# The effect of problem-based learning on enhancing students' workforce competence

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ABSTRACT: After the international financial tsunami, the Taiwan Government implemented several policies to lower the unemployment rate in order to respond to the changeable global economic environment, and to adjust and reorganise the domestic industrial structure. As a result, the technological and vocational education system in Taiwan changed significantly. Therefore, Problem-Based Learning (PBL), which is commonly used and approved in medical education, was applied in this study to practical monograph courses in business management education in technological and vocational institutes, based on active research using a qualitative study. Students' learning data were collected during classroom participation, observation, teachers' instructional journals and semi-structured interviews. A quantitative study using a questionnaire survey was treated as the secondary method and a one-group pre-test and post-test design as a quasi-experiment was applied. The survey used a *workforce competence scale* developed by Yeh et al in 2010 and based on the Delphi technique, to probe into the effect of PBL on students' workforce competence.

## INTRODUCTION

After the international financial tsunami, in order to respond to the changing global economic environment and to adjust and reorganise domestic industrial structures, the technological and vocational education system in Taiwan changed significantly.

Unfortunately, courses of higher technological and vocational education in Taiwan (including technology-related colleges, technological and vocational institutes and technological university) cannot accomplish the goals for practical learning and the teaching of applications. Therefore, in order to meet the demand for technological and vocational skills in the new knowledge economy, curriculum planning reform and instructional development should be treated as priorities. In particular, most students are from vocational schools and their learning is through skills acquisition. Therefore, technological and vocational education should enhance the learning of other abilities in addition to their familiar core learning (skills acquisition).

The earliest concept of competence was proposed by David McClelland, a psychologist at Harvard University [1]. However, the term is differentiated among different cultures. Competence can be divided into Generic competence, Professional competence and Workplace competence [2][3]. Using the Delphi technique, Yeh et al developed a *workforce competence scale* to allow business and management students to self-examine their workforce competence [4].

Students recognise the core competences required by university students in the management field required by the current industrial cycle. Therefore, this study applied Problem-Based Learning (PBL), which is widely used and approved in medical education to practical monograph courses in business management education in technological and vocational institutes [5]. Although PBL is not widely applied to management education, Hallinger and Bridges demonstrated the feasibility of the application of PBL in management education [6].

Based on the motives above, the research purposes were:

1. To recognise the actual feelings and satisfaction of business and management majored students after experiencing PBL.
2. To recognise the actual feelings and satisfaction of business and management teachers after including PBL in practical monograph course teaching.
3. To recognise the changes in business and management majored students' workforce competence and learning outcomes before and after PBL.

## LITERATURE REVIEW

### Practical Monograph

Higher technological and vocational education in Taiwan emphasises practical study, and industrial and academic collaboration with industry. However, students' internships in industry usually cannot be properly arranged and it does not necessarily connect with the knowledge learned in class. Therefore, in technological and vocational institutes in Taiwan, there is a co urse called Practical Monograph (or Project Design), which supplements the above. Practical monograph integrates teachers' lectures in class and students' project study in industry. Practical monograph is basically different from classroom lecturing and aims to allow students to apply professional knowledge and theory learned and, further, to develop their primary exploration and research potential. Therefore, practical monograph aims to integrate the theories learned with practice and allows students earlier contact with industry. Further, practical monograph allows students to understand the business process of industry and so save future costs on training staff. In the meantime, students can also determine whether they are interested in the industry.

The objectives of the practical monograph course are to integrate theory; have an on-site visit; a questionnaire survey; statistical analysis and report writing, and so develop a student's independent thinking, practical experience and competence. Practical monograph expects students in groups to finish the formal papers or project reports by observing facts, collect related information, systematically analyse data, and discover problems and solutions before graduation.

### Problem-Based Learning

The rise of Problem-Based Learning (PBL) took place at medical colleges in the early 1960s. It is a learning method to implement constructivism. It is non-structured learner-centred education based upon learners' active problem-solving. Problem-based learning aims to encourage students to ponder on what to learn and how to learn dealing with issues with ambiguous structures and definitions and to change, modify and expand the cognition by collaborative learning. Although traditional lecture instruction allows students to obtain knowledge, students will not be able to solve real problems through the knowledge learned. Sage [7] and Stepien [8] suggested that PBL should integrate technology by various measures, such as email, briefing software, internet tools and special software.

