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Impact of Information Literacy Training on Academic Self-Efficacy and Learning Performance of University Students in a Problem-Based Learning Environment

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ABSTRACT

Problem-based learning (PBL) has emerged as an innovative educational approach and it is increasingly gaining its prominence in the higher education in Malaysia. Past research shows that academic self-efficacy has strong and positive influence on students' motivation and academic achievement. This study aims to examine the influence of information literacy skills training on academic self-efficacy and learning performance of university students in PBL approach in the Physics course. The Solomon Four –group design was used with 78 students in the American Degree Transfer Program of Taylor's University College in Malaysia participated in this study. The study investigated whether causation existed between information literacy skill training and academic self-efficacy as well as between information literacy training and learning performance. The independent variable was the information literacy training. The dependent variables were the mean academic self-efficacy score in a self-reporting and numerically measurable questionnaire developed by Klobas and learning performance scores which constitutes learning satisfaction, learning attitude, and learning score. A between group Factorial ANOVA and one-way ANOVA showed that the treatment of information literacy skills did have an impact on academic self-efficacy and learning performance. The findings showed that there was a cause-and-effect relationship between information literacy training and improvement in academic self-efficacy and learning performance of university students in PBL environment. This study confirmed that information literacy skill training may help raise the academic self-efficacy and learning performance of university students, which is essential to the learning process in PBL.

Keywords: Information literacy skills, problem-based learning, IL competency standard, academic self-efficacy, experimental design, higher education

INTRODUCTION

A shift of educational paradigm from traditional teaching approach to a problem-based learning (PBL) approach has been observed in most of the universities, university colleges and colleges in Malaysia in the past decade. An example is the successful implementation of PBL in the Medical and Dental Faculties of University Malaya (Salimah, 2003; Mohd Arriffin et al., 2004). PBL is a curriculum development and instructional system that simultaneously develops both problem solving strategies and disciplinary knowledge bases and skills by placing students in the active role of problem

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solvers confronted with an ill-structured problem that mirrors real-world problems (Finkle and Torp, 1995). This shift to independent learning has made information literacy skills critical to students' survival and success (Winship, 1995; Coombs and Houghton, 1995; Wales and Harmon, 1998). It has been documented that the role of current IL actually forms the basis for lifelong learning (ACRL Task Force, 2000).

A PBL environment has an important role to play in developing a student's ability to learn how to learn. A PBL environment is a student-centred environment which organizes the curriculum around an ill-structured, "real world" problems or scenarios, purported to empower learners by encouraging them to take a deep approach to their own learning. This approach enables students to become more confident and self-directed in their learning. The key philosophy of PBL is "student empowerment", where the concept of PBL is team-oriented with students empowered to identify their learning needs. This philosophy facilitates personal engagement in learning process and reinforces the student's ability to learn how to learn (Boud, 1991; Ryan, 1993). Harvey (2004) described empowerment as the development of knowledge, skills, and abilities in the student to enable them to control and develop their own learning. Students studying under PBL approach may be able to gain a competitive edge with key characteristics of knowledge worker, such as academically skilled, methodologically competent, team worker, creative and information literate. Information literacy is a means of individual empowerment within today's information society (ALA, 1998). According to Hewer (1999), empowerment provides students and facilitators with the necessary skills to find and use information they need for study and leisure, and equips them with transferable skills they can use for all sorts of information retrieval and tasks, enabling them to cope with the information age.

Despite the recognition of the important concept of student empowerment and IL as means of individual empowerment, there is still little research exploring the learning and understanding in PBL environment from this perspective. The findings of this study showed that IL skills training has an impact on improvement of academic self-efficacy and learning performance which serve as a measure of learning outcomes directly or indirectly in PBL environment.

