Lightening Up a New AI Cognitions and Performances for Engineering Students' Problem-Based Learning in Nature General Education Programs

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Abstract. The purpose of this research focused on designing artificial intelligence (AI) life learning texts for problem-based learning (PBL). Starting students in life AI scientific knowledge experience of practical value. This research used the effective evaluation tool to evaluate the learning results and feedback of 83 university students, and obtained the following four results: (1) to design three AI teaching units on the social application situational issues in life science; (2) to develop authentic tools with a good validity and reliability (Cronbach's α, 0.946) for students' open-ended questions of the AI course PBL learning results and PBL attitude questionnaire with AI situational issues; (3) to present students' logical reasoning and activation ability, and improve the cognitive levels of problem-solving by quantitative analysis of learning achievements; (4) to show that the factor of students disposition AI courses is the most important for their impact on learning attitudes by one-way ANOVA.

Keywords: Artificial intelligence · Problem-based learning · Cognitive levels · Learning performances

1 Introduction

The 21st century is the innovation era of knowledge economy, the rapid rise of new technology industry, in order to meet the fourth era of scientific and technological revolution, Artificial Intelligence (AI), Internet of Things (IOT) and 5G are quietly entering our life circle. With the rise of AI around the world, AI will bring unprecedented changes to human society, AI has become the current learning. In recent years, students' interest in the meaning of AI in social applications has continued to grow, making AI not only appear in their own fields, but also play an interdisciplinary role in the application of tools (Rihtaršič et al. 2016). However, most students' cognition and application of AI is still limited, how to face the talent demand in the new century when AI becomes the core of the fourth scientific and technological revolution, so that students can grasp the

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development trend and context of AI, learn and experience new technology, has become the focus of attention in many countries around the world.

According to this, advanced countries have been actively involved in AI research and development and education site integration (Alimisis 2013). Then, the AI in the information teaching education research is not so much and teaching integration at the university level is more limited. The current AI curriculum and teaching still have some problems that students on AI's social and historical literacy still only stay in the knowledge concept of the machine itself (Benitti 2012). Further general teaching strategy activation, construction and learning effectiveness analysis still need to invest in more research and development (Altin and Pedaste 2013; Sullivan and Heffernan 2016). Educators believe that activated learning strategies are an important way to improve the learning effectiveness of students in the higher education system (Prince 2004; Nasr et al. 2017). The importance of these strategies according to the interest of students will have a real need to be selected. However, PBL is a student-centered teaching strategy to improve their learning effectiveness (Mundilarto 2018; Savery 2006). The strategy has been applied to various subjects teaching and learning by educators.

To sum up, this study designs PBL in the social application of AI (AI-PBL) life situation teaching texts to provide the experience of authenticity problems. Students will through active learning group discusses to propose their learning issues, to determine the scope of knowledge required, and to conduct the necessary research in order to present their problem-solving skills. The narrative skills of engineering students will be enhanced by the PBL strategy in the course "Science and Technology Society and Life". Therefore, students' learning achievement, attitude and interviews will be conducted to improve students' experience of scientific knowledge, cognitive understanding, and their learning performances of AI society's practical value in life in this research.

2 Research Purposes and Question

In summary, the main purpose of this study is to design the life situational teaching texts of AI society application in PBL. Students take the initiative and cooperate in learning to start their experience of scientific knowledge for the AI practical value in life, to enhance cognitive understanding, and to successfully complete the problem-solving in teaching. In order to make teaching more diverse and interesting, and learning to become more meaningful, thereby improving the effectiveness of students in science learning. Therefore, the focus questions of this research is as follows:

1. How to design and develop AI social application life situation experience teaching texts of PBL?
2. How to develop an evaluation tool with validity and reliability for students' pretest and posttest test items, learning attitude questionnaire and interview test items to assess their learning performances?
3. How to explore students' independence variables of different argument gender, enrollment, frequency of using 3C products, disposition of AI issues, 3C equipment and AI-related knowledge background for their cross-disciplinary experience learning attitude statistical analysis after PBL strategic teaching?
4. What is students' feedback reflection in interview of PBL strategic learning?

3 Literature Review of PBL

PBL teaching strategy is a problem-based and student-centered collaborative teaching method (Prince and Felder 2006; Jansson et al. 2015). This method is a case learning which is often varied according to teaching objectives and design (Prince and Felder 2006). In PBL, students acquire problem-solving skills; and in group learning, increase their self-confidence. PBL teaching method also enhances students' self-learning and lifelong learning skills (Hung et al. 2008). The biggest difference between PBL teaching and other methods lies in PBL use ill-structured problem as a learning situation, to start students' learning process, to link learning experience through learning problems in life, and to stimulate their motivation. Therefore, a meaningful learning process is obtained by PBL learning strategies, such as actively identify learning issues, apply self-learning, problem reasoning and solution (Savery 2006).

