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# IMPACT ON LEARNERS' UNCERTAINTY REDUCTION WITH THE INFUSION OF INFORMATION LITERACY SKILLS TRAINING IN PROBLEM-BASED LEARNING ENVIRONMENT

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## ABSTRACT

*Learners in Problem-based learning (PBL) environment are expected to learn from "real world" problems. PBL incorporates uncertainty naturally as a source of intrinsic motivation and a stimulus to learning which appears as the natural provocations for real learning. This is very much different from traditional approach where students and lecturers believe that the purpose of teaching and learning is the reduction of uncertainty and the main resources to uncertainty reduction are teachers and textbooks. Students in PBL environment must possess high level of communication skills, ability to identify and define problems, seeking and evaluating information and use it effectively. These skills are embraced under the broad term of information literacy skills (ILS) which aims to reduce uncertainty. Little research has been done on ILS training to reduce uncertainty of PBL Students. This paper aims to compare the difference in uncertainty reduction of science and engineering students in the two designs of PBL model. 78 students (Winter 2012 Semester) from American Degree Transfer Program of Taylor's University in Malaysia participated in this study. Solomon Four-group quasi experimental design was utilized in this study. The independent variables were groups of students with and without ILS training infusion and pretesting while dependent variables were uncertainty level. Uncertainty construct was developed and designed to measure an individual's real or anticipated uncertainty level with regards to the cognitive, affective and physical dimension in a 30-item self-reporting, numerically measurable questionnaire. Results from the analysis of T-tests, factorial ANOVA, One-way ANOVA and ANCOVA showed that students with ILS training infusion out performs those students with ILS training infusion in terms of uncertainty reduction. This paper contributes to the PBL research field that ILS training infusion in PBL can be viewed as tools of empowerment which transform university students into independent and lifelong learners. The results reported have implications for design of PBL curriculum by infusion of ILS training with collaboration from academic librarian and subject facilitator to empower PBL students in exploring and maximize their potential in deep learning approach and knowledge acquisition in PBL environment.*

**Keywords:** Problem-based learning, information literacy skills, uncertainty reduction

## INTRODUCTION

Traditional lecture system where students and lecturers have the common understanding that the purpose of teaching and learning is the reduction of uncertainty (Lee, 1998) has been practiced in universities and institutes of higher education in Malaysia for decades. They believe that knowledge consists of right answers and learning is the memorization and reproduction of these answers (Perry, 1970). Students are spoon fed with the "prepackaged knowledge" with examination results serve as an indicator of academic performance and achievement in learning. Information seeking is in a "passive mode" through receiving "correct answers" and factual knowledge from lecturers and textbooks, which are perceived

as the main resources to uncertainty reduction. In this mode of learning, problem solving is considered as associated with a definite answer. Students always treated uncertainty as a source of anxiety, rather than a natural provocation for learning. This approach may undermine the process of learning and incapacitates student inquisitiveness and initiative. On the other hand, PBL incorporates uncertainty naturally as a source of intrinsic motivation and a stimulus to learning. Genuine uncertainty and doubt are the natural provocations for real learning. In PBL, facilitators present the scenarios of the learning experience so that students can discover the principle for themselves. PBL students will be stimulated by cognitive dissonance while they are encountering an ill-structured problem. The associated uncertainty acts as a catalyst which provokes real learning. They will begin to seek for information to fill the gaps between what they know in their existing knowledge base and what they do not know. This activity accompanies the appearance of reorganization, stability, and progressive development or learning (Lee, 1998). As the higher education in Malaysia is emphasizing on outcome-based education (OBE) where PBL is considered as one of the learning approach under the framework, uncertainty reduction has emerged as an important construct in measuring learning.

Students in PBL environment are required to actively seek for information from a variety of information sources, make sense of the information to reduce uncertainty and fill their knowledge gap. A PBL environment has an important role to play in developing a student's ability to learn how to learn. It is a student-centered 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. PBL approach which is associated with challenge, incongruity, anomaly, and discrepant event in the problem cause the university students to experience cognitive dissonance (Keller, 1983). They experience uncertainty reduction during information seeking activities such as questioning, snooping and information searching to align themselves from the cognitive dissonance into a state of equilibrium (Keller, 1983). The uncertainty reduction process during problem solving activities enabled students to better understand the problem in learning task and add value to their learning experience.