In problem solving, since technology can provide more favourable and effective tools to select, confirm and organise information, learners can be creative with multiple dimensions and co-operate with each other to solve problems. Since PBL originated from medical education, and it can train students' in competences to deal with real problems, it is gradually becoming popular in law, business education, administration management, at engineering college and in nursing, chemistry, physics, educational psychology and educational administration. However, some scholars suggest that, although PBL is widely applied in medical education, it is rare in management education [5][9]. Tseng et al also indicated that in engineering education in the past, PBL was hardly included in research methods and instructional practice [10]. Therefore, Hallinger and Bridges applied PBL to management education and students' learning outcomes were better than those using ordinary learning approaches [8].

### Workforce Competence

Competence is the external behavioural performance involving knowledge, skill and attitude. It is a person's effective performance of values, attitude, inference and judgment [11]. Therefore, technological and vocational learning must cultivate key and problem-solving competences. The European Training Foundation (ETF) suggests that the competence criterion is the interface between technological and vocational education and the job market. In other words, in order to cultivate competent talents for industry, technological institutes must provide proper courses, which should reflect the demands of the job market. In order to reduce the gap in meeting these demands and improve the mapping of competences to industry needs, the competence criterion will be one of the best measures. Yeh et al defined workforce competence by using the Delphi technique [4]. The workforce competence includes a total of five core competences. These core competences can help universities to prepare appropriate curricula, and to guide business-majored students in learning the skills required by industry.

## DESIGN AND IMPLEMENTATION

### Action Research

Action research originated from the United States in the 1930s. The term was created by John Collier in 1945 [12]. In the 1960s, with educational reforms in Britain and Australia, it b ecame the model for curriculum development and teachers' advanced study. Lewin suggested that social issues were the drivers of social studies and he developed the social exploration model, with plan, action, observation and reflection [13]. Therefore, John Collier and Kurt Lewin became the main pioneers of action research, which particularly emphasises empirical cognition. It treats locality, practicability and problem-solving as purposes and combines researchers with actual workers to construct a

collaborative research team [14]. The concept of action research is popular in the educational field. Many educational scholars, such as Lawrence Stenhouse and John Elliott, are important promoters of action research in British education [15]. Lawrence Stenhouse first proposed the concept of *teachers are researchers*. He was the promoter of school-based curriculum reform. Elliot emphasised the importance of action to enhance reflection [16].

Through action research of educational courses, teachers can validate many problems in instruction and learning. By combining the characteristics of PBL and action research, the researcher plays the roles of instructor, learning helper and researcher. Therefore, at the beginning, the researcher analyses problems, designs teaching plans and, then, develops and implements instructional activities. Besides lecturing, the researcher will help students overcome the obstacles to learning. Two other teachers observe and record students' learning and teachers' teaching and also interview students and teachers. They conduct course learning evaluation and reflection and plan the next teaching programme. The cycle continues until the end of the course.

Questionnaire

The survey questionnaire of this study is based on the scale developed by Yeh et al called the graduate's workforce competence of a business department in technological and vocational institutes, and includes five core competences (see Table 1) [4].

Table 1: Structure of the workforce competence.

| Categories | Core Competences | |
|---|---|---|
| Workforce competence | 1. Teamwork<br>2. Self-learning<br>3. Self-discipline | 4. Leadership<br>5. Work ethics |

The definitions of workforce competence are equally applicable in any other business sectors, and include favourable attitude and personal characteristics generally required by potential employers, as well as a positive attitude toward learning. Workforce competence refers to the competence that can be applied to all sorts of different work environments, regardless of the type of business sector. This usually includes having a positive attitude towards both work and learning, as well as having favourable personal characteristics, which are generally preferred by potential employers.

Workforce competence usually cannot be learned directly from courses in classrooms but rather by imperceptible courses (such as teachers' teaching methods, school culture, etc). By observing knowledge, values, regulations or attitudes, students gradually internalise these components as part of their cognition, which eventually allow them to develop their sense of teamwork, self-learning, self-discipline, leadership, and work ethics competences.

For quantitative study, upon finishing the PBL teaching, the researchers conducted a survey by using the questionnaire called *scale of graduate's workforce competence of a business department in technological and vocational institutes*, to find, if there were any significant differences between pre-test and post-test results of workforce competence. The research framework is shown in Figure 3.

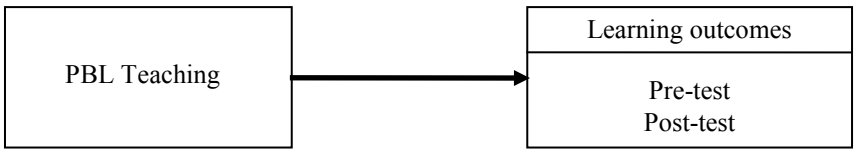


Figure 1: Research framework of survey questionnaire.