The Problem

PBL educators strongly believe that PBL approach empowers students by encouraging them to take a deep approach to learning and to become more confident and self-directed in their learning (Spronken-Smith, 2006). They also recognise that university students who learn in PBL environments have the ability to learn how to learn in order to prepare themselves for their future professions (Dunlap, 2005). PBL educators see that students have the information technology skills to use search engines, while students believe that they already possess information skills with their increased exposure and wider access to search engine technology and technology skills (Macklin, 2002). However, according to Majka (2001), such students are actually functionally information illiterate. With the overconfidence in information skills, PBL students are only able to fulfil simple information needs, searching information to answer simple question that exhibits only surface learning. They are unable to explore deeper concepts or determine if they have really reduced uncertainty successfully. PBL educators may have over estimated the competence and capabilities of university students in IL skills because they are unaware of the subtle difference between information technology skills and IL skills (Fosmire, 2002). They failed to empower university students by giving them the necessary tools they need during problem solving, to perform excellently and maintain quality in accomplishing their learning tasks. They have omitted the importance of IL skills which helps students to acquire an empowering set of "navigational" skills. This set of skills includes the ability to determine what information is needed, how to access this information effectively, efficiently at the same time evaluate

the needed information and its sources critically while incorporate the selected information into his or her knowledge base and value system.

Overconfidence of the information technology skills as perceived by university students themselves and the omission of PBL educators in embedding IL skill training in PBL will limit students' ability to successfully participate in team work so as to explore their full potential in deep learning. Failing to provide proper IL skill training will limit university students' confidence in information seeking, which will in turn demoralise their learning satisfaction and attitude, and eventually limit their learning performance and affect their success and survival in PBL environment.

PURPOSE OF THE STUDY

The purpose of this study is to provide findings on the impact of IL skill treatment on dependent variables of learning in the PBL environment, namely academic self-efficacy and learning performance.

The null hypotheses of this study state that:

$H_{01:}$ Information literacy skill treatment has no statistically significant impact on the improvement of academic self-efficacy of university students in a problem-based learning environment.

$H_{o2:}$ Information literacy skill treatment has no statistically significant impact on learning performance of university students in a problem-based learning environment.

$H_{o2a:}$ Information literacy skill treatment has no statistically significant impact on learning satisfaction of university students in a problem-based learning environment.

$H_{o2b:}$ Information literacy skill treatment has no statistically significant impact on learning attitude of university students in a problem-based learning environment.

$H_{o2c:}$ Information literacy skill treatment has no statistically significant impact on learning scores of university students in a problem-based learning environment.

LITERATURE REVIEW

Rankin (1999) articulated that IL skills are essential to the learning process, and problem solving process in PBL parallel to IL competency standards set for higher education. Research showed that shifting to independent learning in PBL has made IL skills critical to students' survival and success (Wales and Harmon, 1998). PBL entailed an increased use of libraries and wide variety of information sources (Limberg, 1999). However, studies conducted among university students showed that majority of the students showed a very low level of competency in the use of library and displayed poor information seeking patterns (Zondi, 1992), many experienced problems in locating library information material (Kamanda, 1999). Wurman (2001) pointed out that without IL skills, people are condemned to lack of information, dependence upon others for access to knowledge and information, and even experience an acute level of information anxiety. Mayer (1992) articulated that although IL competency influence the learning performance through the acquisition of knowledge and skills, without self-efficacy, the performance may not even be attempted.

Self-efficacy is the confidence in one's ability to behave in such a way as to produce a desirable outcome (Bandura, 1977). Bandura (1997, p.3) speculated that it is "the belief in one's capabilities to organize and execute courses of action required to produce given attainments". In academic context, academic self-efficacy is the "self-evaluation of one's ability and chances for success in the academic environment" (Robbins et al., 2004, p. 267). Researchers found that academic self-efficacy is a strong predictor of academic performance in college students (Robbins et al., 2004; Pajares, 1996; Chemers et al., 2001). As students' academic expectations and self-efficacy increased, they were more likely to "show higher performance". In PBL research community, researchers recognize the importance of IL skills to the successful implementation of PBL (Breen and Fallon, 2005), but little research has been done.

Given the evidence that academic self-efficacy is closely linked to academic achievement and performance, it warrants a research to study the impact of IL skills training on the improvement of academic self-efficacy of university students in PBL environment.