## THE PROBLEM

With the increased exposure and wider access to search engine technology and technology skills, PBL students believe that they already possess information skills, which Majka (2001) described that they may be functionally information illiterate. With the overconfidence of the information skills, students are able to fulfill simple information needs, searching information to answer simple question that exhibits only surface learning. However, they are unable to explore deeper concepts or determine if they have really reduced uncertainty successfully. They are unmotivated to learn and consequently this will affect their learning outcome. Research shows that this phenomenon can be viewed as the overconfidence in their information technology proficiency but lack of critical awareness (Armstrong et al, 2001; Brown et. al, 2003; Edwards, 2006; Jones 2002 and Logan, 2004). PBL educators on one hand, feel that university students have the information technology skills to use search engines to search for information in uncertainty reduction process, on the other hand complaint that student's presentation of proposal in PBL continue to decline in quality, which is due to exhaustive dependence on inappropriate online information resources. They are not aware of the subtle difference between information literacy skills and information technology skills, and the important role played by information literacy skills in successful PBL implementation. PBL educators have overestimated the competence and capabilities of

university students in information technology skills and omitted the importance of information literacy 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. information literacy skills also includes empowering students to use information effectively to accomplish a specific purpose individually or as a member of a group as well as understand the economic, legal, and social issues surrounding the use of information so as to access and use information ethically and legally. Overconfidence of the information technology skills as perceived by university students themselves and omission of PBL educator in embedding information literacy skills in PBL will limit students' ability to reduce uncertainty and successfully participate in team work so as to explore their full potential in deep learning in PBL environment. This will also restrain the incorporation of generic skills which include critical thinking, communication and problem solving skills in PBL.

## THE PURPOSE OF THE STUDY

The purpose of this study is to provide findings on the university students' uncertainty reduction with different designs of PBL model in the same physics course. The design of PBL model is shown in Figure 1.

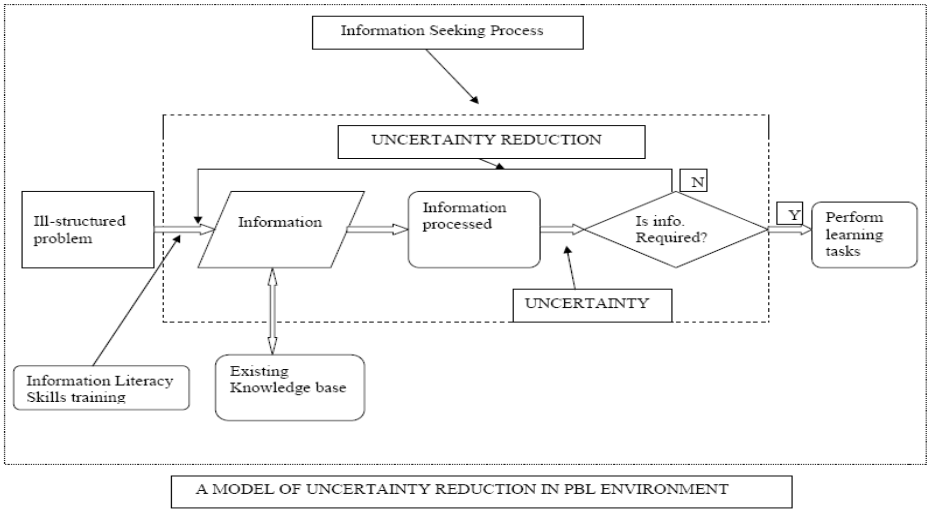


Figure 1. Designs of PBL model with / without information literacy skills training embedded

The null hypothesis and its subsidiary null hypotheses of this study state that

$H_{o1}$: There is no statistically significant difference in uncertainty reduction for PBL learners with information literacy skills training and PBL learners without information literacy skills training.

$H_{o1a}$: There is no statistically significant difference in cognitive uncertainty reduction for PBL learners with information literacy skills training and PBL learners without information literacy skills training.