Sample and Data Collection

According to the research framework in Figure 1, the researchers divided the practical monograph into workforce competence and conducted qualitative and quantitative data collection, coding, analysis and reliability and validity tests. Before action research, PBL was applied to design the teaching plans. Then, instructional activities were implemented according to the teaching plans. The researchers recorded every detail in instruction, discovered problems through self-reflection and modified the action strategy in order to solve the problems. For the teaching of unit courses, recorded in this study were the students' situation in the classroom and through expert interviews, to indicate students' learning performance in each class, thus, giving a *classroom observation record*.

Therefore, when analysing data, the researchers obtained more relevant information. It would enhance the action research and function as a criterion for future research [7][8]. With regard to the learning sheet, according to scholars' suggestions, PBL should integrate technology through various means, provide more favourable and effective tools to

select, as well as confirm and organise information. Thus, learners will be creative in different dimensions and co-operate with each other to solve problems. Therefore, at the end of each teaching activity, the researchers asked the students to fill in a blog learning sheet and analysed these learning sheets so as to recognise their learning, attitude, progress, any obstacles and questions. It can not only diagnose the feasibility of instructional activities and the design of future activities, but also function as a criterion for evaluating students' learning outcomes.

After the end of each unit course, students were interviewed randomly. Thus, students freely shared personal opinions. The researchers learnt about their learning situations by carrying out informal interviews, reorganised and analysed the data to obtain more information in order to modify action research. The teacher's teaching journal includes three stages: 1) before implementation of instructional activity: this is related to the teachers' recognition of the practical monograph and its importance, as well as their thoughts and approaches to the instruction; 2) in implementation of instructional activity: this refers to the obstacles, the review of problems, responses and modifications to the implementation of the workforce competence; 3) after implementation of the instructional activity: according to students' learning outcomes and the collaborative teachers' suggestions and feedback, the researchers review, ponder on and modify the process of instruction and propose specific measures for future instruction or studies.

Each instruction is recorded by video camera. After instruction, the recording is transcribed and the researchers, then, review the reactions of teachers and students and use these as the criteria for the next instruction.

The survey questionnaire is based on a one-group pre-test and post-test design of a quasi-experiment and the Yeh et al scale of the graduate's workforce competence of a business department in technological and vocational institutes, and it is treated as a research tool [4]. The pre-test was conducted in the first week (before PBL) and the post-test was conducted in the 11th week (after PBL). There were 51 questionnaires collected with a 100% return rate.

Data Coding and Analysis

Qualitative data collected was reorganised and encoded. After the coding of qualitative data, the researchers reorganised the content according to industrial-orientated competences. The researchers, then, reviewed the primary data, generalised and analysed them to find the same or similar incidents; viewed content and development, and reflected on the instruction. Important concepts were analysed, to select the more representative and critical sentences and paragraphs. Quantitative data were analysed by SPSS 14.0 for Windows, descriptive statistics, a paired sample *t*-test, product-moment correlation and independent sample *t*-test.

Reliability and Validity Test

Since this study was based on a qualitative approach and the record refers to observation and interview, an inter-observer agreement test was performed. In order to avoid subjectivity, the researchers and the other two teachers were the observers. According to the formula below, reliability of inter-observer consistency was conducted and the reliability percentage was set to at least 80% [17].

Three reliability tests were conducted yielding 85.5%, 87% and 87.5%. The average outcome was 86.6%. In the interests of objectivity in a qualitative study, which used quantitative descriptions, the researchers invited two teachers from the business administration department of a technological university to review the internal and external validity.

Yeh et al's scale of the graduate's workforce competence of a business department in technological and vocational institutes was treated as the tool of the quantitative study [4]. The statistical analysis result showed that the mean (*M*) and mode (*Mo*) of each core competence were above 4 and the Cronbach α of internal reliability was 0.935. This shows that the consistency of core competences was high. Absolute values ( $|Mo\text{-}M|$ ) of the differences between modes and means of core competences were below one. The mean value of all the $|Mo\text{-}M|$ is 0.27. This means that the scale has good expert validity [18][19].

