to the lecture-discussion. NAV 5 is 0.4. This means that the effect size is small and the lecture-discussion is slightly effective compared to the intervention applied. SEAM 6 is 0.4. This means that the effect size was small and the intervention is slightly effective compared to the lecture-discussion. NAV 7 is 1.55. This means that the effect size is large and the intervention is effective compared to the lecture-discussion. This means that the effect size is large and the intervention was more than a 100% effective [43].

Table 11. Effect Size, Descriptive Rating, and Interpretation

Course	Effect Size	Descriptive Rating	Interpretation
NGEC 9	0.2	Small	PBL is slightly effective compared to lecture-discussion
NAV 2	3.01	Very Large	PBL is very effective compared to lecture-discussion
NAV 4	0.7	Medium	PBL is moderately effective compared to lecture-discussion
NAV 5	0.4	Small	Lecture-discussion is slightly effective compared to PBL
SEAM 6	0.4	Small	PBL is slightly effective compared to the lecture-discussion
NAV 7	1.55	Large	PBL is effective compared to the lecture-discussion

4 CONCLUSIONS

The experimental group appeared to have learned significantly better in most identified courses after having been subjected to the PBL approach than the control group. It was shown that the PBL approach was an effective teaching styles in almost all identified courses.

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