In the process of PBL teaching, students play an active role in learning, identifying problems, constructing problems and solving problems, while teachers play the role of promoters, supporters and monitors of learning, constructing a safe learning environment and assisting students in their learning functions (Dolmans and Schmidt 2006). Researchers (Belt et al. 2002; Yoon et al. 2014; Jansson et al. 2015) point out that PBL strategy can help improve students' problem solving, self-learning and self-assessment skills, increase students' learning and in-depth understanding of the subject in science. (Gunter and Alpat 2017) also found that PBL has significant results for students' scientific achievements. (Selco et al. 2003) designed the study of PBL learning strategy for seawater analysis and found that students were able to produce high-quality study reports. (Sendag and Odabasi 2009) using online PBL courses, found that this strategy does improve student critical thinking.

Based on these studies, this research takes PBL as the teaching strategy to design AI's life teaching texts applied in society as the learning connotation, and tries to explore students' learning processes, problem-solving abilities, learning attitude and feedback analysis.

4 Methodology

4.1 Participants of Research and Ethical Approval

Participants include engineering students and experts in the relevant fields, divided into the following:

In students, this research takes the students of author's school as research samples, mainly from the sophomore students who take the general course of "Technology Society and Life". Students from different departments of the three colleges of the whole school, a total of 83 students participated (distributed gender from 48 boys and 35 girls; age about 20–22 year-old), the curriculum discussion in a group of 6 to 8 people, homogeneity divided into six experimental groups by group cooperative learning.

In the relevant fields of experts, including scientific education experts, sociology experts and psychology experts, such as a total of seven in three fields, and seniority in more than 10 years, mainly in assisting the questionnaire question logic, focus and fluency of the examination, in order to construct the appropriate expert content validity.

4.2 Instrument Design

The instrument of this research contains open-ended questions and PBL learning attitude questionnaire. All the design instructions for the research evaluation instrument are as follows:

Development of Open-Ended Questions. This study designs the draft of the open-ended questions which invites 1 scientific education scholar, 3 information education communication scholars, 1 humanities education scholar and 2 artificial intelligence education scholars, and a total of seven people to conduct the question content and logical examination. The first draft has been revised to form an expert content validity. The open-ended questions are designed to assess students' cognitive understanding of AI in life social application situational issues.

Development of Learning Attitude Questionnaire. The learning attitude questionnaire consists of two parts, the first part is the basic background information of the students, and the second part is Likert structured learning attitude questionnaire. The Likert five scale consists of five options: "very agree", "agree", "ordinary", "disagree" and "very disagree".

Basic background information of students aims at providing the independent variable of the research framework. Then, six aspects of the learning attitude questionnaire provide the dependent variable of the research. The first draft of the "AI Situational PBL Attitude Questionnaire" was adapted from author's questionnaire (Su 2016) and the seven experts were invited to conduct substantial review, revision and deletion. The revised questionnaire is examined in 109 academic-year. A total of 44 students participated in the pilot test. Attitude questionnaire with the main component analysis, Bartlett spherical test reached significant, indicating suitable for factor analysis. There are six aspects considered in main component analyses of the questionnaire. The Eigenvalue obtained is above 1.0 with an accumulative explanation variation of 71.85%. The total scale score of the Cronbach's α 0.946 reached the satisfactory degree of internal consistency in accordance to students' learning attitude. According to the research of (Salta and Tzougraki 2004) reliability, the result of coefficient reliability over 0.900 gave better indication of learning scale which confirmed the high internal consistency of this questionnaire (Su 2008, 2018).

All findings of factor analyses were classified into six dominating dependent variables of learning attitude: A1 (attitude towards situation-based PBL courses), A2 (attitude towards science instructors), A3 (attitude towards multimedia learning environment), A4 (attitude towards AI-PBL students), Qa5 (attitude towards self-evaluation), and A6 (attitude towards statistical results) and these six variables are designed for further SPSS analytical developments. A total 31 test items in this questionnaire is used to explore affected factors of learning attitudes. A total result of pilot test indicated that mean score is 4.000, the standard deviation is (SD) 0.688, Cronbach's α value is greater than 0.9, according to the literature shows that the internal consistency of the scale is excellent (Salta and Tzougraki 2004; Su 2008, 2018).

4.3 Data Analysis

The data collected before and after the AI-PBL experimental teaching were computer coded (Arabic numerals in English) and viewed. The statistical method includes the internal consistency of the Cronbach's α, descriptive statistical analysis and one-way ANOVA. All statistical information is carried on the file of SPSS for MS Windows 22.0 software.

5 Results and Discussion

5.1 Designing AI-PBL Innovative Texts

PBL-guided multi-learning texts of AI life issues, such as face recognition system, self-driving cars and robots, were designed with Ausubel (1968) construction learning theory in this research. Instructor is the role of promoter and guide, design authentic AI in life social application situation teaching texts, the application of PBL to guide students to interactive learning, so that students ponder over and over again, strengthen the concept of cognition and application.

5.2 Analysis of Pretest and Posttest for Open-Ended Questions

Students' learning effectiveness are assessed and compared with pretest and posttest of open-ended questions. The scores are based on the design of Gunter and Alpat (2017). The percentage of students' response results shown in Table 1 and improved the overall conceptual cognitive level for pretest ones.