Data Analysis and Results

For the three teaching subjects conducted in 11 weeks, the researchers observed that after being involved with PBL, students were more concentrated on learning the course content. They actively analysed the problems, shared their opinions and were willing to pose questions for discussion. The result meets the research findings of Hong [20], Jih and Chang [21]. The following are a sample of four interview records of students:

S07: *I am an introvert. I thought it was a traditional teaching-type course in classroom. Instructional activity designed by the teachers draws my attention. Every time I encounter questions, I raised my hand and asked the teacher. By guidance, the teacher helped me to find the answer. I was really happy because I was finally able to open up and ask questions!*

S12: *The teacher helped us learn by blog and I could review the work on-line at home. I could also share my learning with classmates on forum. The course was fun.*
S29: *I have studied in the university for three years and it was the first time that I was not afraid of answering the questions in front of the teacher and classmates in class. In other words, I could freely share my opinions and thoughts.*
S49: *In this class, I first learned how to learn. I enjoyed the teacher's teaching approach.*
S43: *I felt warm by listening to my classmates' experience sharing. I have been studying with them for 3 years and I rarely had the chance to absorb the information.*

In practical monograph, PBL allows the students to internalise their learning and enhance their learning outcomes. Students become self-oriented learners; they learn to learn and gradually construct their workforce competence. It can enhance the students' learning motive and their learning outcomes to adapt to reality in the future workplace. The result agrees with the research findings of Wu [22], Hallinger and Bridges [6]. Four student interview records follow:

S41: *The teaching method of practical monograph was new to me and I would not feel bored in class.*
S51: *Through the interaction, I realised the importance of how to solve the problems, particularly the logic when analysing the problems. I could train myself step by step. It was a practical skill.*
S25: *Wow! I was interested in the research approaches and how to manage them? Finally, I learned the case study. From data collection, interview with employers and employees, content analysis, and induction key points, I have learned the knowledge and skills, which I could not absorb from textbooks.*
S40: *Currently, the society lacks ethics, particularly work ethics in the workplace. I enjoy the teacher's training of our responsibility and loyalty to work.*

Descriptive Statistics Analysis

There were 27 male (52.9%) and 24 female (47.1%) students in the class. Numbers of participants in the two groups were close. Likewise, as for *daily studying time* for 9 people (17.6%) were *None*, 28 participants (54.9%) were *within 1 hour*, 11 participants (21.6%) were *1-2 hours*, and 3 participants (5.9%) were *above 2 hours*. As for *planning after graduation*, 7 participants (13.7%) were *advanced study*, 34 participants (66.7%) were *employment* and 10 participants (19.6%) were *military service*.

Paired Sample *t*-Test

Table 2 shows the paired sample *t*-test of pre-test and post-test of 51 students for workforce competence, which reveal significant differences between pre-test and post-test. All mean values of post-test are significantly higher than the mean values of pre-test. Overall, the workforce competence also reveals significant differences between pre-test and post-test. In summary, PBL can actually enhance the workforce competence of business and management-majored students.

Table 2: Paired sample *t*-test.

| Variables | Pre-test ($n$=51) | | Post-test ($n$=51) | | $t$ value | $p$ value | 95%CI | |
|---|---|---|---|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* | | | *LL* | *UL* |
| Workforce competence | 18.16 | 3.11 | 19.78 | 3.75 | -2.24 | $p$<0.05 | -3.09 | -0.17 |

Note: $df = 50$

Independent Sample *t*-Test of Different Gender

According to Table 3, males and females do not reveal significant differences in scores of workforce competence. In other words, after PBL, males' and females' industrial-orientated competences will not be different because of gender.

Table 3: Independent sample *t*-test of different gender.

| Workforce competence | Male ($n$=27) | | Female ($n$=24) | | Sig (2-tailed) |
|---|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* | *t*-test |
| 1. Teamwork | 4.07 | 0.78 | 4.38 | 0.77 | -1.38 |
| 2. Self-learning | 3.85 | 0.95 | 3.92 | 0.83 | -0.26 |
| 3. Self-discipline | 4.07 | 0.78 | 4.04 | 0.69 | 0.16 |
| 4. Leadership | 3.48 | 0.98 | 3.79 | 0.88 | -1.18 |
| 5. Work ethics | 3.85 | 0.99 | 4.17 | 1.01 | -1.13 |

## CONCLUSIONS AND RECOMMENDATIONS

PBL was applied in this study to a practical monograph course of business management education in technological and vocational institutes. Both qualitative and quantitative studies were conducted. Through PBL, the researchers identified the influence on students' workforce competence and have suggested three conclusions for educational and industrial societies.

According to the observations made in the classroom and by interviews with students, after PBL, the instructional activity became more interesting to students. The learning method changed from static to dynamic. Blog-learning, in particular, can not only draw students' attention and increase their interests, but also allows students to review their work on-line and at home. The forum enhanced the interaction between teachers and students and among students. Students are satisfied with PBL.