$H_{o1b}$: There is no statistically significant difference in affective uncertainty reduction for PBL learners with information literacy skills training and PBL learners without information literacy skills training.

$H_{o1c}$: There is no statistically significant difference in physical uncertainty reduction for PBL learners with information literacy skills training and PBL learners without information literacy skills training.

## LITERATURE REVIEW

It has been known that human's daily activities are involved with uncertainty (Weber, 1997). These uncertainties will shape our action in seeking additional information to resolve unknown situation. Because of uncertainty, people seek information to make decisions and solve problem. It can be seen that uncertainty occurs in all aspects of our life. Generally, anxiety, concerns, emotions that we might encounter are due to uncertainty.

In a PBL environment, students are presented with ill-structured problem which creates a cognitive dissonance (Keller, 1983) or state of disequilibrium on them. The ill-structured and problematic nature of PBL problems is designed to create an imbalance or "cognitive dissonance" (Festinger, 1962) in the learner which motivates a search for explanations. In PBL, engagement in the problem comes before any preparation or formal study. Thus, during problem solving process, uncertainty is a possible disorder in student's cognitive state, which includes missing knowledge about the existence of important concepts or associations between concepts, incorrect association, or mistakes in procedural information (Reggia, 1990). This disorder in cognitive state leads to affective symptoms of anxiety to perform the tasks and lack of confidence in solving the problem. PBL students are actively involved themselves in questioning, snooping, and searching for information to reduce uncertainty and reenter a state of equilibrium. Kuhlthau (1993) defined uncertainty as a cognitive state which commonly causes affective symptoms of anxiety and lack of confidence. Her research shows that uncertainty and anxiety can be expressed in the early stages of the information search process and uncertainty due to lack of understanding, a gap in meaning, or a limited construct initiates the process of information seeking. Krikelas (1983) defined information need as the recognition of the existence of uncertainty, and information is "any stimulus that reduces the uncertainty". Shannon and Weaver (1949) posited that information itself refers to the reduction in uncertainty about the state of an event after a message has been sent relative to the uncertainty about the state of the event before the message was sent. Information theory defines uncertainty as lacking of information to choose from an exhaustive and well-defined set of possible states though it is not a complex set (Shannon 1949). Gate (1995) paraphrases Shannon's theories into the concept which suggested that information is the reduction of uncertainty.

Study on online learning shows that uncertainty reduction will enhance learning (Kati Mäkitalo 2004). Kuhthau (1993) maintains that information seeking to reduce uncertainty is actually a complex learning process in a series of phases. Learning is always associated with knowledge acquisition, whereby users' cognitive state will be changed due to the change in uncertainty level. Even though information is the reduction of uncertainty, but it takes the university students to recognise when, and what information is needed and at the same time have the ability to effectively locate, evaluate and use the information needed. Yovits and Foulk (1985) found that in some situations information may increase the uncertainty of a person. Thus, a certain level of information literacy skills will definitely be advantageous to university students in reducing uncertainty as it enables them to effectively retrieve relevant information to solve problems, and not overload with information unnecessarily. University students can effectively reduce their uncertainty by acquiring, developing or improving the subject knowledge and ability to predict, infer or estimate through information seeking. Attitude towards uncertainty changes with the change in understanding of a situation. Rankin (1999) articulated that ILS 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 ILS fundamental to students' survival and success (Wales and Harmon, 1998). In PBL, uncertainty is effectively reduced when student is empowered and takes control of his own learning through effective information seeking.

Much research have emphasised on the uncertainty experienced by the users in information seeking and searching process. However, an important aspect which has not gained much attention in information searching is the impact of the ILS on uncertainty reduction. This research aims to compare the uncertainty reduction of university students while searching information to perform learning tasks in two designs of PBL model, namely PBL with ILS embedded and PBL without ILS embedded.

## MATERIALS AND METHODS

### The Sample

A total of 78 undergraduate students who have registered the Winter-2012 Physics course in 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 two PBL sections, one section with information literacy skills training embedded in PBL process (treatment) while the other without information literacy skills training embedded (control). Half of the participants in each section will be pretested. Thus, four groups of participants were formed in this study.