Table 1. Analysis of students' average responses rate (%) for open-ended questions between pre-tests and post-tests.

Cognitive level	Score	Mean	
		Pretest	Posttest
I	0	3.7	0
SM	1	29.2	15.7
PUSM	2	58.2	67.8
PU	3	8.1	14.8
CU	4	0.8	1.7

In summary, after the application of PBL conducted AI situation-based teaching posttest, the results showed that the blank volume students who did present incomprehension (I) decreased from 3.7% to 0%, the specific misconception (SM) students decreased by 13.5%, partial understanding with specific misconception (PUSM) increased by 9.6%, partial understanding (PU) students who increased by 6.7%, and clearly understood (CU) increased by 0.9%. Su' study (2017) suggested that aids help students to cultivate their

problem-solving skills and demonstration of reasoning ability. Cracolice et al. (2008) also pointed out that students' reasoning ability is related to the improvement of problem-solving skills. However, PBL teaching on AI situational issues is indeed very important for students' logical reasoning and active learning (Eichler and Peeples 2016; Sadler et al. 2016).

5.3 Analysis and Discussion for Learning Attitude Questionnaire

Descriptive Statistical Analysis. Effective recovery rate of the students' learning attitude questionnaire is 81.9%. The descriptive statistical analysis showed that overall mean (*M*) value is 3.713, the standard deviation(*SD*) is 0.596, and the total scale score of the Cronbach's α is 0.960. There were totally 31 items in the questionnaire which could be classified into six dominant aspects: A1, A2, A3, A4, A5 and A6.

- A1: students' learning attitude towards AI situation-based PBL courses.
- A2: attitudes towards teachers
- A3: attitudes to the multimedia learning environment
- A4: attitudes towards AI-PBL students
- A5: attitudes towards self-learning AI-PBL courses
- A6: views on AI-PBL course results

The mean (M) value above 3.50 revealed that students' learning attitudes were positive attributes (Su 2008), and the overall Cronbach's α value of 0.960 for the internal consistency in total scales which reached a good satisfactory degree of statistic results (Salta and Tzougraki 2004). This finding was an important echo for scholars' research (Adesope and Nesbit 2012; Lin and Atkinson 2011). Thus, PBL-guided learning could help students enhance their positive learning attitude (Adesope and Nesbit 2012).

One-Way ANOVA. Owing to AI-PBL group's blocking variable, a series of ANOVAs were guided for the multi-variants of the Wilks' Lambda parameter upon attitude survey samples of the six subscales in this research. Accordingly, a brief summary of individual learning attitude with the F-ratios, p-values, effect sizes (f), and Scheffé's post hoc comparisons was provided from independent variable of gender of students and disposition of AI courses.

Independent variable of gender of students (male, 24; female, 44) in six dependent variables, only aspect A4 has significant (F, 4.563; p, 0.036; f, 0.264), and girls are better than boys, Cohen's (1988) effect size f above medium (>.25), other dependent variables do not differ significantly.

The blocking variable for students' AI-PBL course disposition (very positive, 17; positive, 39; neutral, 12; negative, 0; very negative, 0) toward AI-PBL learning attitude stemmed from a series of ANOVA and combined participants. All six significant aspects, A1(7.644, 0.001, 0.491), A2(8.088, 0.001, 0.498), A3(4.699, 0.012, 0.380), A4(6.800, 0.002, 0.457), A5(3.253, 0.045, 0.316) and A6(5.712, 0.005, 0.418), were fit together in determining students' learning disposition toward AI-PBL nature general course. The dependent variables from A1 to A6 in Scheffe's post hoc comparisons showed that

students had expressed more learning attitudes in "very positive" orientations than those in "neutral" ones.

Students show a positive learning attitude from descriptive statistical analysis. Furthermore, in terms of students' learning attitude shows that the independent variable of AI-PBL course disposition is significant to all six dependent variables, representing students who like AI courses, and the influence on learning attitude is positive. Scholars (Alan et al. 2019; Mohtar et al. 2019) emphasize that integrating cross-disciplinary learning can help students improve their self-efficacy, ensure sustained interest in learning, and create better products.

6 Conclusions

After this research, developed a reliability assessment tool to evaluate engineering students' learning performances. According to the results of research and analysis, put forward the following some findings:

1 Texts designing will help the majority of students, so that they can learn and guide through
2 interaction, enrich their own learning connotation, and improve their learning visions.
3 Instrument developing will assess students' logical reasoning and activation ability, improve the cognitive level of problem solving, and make learning results better.
4 The descriptive statistical analysis of students' learning attitude shows positive thinking attributes.
5 One-way ANOVA indicates that the factors of students' natural science course disposition have an important influence on learning attitude.

This research introduces new thinking for problem-solving to promote engineering students' cognitive levels and become a decision maker. The future research will focus on integration of academic resources and cross-discipline leaning (such as STEM) in engineering classroom.

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