Unlike the traditional lecture-based approach which assesses learning outcomes based on examination to measure the acquisition of content knowledge, PBL presents some unique challenges for assessment. Due to the fact that PBL is primarily focused on learning how to learn and less on mastery of a particular body of knowledge, traditional methods of course assessment may not be very effective (Major, 2002). Thus, alternative assessment strategies seem necessary as a better measure of knowledge acquisition from PBL. There are alternative assessment strategies such as authentic assessment which uses tasks developed from realistic activities in the professional world (Nightingale et al., 1996) can help bridge the gap between instruction and assessment. Authentic assessment task is defined as complex simulations, case studies, or multi-faceted projects in assessing a range of knowledge, skills and attitudes in the assessment task (Nightingale et al., 1996). Luh et al. (2007) have shown that student' attitudes are factors which significantly influence student performance in PBL courses. Giving students the opportunity to evaluate and reflect on their own learning is a key element in PBL. This will also allow the facilitator to help students in assessing their own performance in solving a problem. The self-evaluation of students can be recorded through the learning satisfaction form. An effective assessment tool must be designed to assess the learning outcome from performing the learning task. Waters (1996) has suggested two options for the assessment: 1) prepare objective questions that test the student's comprehension of the learning tasks given, and 2) create a problem statement to the solution of which requires the student to demonstrate the desired depth of understanding of the learning outcomes. The learning performance in this study thus consists of subjective indicators such as learning satisfaction and attitudes as well as objective indicators such as learning scores, including objective tests and presentation of solutions to learning tasks.

MATERIALS AND METHODS

Sampling

A total of 78 undergraduate students who registered for the Fall-2009 Physics course in the American Degree Transfer Program at Taylor's University College (Malaysia) participated in this study. The list of these students was obtained from the registrar office at Taylor's University College. These participants were randomly assigned to four groups, namely E_1, E_2, C_1, and C_2 during the experiment. All these groups were comparative enough in terms of number and resources. Moreover, the pretest analysis showed no significant difference in the dependent measures.

Research Design

This study utilized Solomon Four–group quasi-experimental design (Solomon, 1949; McGahee, 2009) by setting up two experimental groups and two control groups for the experiment. The design is rigorous and robust enough to eliminate variations that might arise from individual experiences to contaminate the validity of the study (Koul, 1992; Kothari, 2003). Participants were randomly assigned to experimental groups and control groups. The participants were asked to write their name on an identical sticker, fold the sticker along the middle line and put the sticker into a hat. Four students were nominated as representatives to draw the stickers from the hat in turns. The first representative drew a sticker from the hat and stuck it on the list of E_1 group. The second representative drew another sticker and stuck it on the list of C_1 group. The same was followed by the third and fourth representatives. This process was repeated until all the stickers were drawn to create four probabilistically equal groups in order to increase the internal validity of the study.

A carefully crafted ill-structured problem was given to all participants. They were allocated

20 minutes to study the problem. One of the experimental groups and control groups (E_1 & C_1) were given 20 minutes to fill up the pretest questionnaire that measured their academic self-efficacy and learning satisfaction after reading the PBL problem. The other two groups were subdivided into smaller groups of five members before the PBL activities. The pretest instrument was a questionnaire comprising 10 items of learning satisfaction and 27 items of academic self-efficacy. The experimental groups then attended a two-hour IL skill training conducted by the facilitator in collaboration with a librarian before carrying out PBL activities and information seeking activity. The control groups (C_1 & C_2) began the normal process of PBL activities and information seeking activity. All participants were post-tested on their academic self-efficacy and learning satisfaction about the learning task at the end of the PBL process after they submitted their report or solution.

The set up of the Solomon four-group design in this research is as shown in Table 1:

The reasons of using Solomon Four-Group design in this study were:

1. Even though non-random sampling was used to draw the sample, a quasi-experimental study was still possible with the purposive sampling (Gall et al., 1996). This purposive sample can be randomly assigned to two experimental groups and two control groups.
2. The ability to control for instrument reactivity. Instrument reactivity refers to situations where pre-test cues subjects about the treatment and enables them to guess the expectation. In Solomon Four-Group design, half of the participants from both the treatment and control groups were pre-tested while the other half were not. Thus, it was able to control and test instrument reactivity.
3. Ability to assess the presence of pre-test sensitisation.
4. Allowing more confidence in inferring causal relationships as it has higher degree of internal validity.
5. Extraneous temporal effect was avoided as the treatment for the two experimental groups was given at the same time, with the collaboration of the facilitator and the librarian.
6. Most of the threats to internal validity were eliminated.