### Research Design

This study utilized Solomon Four–group quasi-experimental design (Solomon, 1949; McGahee, 2009) by setting up two experimental groups (with ILS training) and two control groups (without ILS training) for the experiment. The design is rigorous and robust enough to eliminate variations that might arise because of experiences and contaminate the validity of the study (Koul, 1992; Kothari, 2003). Participants were randomly assigned to experimental groups and control groups through the process elaborated below: Each of the 78 participants will write his/her name on an identical sticker, fold the sticker along the middle line and put into a hat. Four students were nominated as representatives to draw the stickers from the hat in turn. First representative will draw a sticker from the hat and stick it on the list of $E_1$ group, second representative will draw another sticker and stick it on the list of $C_1$ group, third representative will draw a sticker and stick it on the list of $E_2$ group and fourth representative will draw a sticker and stick it on the list of $C_2$ group. This process was repeated until all the stickers have been drawn to create four probabilistically equal groups in order to increase the internal validity of the study.

A carefully crafted ill-structured problem that triggers the learning activity was given to all participants, allocating 20 minutes for them to study through the problem. One experimental group and one control group ($E_1$ & $C_1$) were given 20 minutes to fill up the pretest questionnaire which measures their uncertainty level 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 consists of 30 items of uncertainty constructs. The experimental groups were then attending a two-hour information literacy skills training conducted by the facilitator in collaboration with 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 uncertainty level 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 shown in Table 1:

**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 information literacy skills training.

$O_1$, $O_3$: Measurement of dependent variables before information literacy skills training.

$O_2$, $O_4$, $O_5$ and $O_6$: Measurement of dependent variables after performing the learning task.

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

I. Even though non-random sampling was used to draw the sample, a quasi-experimental study was still possible with the purposive sampling (Gall, Borg & Gall, 1996). This purposive sample can be randomly assigned to two experimental groups and two control groups.

II. The ability to control for instrument reactivity. Instrument reactivity refers to situation 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 treatment group and control group were pre-tested while the other half were denied. Thus, it was able to control and test for instrument reactivity.

III. Ability to assess the presence of pre-test sensitisation.

IV. Allowing more confidence in inferring causal relationships as it has higher degree of internal validity.

V. Extraneous temporal effect is avoided as the treatment for the two experimental groups occur at the same time, with the collaboration of facilitator and librarian.

VI. Most of the threats to internal validity were eliminated.

## Treatment

The collaboration between the facilitator and librarian enabled the treatment of the IL skills training conducted to the two experimental groups at the beginning of the PBL process. Each training consists of two phase, the first phase was a 40-minutes lecture of IL knowledge conducted by the facilitator, while the second phase was 80 minutes hands-on ILS training session conducted by a librarian in the library training room.

The contents 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, such as how to

a. determine the nature and extent of the information needed,
b. **access needed information effectively and efficiently,**
c. **evaluate information and its sources critically and incorporates selected information into his or her knowledge base and value system,**
d. **use information effectively to accomplish a specific purpose, individually or as a member of a group,**
e. **understand many of the economic, legal, and social issues surrounding the use of information and accesses and uses information ethically and legally.**

**The librarian conducted a "mini-PBL" session in the second phase by giving four learning tasks related to the assessment of the project bibliography to work in small groups. The tasks were:**

I. **make a list of information sources,**
II. **describe the need of citing information sources in a bibliography,**
III. **identify the element included when citing a book or websites, and**
IV. **identify a list of criteria that could be used to critically assess an information source.**

**These tasks involve the three elements of information literacy instruction outlined by Nahl-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 pretest given as well as with and without treatment given is tabulated in Table 2.

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.