By including PBL in practical monograph courses, teachers may feel there is an extra workload, such as teaching plans, observations in the classroom, interviews and journals of reflection, but after being familiar with the whole process of PBL, teachers can enjoy it and become satisfied with the students' learning motivation and improved learning outcomes. It significantly enhances the development of instructional knowledge and capability.

After PBL, the students' workforce competence in pre-test and post-test revealed significant differences. It showed that PBL is the teaching approach for training learners in a high level of competent thinking. Instructors in this study played the role of the promoters or instructors and learners gradually constructed knowledge through teamwork and self-learning. Students made significant progress on learning outcomes by being stimulated with *realistic* questions. The study's findings demonstrated the results of Hallinger and Bridges that PBL can be applied to management education and increase students' learning outcomes [6].

The scale set by Yeh et al of the graduate's workforce competence of a business department in technological and vocational institutes, was the tool for quantitative study applied in this study [4]. The result shows that it can measure the workforce competence of business and management-majored students in technological universities. Teachers can implement individual guidance or adjust course content and the teaching approach according to students' capabilities.

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## REFERENCES

1. McClelland, D.C., Testing for competence rather for intelligence. *American Psychologist*, 28, **1**, 1-24 (1973).
2. Weinert, F.E., Definition and Selection of Competencies: Concepts of Competence. Organization for Economic Co-operation and Development (1999).
3. Boddy, D., Paton, R. and MacDonald, S., Competence-based management awards in higher education? *Management Learning*, 26, **2**, 179-192 (1995).
4. Yeh, R.C., Chen, Y-C. and Kuo, S-H., Industry-oriented competency requirements of business administration majored technological university students in Taiwan. *World Transactions on Engng. and Technol. Educ.*, 8, **4**, 431-435 (2010).
5. Boud, D. and Feletti, G.I., *The Challenge of Problem-Based Learning*. London: Kogan Page (1998).
6. Hallinger, P. and Bridges E.M., *A Problem-Based Approach for Management Education: Preparing Managers for Action*. Dordrecht: Springer (2010).
7. Sage, S., A natural fit: problem-based learning and technology standards. *Learning and Leading with Technol.*, 28, **1**, 6-12 (2000).
8. Stepien, W.J., *Problem-Based Learning with the Internet, Grades 3-6*. Arizona: Zephyr Press (2002).
9. Wilkerson, L. and Gijselaers, W.H., Concluding comments. *New Directions for Teaching and Learning,* 68, **1**, 101-104 (1996) .
10. Tseng, K.H., Chiang, F.K. and Hsu, W.H., Interactive processes and learning attitudes in a web-based problem-based learning (PBL) platform. *Computers in Human Behavior*, 24, **3**, 940-955 (2008).
11. Lysaght, R.M. and Altschuld, J.W., Beyond initial certification: the assessment and maintenance of competency in professions. *Evaluation and Program Planning*, 23, **1**, 95-104 (2000).
12. Collier, J., United States Indian Administration as a laboratory of ethnic relations. *Social Research*, 12, **1**, 265-303 (1945).
13. Lewin, K., Action research and minority problems. *J. of Social Issues*, 2, **4**, 34-46 (1946).
14. *Introduction to Inquiry and Participation in Search of a World Worthy of Human Aspiration*. In: Reason, P. and Bradbury, H. (Eds), Hand-book of Action Research: Participative Inquiry and Practice, 1-14. London: Sage (2001).

15. McNiff, J., *Action Research: Principles and Practice*. New York: Macmillan (1988).
16. Elliott, J., *Action Research for Educational Change*. London: Open University Press (1991).
17. Cohen, J., A coefficient of agreement for nominal scales. *Educ. and Psychological Measurement*, 20, **1**, 37-46 (1960).
18. Osborne, J., Colins, S., Ratcliffe, M., Millar, R. and Duschl, R., What ideas-about-science should be taught in school science? A Delphi study of the expert community. *J. of Research in Science Teaching,* 40, **7**, 692-720 (2003).
19. Wen, J.R. and Shih, W.L. Exploring the information literacy competence standards for elementary and high school teachers. *Computers & Educ.*, 50, **3**, 787-806 (2008).
20. Hong, J.C., PBL teaching strategy. *Technol. and Vocational Educ. Bimonthly*, 61, **1**, 10-12 (2001).
21. Jih, H.J. and Chang, H.F., The instructional design model for problem-based learning. *Instructional Technol. and Media*, 55, **1**, 58-71 (2001).
22. Wu, C.S., Definition of educational terms: problem-based learning. *Educ. Research Monthly*, 97, **1**, 120 (2002).