Treatment

The independent variable of this study was the treatment which aimed to improve the academic self-efficacy and learning performance of the university students by raising their IL skills. The treatment was a two-hour IL skill training programme conducted by the facilitator in collaboration with the librarian in two separate

TABLE 1
Solomon four-group design

Group	Pretest	Treatment	Posttest
1. R Experimental (E_1)	O_1	X	O_2
2. R Control (C_1)	O_3		O_4
3. R Experimental (E_2)		X	O_5
4. R Control (C_2)			O_6

X : Treatment of IL skill training.
O_1, O_3 : Measurement of dependent variables before IL skill training.
O_2, O_4, O_5 and O_6 : Measurement of dependent variables after performing the learning task.

phases. The first phase was a 40-minute lecture of IL knowledge conducted by the facilitator, while the second was 80-minute hands-on IL skill training conducted by the librarian in the library training room. The content of the lecture included the five standards of IL for higher education, the importance of these standards and how to relate and apply the five standards as they participated in PBL. The skills taught are:

1. to determine the nature and extent of the information needed,
2. to access needed information effectively and efficiently,
3. to evaluate information and its sources critically and incorporate selected information into knowledge base and value system,
4. to use information effectively to accomplish a specific purpose individually or as a member of a group, and
5. to understand the economic, legal, and social issues surrounding the use of information and to access and use information ethically and legally.

The librarian conducted a mini-PBL session in the second phase by giving four learning tasks related to a bibliography project that required the participants to work in small groups. The tasks were:

1. to make a list of information sources,
2. to describe the need of citing information sources in a bibliography,
3. to identify the element included when citing a book or websites, and
4. to identify a list of criteria that could be used to critically assess an information source.

These tasks involve the three elements of IL instruction outlined by Nahl and Jakobovits (1993) – critical thinking or information evaluation skills, information use skills, and learning to learn or enjoying the benefits of information success.

A summary of the four groups with and without the pretest as well as with and without the treatment is tabulated in Table 2.

Instruments

The independent variable of this study was the treatment of IL skills. The experimental groups were trained in a two-hour IL skill program by the facilitator in collaboration with the librarian. The dependent variables were the academic self-efficacy scores and learning performance scores on the self-reporting and numerically measurable questionnaire measured in 11-point scale for academic self-efficacy and 5-point Likert scale for subjective measure of learning performance which constitute learning satisfaction and learning attitude respectively. The questionnaire was administered in a pretest and posttest format to one experimental and one control group, and posttest only for others. By precluding the other two groups from pretesting allowed the researcher to determine if the actual act of pretesting influenced the results. If the difference between the posttest

TABLE 2
A summary of the four groups of participants during the experiment

Treatment condition / Pretest condition	ILS training	No ILS training
Pretest	E_1	C_1
No Pretest	E_2	C_2

Notes: Group E_1: Experimental group, with ILS Training and Pretest; Group C_1: Control group, No ILS Training but with Pretest; Group E_2: Experimental group, with ILS Training but No Pretest; Group C_2: Control group, No ILS Training and No Pretest.

results of E_2 and C_2 was different from the E_1 and C_1, then the researcher can assume that the pretest has had some effect upon the results. The questionnaire was used to ascertain the cause and effect relationship between IL skill training and academic self-efficacy as well as between IL skill training and learning performance. The academic self-efficacy questionnaire comprises a series of element developed by Klobas et al. (2007). Learning performance was expressed as a function of learning satisfaction, learning attitude, and learning scores (see *Fig. 1*).

Learning satisfaction was measured by a 10-item self-report rated by a scale from 1 being "strongly disagree" to 5 being "strongly agree". This instrument was adapted from the usefulness instrument developed and tested by Davis (1989). Learning attitude was measured during the whole PBL activities on a scale from 1 being "unsatisfactory" to 5 being "exceptionally satisfactory". The learning assessment was based on a test that consists of 15 multiple-choice questions on the course unit conducted in PBL, and the quality of the solution to the PBL task.

RESULTS AND DISCUSSION

Testing of Hypothesis 1

Information literacy training and academic self-efficacy

The mean score of academic self-efficacy was computed by dividing the total score of the 27 items on academic self-efficacy divided by 27. The mean post-test scores of the academic self-efficacy of the four groups were compared and analysed using 2 (pre-test/ no pre-test) x 2 (treatment / no treatment) between-group factorial ANOVA. In this analysis, 2 factors were each applied in two levels. The first factor was the condition of pretesting and the two levels were pre-test and no pre-test. The second factor was the treatment of IL training and the two levels were IL training and no IL training. Table 3 shows the results of this analysis. From the results in Table 3, it was axiomatic that there was no significant interaction ($F_{1,74}$ =2.24, p = 0.139) between the two main effects. It was therefore concluded that no pre-test sensitisation was present. The analysis of the treatment effect on the post-test scores ($F_{1,74}$ = 10.499, p=0.002) revealed a statistically significant result. This implied that the treatment had an effect and this effect existed without any prerequisite. Information literacy skill training has significantly improved academic self-efficacy of university students despite the presence of the pre-test. Thus, H_{o1} was rejected in favour of the alternative hypothesis. It follows that IL skill treatment has a statistically significant impact on the improvement of academic self-efficacy of university students in a PBL environment.