**Table 2. A summary of the four groups of participants during the experiment**

| *Pretest Condition* | *Treatment Condition* | |
|---|---|---|
| | *ILS Training* | *No ILS Training* |
| Pre-test | $E_1$ | $C_1$ |
| No Pre-test | $E_2$ | $C_2$ |

## Instruments

The independent variable of this study was type of PBL design. The experimental groups were trained in a two-hour ILS program in the Physics related area by facilitator in collaboration with the librarian. The dependent variable was student's uncertainty reduction. A carefully crafted problem that triggered the learning activity was given to all participants, with 20 minutes perusal time. The pretest of uncertainty level was administered to an experimental group ($E_1$) and control group ($C_1$). The pretest instrument is a questionnaire, consists of 30 items of uncertainty construct which record their thinking, feeling and action in terms of cognitive dimension, affective dimension and physical dimension. The 2 control groups, $C_1$ and $C_2$ will immediately follow the normal process of PBL and information seeking activity to solve the problem. The experimental groups will undergo a two-hour ILS training session, arranged in two separate phases prior to information seeking process of the PBL activities. All participants will then be post-tested on their uncertainty level at the end of the PBL process while they submit their report or solution. The dependent variable can be computed using SPSS to determine the gain score of the uncertainty level in each item attributed to the uncertainty construct.

## RESULTS AND DISCUSSION

The objective of this study was to determine the differences in university students' uncertainty reduction with different designs of PBL model in the same physics course, by comparing students' uncertainty scores in three dimensions: cognitive, affective and physical, across the treatment and control groups. In order to examine whether this objective was

achieved, it was imperative to test the three subsidiary null hypotheses before the main null hypothesis $H_{01}$ was investigated. If all three subsidiary hypotheses have shown significant result, it was very likely that the hypothesis $H_{01}$ will exhibit a significant result. Further analysis can be carried out to confirm this prediction. A summary of the F statistics and p values for the main effects and interaction of main effects of Factorial ANOVA tests was tabulated as shown in table 3.

**Table 3. F statistics and p values from Factorial ANOVA**

| Dependent Variables | Source | MS | df | F | p |
|---|---|---|---|---|---|
| Cognitive Uncertainty | Treatment | 71.33 | 1 | 4.88 | 0.030 |
| | Pretest | 2.92 | 1 | 0.20 | 0.656 |
| | Treatment x Pretest | 27.33 | 1 | 1.87 | 0.175 |
| | Error | 14.60 | 74 | | |
| | | | | | |
| Affective Uncertainty | Treatment | 141.09 | 1 | 5.066 | 0.027 |
| | Pretest | 17.25 | 1 | 0.619 | 0.43 |
| | Treatment x Pretest | 9.88 | 1 | 0.355 | 0.553 |
| | Error | 27.85 | 74 | | |
| | | | | | |
| Physical Uncertainty | Treatment | 112.00 | 1 | 3.63 | 0.061 |
| | Pretest | 44.00 | 1 | 1.43 | 0.236 |
| | Treatment x Pretest | 100.74 | 1 | 3.27 | 0.075 |
| | Error | 30.83 | 74 | | |
| | | | | | |
| Total Uncertainty | Treatment | 955.23 | 1 | 5.44 | 0.022 |
| | Pretest | 17.53 | 1 | 0.100 | 0.75 |
| | Treatment x Pretest | 388.82 | 1 | 1.931 | 0.17 |
| | Error | 175.46 | 74 | | |

### Testing null hypothesis $H_{01a}$

A 2 x 2 between-group Factorial ANOVA was performed on the cognitive dimension of uncertainty posttest scores for the four groups. Table 3 shows the results of this analysis. There was no significant interaction ($F_{1,74}$ =1.87, p = 0.175) between the two main effects. It can be concluded that no pretest sensitisation was present. An investigation of treatment effect on posttest scores ($F_{1,74}$ = 4.88, p=0.030) revealed a statistically significant result. This implied that infusion of ILS training in PBL design had an effect and this effect existed without any prerequisite. The cognitive uncertainty of PBL design with ILS training infusion was significantly reduced (posttest scores lower than pretest scores) despite the presence of pretest. Thus, $H_{o1a}$ was rejected in favour of its alternative hypothesis. It follows that there was a statistically significant difference in cognitive uncertainty reduction between PBL learners with ILS training and PBL learners without ILS training.

### Testing null hypothesis $H_{01b}$

A 2 x 2 between-group Factorial ANOVA was performed on posttest affective dimension of the posttest uncertainty scores for all four groups of participants. From the results in table 3, there was no significant interaction ($F_{1,74}$ =0.355, p = 0.553) between main effects. It can be concluded that no pretest sensitisation was present. An investigation on treatment effect of posttest scores ($F_{1,74}$ = 5.066, p=0.027) revealed a statistically significant result. This implied that infusion of ILS training in PBL design had an effect and this effect existed without any prerequisite. The affective uncertainty of PBL learners with ILS training was significantly reduced (posttest scores lower than pretest scores) despite the presence of pretest. Thus, $H_{o1b}$ was rejected in favour of its alternative hypothesis. It follows that there was a statistically significant difference in affective uncertainty reduction between PBL learners with ILS training and PBL learners without ILS training.

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### Testing null hypothesis $H_{01c}$

A 2 x 2 between-group Factorial ANOVA was performed on physical dimension of uncertainty posttest scores of all four groups of participants. From the results in table 3, it was evident that no significant interaction ($F_{1,74}$ =3.267, p = 0.075) between the two main effects. It can be concluded that no evidence of pretest sensitisation was present. An investigation on treatment effect of posttest scores ($F_{1,74}$ = 3.632, p=0.061) indicated that no statistically significant result was obtained. Since the above test disregards the pretest information available for the pretest groups, it should not be considered conclusive evidence against the treatment (Braver, 1988). Thus, ANCOVA on posttest scores with pretest scores as covariant was performed to compare the physical uncertainty scores between groups $E_1$ and $C_1$. The results were shown in table 4. Result from ANCOVA, ($F_{1, 37}$ = 1.55, p = 0.221) indicated similar finding to previous results, no statistically significant result was obtained.

**Table 4. ANCOVA for physical dimension of uncertainty for groups $E_1$ & $C_1$**

| Dependent Variables | Source | MS | df | F | p |
|---|---|---|---|---|---|
| Physical Uncertainty | Treatment | 54.28 | 1 | 1.55 | 0.221 |
| | Error | 35.03 | 36 | | |
| | | | | | |
| | | | | | |

An independent sample t-test was thus conducted on post-test scores of physical dimension of uncertainty for groups $E_2$ and $C_2$. The result was shown in the table 5. Result from independent sample t-test showed that 19 participants in the treatment group ($M$ = 25.58, $SD$ = 2.93) and 20 participants in the control group ($M$ = 30.25, $SD$ = 4.99), demonstrated a significant difference in physical dimension of uncertainty level ($t$[37] = -3.538, $p$ = .001). This indicated that the physical uncertainty of PBL learners in PBL design with infusion of ILS training was significantly lower than those learners in PBL design without infusion of ILS training. Thus, $H_{o1c}$ was rejected in favour of its alternative hypothesis. It follows that there was a statistically significant difference in physical uncertainty reduction between PBL learners with ILS training and PBL learners without ILS training.

**Table 5. Independent sample T-test on posttest physical uncertainty for group $E_2$ & $C_2$**

Independent Samples Test

| | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
| | | | | | | | Lower | Upper |
| PHYSICAL dimension of the uncertainty | Equal variances assumed | -3.538 | 37 | .001 | -4.6711 | 1.3202 | -7.3461 | -1.9960 |
| | Equal variances not assumed | -3.584 | 30.979 | .001 | -4.6711 | 1.3034 | -7.3294 | -2.0127 |

Since all these subsidiary null hypotheses were rejected in favour of the alternative hypotheses, it enabled the researcher to predict that there was a significant difference in uncertainty reduction between PBL learners with ILS training and PBL learners without ILS training.Further test on this hypothesis was conducted to verify this prediction.

A 2 x 2 between subjects Factorial ANOVA was performed on overall scores of posttest uncertainty of all four groups. Table 6 showed that there was no significant interaction ($F_{1,74}$ =1.931, p = 0.169) between the two main effects. It can be concluded that no pretest sensitization was present. An investigation on treatment effect on posttest scores ($F_{1,74}$ = 5.44, p=0.022) revealed a statistically significant result. This implied that ILS training has an effect

and this effect existed without any prerequisite. The ILS training thus significantly reduced uncertainty of university students (posttest scores is lower than pretest scores) despite the presence of pretest. Thus, as anticipated in the prediction, $Ho_1$ was rejected in favour of its alternative hypothesis. It follows that there was a statistically significant difference in uncertainty reduction between PBL learners with ILS training and PBL learners without ILS training.