Testing of Hypothesis 2

Information literacy skill training and learning satisfaction

Learning satisfaction score was computed as the total scores of the 10 items of learning

$$\text{Learning Performance} = \Sigma\ \text{Satisfaction (W), Attitude (W), Score (W)}$$

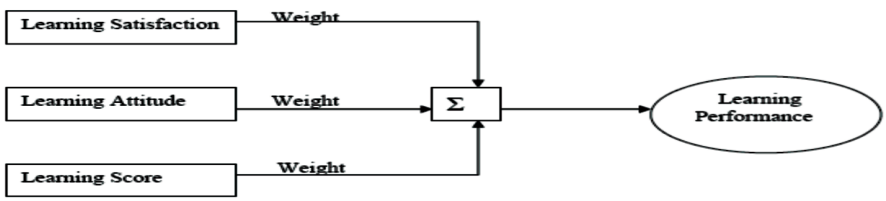

Fig. 1: Expression of Learning Performance (Loh, 2010, p. 35)

TABLE 3
Factorial ANOVA on academic self-efficacy post-test scores of all four groups

Descriptive Statistics

Dependent Variable: ACADEMIC SELF_EFFICACY

experimental group	pretest identifier	Mean	Std. Deviation	N
Experimental group	pretest	7.9923	1.1156	20
	no pretest	7.3502	.6451	19
	Total	7.6795	.9618	39
control group	pretest	6.9939	1.1814	19
	no pretest	6.9827	.6407	20
	Total	6.9882	.9308	39
Total	pretest	7.5059	1.2406	39
	no pretest	7.1617	.6611	39
	Total	7.3338	1.0026	78

Tests of Between-Subjects Effects

Dependent Variable: ACADEMIC SELF_EFFICACY

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	13.338[a]	3	4.446	5.136	.003
Intercept	4187.850	1	4187.850	4837.677	.000
TREATMEN	9.089	1	9.089	10.499	.002
PRETEST	2.080	1	2.080	2.402	.125
TREATMEN * PRETEST	1.939	1	1.939	2.240	.139
Error	64.060	74	.866		
Total	4272.629	78			
Corrected Total	77.398	77			

a. R Squared = .172 (Adjusted R Squared = .139)

satisfaction. The post-test learning satisfaction scores of the four groups were compared and analysed using 2 (pre-test/no pre-test) x 2 (treatment/no treatment) between-group factorial ANOVA. Table 4 shows the results of this analysis. There was no significant interaction ($F_{1,74}$ =1.855, p = 0.177) between the two main effects. It can be concluded that no evidence of pre-test sensitisation was present. An analysis on the treatment effect of the post-test scores ($F_{1,74}$=3.011, p=0.087) indicated that no statistically significant result was obtained. An ANCOVA with the pre-test scores used as the covariant was performed to determine the effect of treatment on the post-test scores of Groups E_1 and C_1.

The result from the ANCOVA ($F_{1, 37}$= 6.682, p=0.014) indicated that a statistically significant result was obtained. This indicated that the treatment had an effect on the learning satisfaction regardless of the presence or absence of the pre-test. Thus, no further analysis was needed and the null hypothesis H_{o2a} was rejected in favour of its alternative hypothesis. It follows that IL skill treatment had a statistically significant impact on the learning satisfaction of university students in a PBL environment.