**Table 6. 2 x 2 Between Subjects Factorial ANOVA for Posttest uncertainty scores**

Tests of Between-Subjects Effects

Dependent Variable: FTOTALUN

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 1318.869[a] | 3 | 439.623 | 2.506 | .066 |
| Intercept | 389517.126 | 1 | 389517.126 | 2219.983 | .000 |
| TREATMEN | 955.231 | 1 | 955.231 | 5.444 | .022 |
| PRETEST | 17.538 | 1 | 17.538 | .100 | .753 |
| TREATMEN * PRETEST | 338.818 | 1 | 338.818 | 1.931 | .169 |
| Error | 12984.003 | 74 | 175.459 | | |
| Total | 404666.000 | 78 | | | |
| Corrected Total | 14302.872 | 77 | | | |

a. R Squared = .092 (Adjusted R Squared = .055)

An independent sample t-test was also performed for the two groups with pretest and posttest, Results in Table 7 showed that the reduction of uncertainty scores between the posttest and pretest, DELTAUNC, for 20 participants in the experimental group (M=16.10, SD = 14.35) and 19 participants in the control group (M=6.79, SD = 13.92) demonstrated a significant difference in uncertainty reduction ($t$[37] = 2.055, $p$ = 0.047). These findings can also infer that uncertainty reduction of PBL learners with ILS training outperform PBL learners without ILS training.

**Table 7. Independent sample t-test for uncertainty reduction between $E_1$ and $C_1$**

Group Statistics

| | group identifer | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| DELTAUNC | experimental group with pretest posttest | 20 | 16.1000 | 14.3523 | 3.2093 |
| | Control group with pretest posttest | 19 | 6.7895 | 13.9227 | 3.1941 |

Independent Samples Test

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 95% Confidence Interval of the Difference | |
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower | Upper |
| DELTAUNC | Equal variances assumed | .080 | .779 | 2.055 | 37 | .047 | 9.3105 | 4.5315 | .1288 | 18.4922 |
| | Equal variances not assumed | | | 2.056 | 36.982 | .047 | 9.3105 | 4.5279 | .1360 | 18.4850 |

## IMPLICATION

The result from this study will serve as an indicator of the success of reforms made on the university teaching approach. Educators and facilitators can use the results of this study to learn how information literacy skills program can be infused in the PBL approach to overcome the challenge of implementing PBL in their courses. The study provided

information on the strength of collaboration between facilitators and librarian in designing a tailor-made information literacy skills training session for PBL learners to accommodate their needs. One implication is that universities and colleges begin to emphasise information literacy as a standalone course or infusing into the curricula can significantly impact students' uncertainty reduction in PBL environment. While this study cannot provide a guideline for adoption of PBL approach in every course in higher education, all courses could consider infusion of information literacy skills training by emphasising the respective subject matter into their curricula. This will train students to be information literate and facilitate lifelong learning, transforming the skills from student empowerment into knowledge worker empowerment in their future profession.

## CONCLUSION

In this study, students demonstrated high level of uncertainty in the pretest provide the evidence of incorporation of uncertainty in the PBL learning tasks. The uncertainty may have reduced after seeking the information to fill the gap. The more confident they are in seeking information, i.e., more competent in ILS, the better uncertainty reduction and understanding in the resolution of the problem, consequently perform better in the learning tasks. The positive results gained due to the experimental intervention confirmed the effectiveness of infusion of information literacy skills in student empowerment. This intervention encompasses problem solving skills, critical thinking ability, team work, effective information gathering and use the information ethically to reconstruct the information into knowledge and communicate among the members within the group. The success of the intervention endorses the successful implementation of PBL approach in helping students to overcome the anxiety due to uncertainty built in the authentic learning task in PBL. The information literacy skills required by the students have to be identified in advance and planned with explicit learning objectives based on the knowledge, skills and attitudes required by the other educational components in the curriculum. Much of the challenge lies in identifying the information knowledge and skills actually needed by students, teachers/tutors and ultimately practitioners and then work to incorporate these into the curriculum (Rankin, 1996). The result from this study will serve as an indicator to the success of reforms made on the university teaching approach.

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