Information literacy skill training and learning attitude

Learning attitude was computed as the total scores from the 8 items on learning attitude. Since there was no pre-test administered for the learning attitude, one-way ANOVA was conducted on the learning attitude in all four groups of subjects. The ANOVA results showed that there were at least two groups of subjects who showed significant difference in the mean scores of learning attitude, with the result F(3, 74) = 15.882, p = 0.00. A further examination of the Turkey Post Hoc test indicated that subjects

TABLE 4
Factorial ANOVA on learning satisfaction post-test scores of all four groups

Dependent Variable: learning satisfaction for post test

experimental group	pretest identifier	Mean	Std. Deviation	N
Experimental group	pretest	41.6500	2.3232	20
	no pretest	39.2632	2.9029	19
	Total	40.4872	2.8550	39
control group	pretest	39.0526	3.5351	19
	no pretest	38.9500	5.3062	20
	Total	39.0000	4.4721	39
Total	pretest	40.3846	3.2169	39
	no pretest	39.1026	4.2538	39
	Total	39.7436	3.8017	78

Dependent Variable: learning satisfaction for post test

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	98.740[a]	3	32.913	2.402	.074
Intercept	123033.419	1	123033.419	8977.605	.000
TREATMEN	41.270	1	41.270	3.011	.087
PRETEST	30.193	1	30.193	2.203	.142
TREATMEN * PRETEST	25.419	1	25.419	1.855	.177
Error	1014.132	74	13.704		
Total	124318.000	78			
Corrected Total	1112.872	77			

a. R Squared = .089 (Adjusted R Squared = .052)

TABLE 5
ANCOVA on learning satisfaction for Groups E1 and C

Dependent Variables	Source	MS	df	F	p
Learning Satisfaction	Treatment	58.14	1	6.68	0.014
	Error	8.70	36		

in the experimental groups showed higher scores in learning attitude than those in control groups, while no significant difference was found in learning attitude of subjects between control groups ($p = 0.889$) as well as subjects between experiment groups ($p = 0.970$) (*see* Table 6). Hence, hypothesis H_{o2b} was rejected in favour of its alternative hypothesis. It follows that IL skill treatment had a statistically significant impact on the learning attitude of university students in a PBL environment.

Information literacy skill training and learning score

The learning score of the students was derived from the mark assigned to each student based on the total scores in multiple-choice test questions on the topics covered in PBL and the solution to the learning task. As there was no pre-test for the learning score, one-way ANOVA was performed on learning scores in all groups of subjects. Results of the ANOVA revealed that at least two groups of subjects showed significant difference in the learning score mean (F(3, 74)

TABLE 6
One-way ANOVA for learning attitude post-test scores

ANOVA

Learning attitude

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	163.280	3	54.427	15.882	.000
Within Groups	253.592	74	3.427		
Total	416.872	77			

Learning attitude

Tukey HSD[a,b]

group identifier	N	Subset for alpha = .05	
		1	2
control group with posttest only	20	28.1000	
Control group with pretest posttest	19	28.5263	
experimental group with pretest posttest	20		31.0500
experimental group with posttest only	19		31.3158
Sig.		.889	.970

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 19.487.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

= 4.788, p = 0.004). A further examination of the Turkey Post Hoc test indicated that subjects in experimental groups showed higher learning scores than those in the control groups, while there was no significant difference in learning scores of subjects between control groups (p = 0.778) as well as subjects between experiment groups (p = 0.073) (*see* Table 7). Hence, hypothesis H_{o2c} was rejected in favour of its alternative hypothesis. It follows that IL skill treatment has a statistically significant impact on learning scores of university students in a PBL environment.

Information literacy skills training and learning performance

Since all the subsidiary null hypotheses were rejected in favour of alternative hypotheses, it was reasonable to predict that the IL skill training has an impact on learning performance of university students.

A one-way ANOVA was employed to further analyse the learning performance of the four groups of students. The results were shown in Table 8. The one-way ANOVA analysis showed that at least two groups of subjects showed significant difference in the mean score of learning performance (F(3, 74) = 8.227, p = 0.000). A further examination of the Turkey Post Hoc test indicated that subjects in the experimental groups showed higher scores in the learning performance than subjects in the control groups, while there was no significant difference in the learning scores of subjects between the control groups (p = 0.895) as well as subjects between the experiment groups (p = 0.855) (*see* Table 8). Hence, hypothesis H_{o2} was rejected in favour of it alternative hypothesis. The statistical analysis revealed that there was evidence suggesting that IL skill treatment had a statistically significant impact on learning performance of university students in a PBL environment.

A 2 (pre-test/no pre-test) x 2 (treatment/ no treatment) between-group factorial ANOVA was also performed on the learning performance

TABLE 7
One-way ANOVA for the learning score

ANOVA

LEARNING SCORE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	817.643	3	272.548	4.788	.004
Within Groups	4212.011	74	56.919		
Total	5029.654	77			

LEARNING SCORE

Tukey HSD[a,b]

group identifier	N	Subset for alpha = .05	
		1	2
Control group with pretest posttest	19	77.1053	
control group with posttest only	20	79.4000	79.4000
experimental group with pretest posttest	20		83.5000
experimental group with posttest only	19		85.3684
Sig.		.778	.073

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 19.487.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

TABLE 8
Results of one-way ANOVA for learning performance

ANOVA

LEARNING PERFORMANCE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1670.771	3	556.924	8.227	.000
Within Groups	5009.201	74	67.692		
Total	6679.972	77			

Homogeneous Subsets

LEARNING PERFORMANCE

	group identifier	N	Subset for alpha = .05	
			1	2
Tukey HSD[a,b]	Control group with pretest posttest	19	109.5368	
	control group with posttest only	20	111.3950	
	experimental group with pretest posttest	20		118.5050
	experimental group with posttest only	19		120.6105
	Sig.		.895	.855

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 19.487.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

post-test scores of all four groups. Table 9 shows the results of this analysis. From the results in Table 9, it was evident that no significant interaction existed ($F_{1,74}$ =0.004, p = 0.947) between the main effects. It can be concluded that no pre-test sensitisation was present. An analysis on the treatment effect of post-test scores ($F_{1,74}$ = 23.797, p=0.00) revealed a statistically significant result. This implied that the treatment had an effect that existed without any prerequisite. The IL skill training thus significantly improved the learning performance of university students. Thus, as anticipated, H_{o2} was rejected in favour of its alternative hypothesis which was consistent with the results obtained from the one-way ANOVA.

The Solomon four-group design used in this research met all the conditions for a cause-and-effect study. Firstly, this experimental study established a relationship. Secondly, a proper time order was observed, whereby the independent variable was manipulated and then the outcome was observed. Finally, it ruled out alternative explanations because random assignment equates the groups on all extraneous variables at the start of the experiment. Thus, the findings inferred that there was a cause-and-effect relationship (causation) between IL skill training and the two dependent variables, and there was a cause-and-effect relationship (causation) between IL skill training and learning performance, and between IL skill training and academic self-efficacy of university students in a PBL environment.

CONCLUSION

The results have demonstrated that IL skill training in a PBL environment by the facilitator in collaboration with the librarian was effective in improving students' academic self-efficacy and learning performance. The inferential statistics

TABLE 9
Factorial ANOVA on learning performance post-test scores of all four groups

Descriptive Statistics

Dependent Variable: sum of PBL learning satisfaction, learning attitude and score

experimental group	pretest identifier	Mean	Std. Deviation	N
Experimental group	pretest	118.5050	7.4568	20
	no pretest	120.6105	7.3995	19
	Total	119.5308	7.4077	39
control group	pretest	109.5368	9.4244	19
	no pretest	111.3950	8.4867	20
	Total	110.4897	8.8865	39
Total	pretest	114.1359	9.5130	39
	no pretest	115.8846	9.1500	39
	Total	115.0103	9.3141	78

Tests of Between-Subjects Effects

Dependent Variable: sum of PBL learning satisfaction, learning attitude and score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1670.771[a]	3	556.924	8.227	.000
Intercept	1031084.113	1	1031084.113	15232.015	.000
TREATMEN	1610.841	1	1610.841	23.797	.000
PRETEST	76.540	1	76.540	1.131	.291
TREATMEN * PRETEST	.298	1	.298	.004	.947
Error	5009.201	74	67.692		
Total	1038413.980	78			
Corrected Total	6679.972	77			

a. R Squared = .250 (Adjusted R Squared = .220)

revealed that differences in the mean scores of academic self-efficacy and learning performance of students in the treatment group and those in the control groups were statistically significant. With the increase in academic self-efficacy in PBL, students may increase their confidence to accomplish their learning tasks and perform better while learning in the PBL environment. This will catalyse their ability to successfully participate in team work and foster their deep learning and empowerment. The collaboration with librarians to conduct IL skill training is essential in the successful implementation of PBL. Further research is recommended to expand this study to university students from other majors such as business, humanity, laws, arts, or with post graduate students. Students with different majors and maturity may respond differently to an intervention.

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