Using Problem-Based Learning teaching model to promote the Self-Directed Science Learning Readiness and Science Learning Motivation of eighth-grade students

CHEN, Yu-Kai
Graduate Institute of Science Education, National Kaohsiung Normal University
YANG, Kun-Yuan
Graduate school of Education, Chung Yuan Christian University

Abstract: The object of this study is to realize the effectiveness of the problem-based learning (PBL) teaching model on the self-directed science learning readiness and science learning motivation of junior high school students. An unequal group pretest-posttest design was employed in this study. Two eighth-grade classes of a public junior high school in Tao Yuan country were selected to be the research sample, which divided into the experimental group (n=38) and the control group (n=38). The experimental group received the instruction which is based PBL teaching model, while the control group received regular lecture instruction. The quantitative analysis method included one-way ANCOVA, effect size while the qualitative data is to analyze the interview content and learning portfolios of the learners. The findings indicate that PBL teaching model has specific effects on both self-directed science learning readiness and science learning motivation of students. Furthermore, the students engaging PBL curriculum show some self-directed science learning and science learning motivation behaviors in the PBL process.
Keywords: problem-based learning, self-directed science learning readiness, science learning motivation, junior high school students.

Introduction

It is a ‘knowledge economy’ generation in 21st century, knowledge is becoming the most important property for all humanities. Because of the rapid change in the world, people have to maintain competence to overcome all of the difficulties in their life. Therefore, how to get knowledge by active learning is getting important. The goal of science education is to enhance the students’ scientific literacy, that is, to help students to understand the science concepts and the nature of science, to realize the relationship between science and technology in their life, and to develop the active learning skill in school and continue learning skill beyond school (National Research Council (NRC), 1996). Thus, the teaching and learning in science education should address not only the cognition component, but also the affective component to cognition (Tuan, Chin & Shieh, 2005).

In light of the goals, recently there has been a shift in attention from a focus on the

product of learning to an emphasis on determining the inquiry processes and self-directed learning. Problem-based learning (PBL) is an instructional model originally developed in medical school programs (Barrows, 1996), and later adapted for use in elementary and high school (Delisle, 1997). Barrows (1998) point out, PBL initiating learning with an ill-structured problem, using the teacher as a metacognitive coach, and cooperative learning in a small group. Ill-structured problems are those where (a) the initial situations lack the information necessary to develop a solution, (b) there is no single right way to finish the task of problem-solving, (c) when the new information is gathered, the problem definition changes, and (d) students will never be completely sure that they have made the best selection of solution options (Gallagher, Stepien, Sher, & Workman, 1995). In such problems, students hold all the learning responsibilities themselves.

As the review has shown, most classroom-based research on the extent to which PBL instruction is beneficial to students has been undertaken. Several studies have suggested the benefit of PBL teaching model in self-directed learning skills. According to Blumberg and Michael (1992), the students who received training in a PBL curriculum have better ability in using library and other related learning resource, in addition, they can self-report more details while using the learning resource. Hmelo, Gotterer and Bransford (1997) demonstrated that, PBL teaching model can promote the competence in constructing learning goals and data seeking skills, and the students tend to use hypothesis-driven way to build some learning issues in their learning process. LeJeune (2002) compared the PBL instruction with traditional teacher-centered instruction for self-directed learning in undergraduate computer science program, his research result showed that the effect of teaching method was statistically significant for the SDL performance measure with the PBL section demonstrating greater performance.

There have been a number of researches that have investigated how PBL teaching model benefit to students in self-directed learning, however, little literature has been published on affective component. While there is a strong assumption of a link between self-directed learning and motivation in PBL teaching model, little empirical evidence has been found to establish a direct relationship between the two variables. Although much work has been done to date, more studies need to be conducted to ascertain the effects of PBL teaching model in promoting the self-directed science learning readiness and science learning motivation. The purpose of this research is to investigate the effects of PBL teaching model on the self-directed science learning readiness and science learning motivation of eighth-grade students. The research question of this paper is threefold. The following questions are posed:
(a) What is the effect of PBL teaching model on the self-directed science learning readiness and science learning motivation of eighth-grade students ?

(b) What are the self-directed science learning behaviors of students during the PBL learning process ?
(c) What are the science learning motivation behaviors of students during the PBL learning process ?

Method

The section of this paper describes the research that has been undertaken in terms of the subjects, the research tools, the teaching procedures involved, and the data analysis methods that were employed.

Subjects

A total of 76 students from a public junior high school in Tao Yuan country of Taiwan were selected to be the subjects, which divided into the experimental group (N=38) and the control group (N=38). The experimental group received the instruction which is based on PBL teaching model, while the control group received regular lecture instruction. An unequal group pretest-posttest design was employed in this research.

Research tools

(a) Self-directed science learning readiness scale (SDSLRS) (Huang, 2003)

The purpose of this scale is to measure the self-directed science learning readiness of the subjects. Six subscales are developed: the metacognition strategy - execute - evaluation for science learning, the preference for science learning, the resource management strategy for science learning, the achievement motivation for science learning, the self-efficacy for science learning, and the metacognition strategy - plan.

(b) Students' motivation toward science learning (SMTSL) questionnaire (Tuan, Chin & Shieh, 2005)

The SMTSL is a standardized measure designed to predict science learning motivation of junior high school students. Six scales are developed: self-efficacy, active learning strategies, science learning value, performance goal, achievement goal, and learning environment stimulation.

(c) Semi-structured interview outline

The interview outline is constructed by the researcher. The goal of this outline is to realize the behaviors and tendencies of self-directed science learning readiness and science learning motivation. Following all the classes, 12 subjects were interviewed for approximately 20 minutes about their self-directed science learning readiness and motivation toward science learning.

Teaching procedures

The research frequency was four classes a week, and the all research time was lasting six weeks. In light of the literature review, the teaching procedures in this research included six phases. First, the teacher presented an ill-structured problem about the subject matter to students, so as to evoke the students' learning motivation. Second, students developed the learning issues by analyzing the ill-structured problem. At the same time, teacher checked the suitable extent of the students' learning issues. Third, students collected the data for learning issues. In this phase, students proceeded to do the self-directed learning. Forth, every group formed the initial problem-solving program by synthesizing and generalizing the learning outcomes from each member. Fifth, every group presented the final learning outcome for solving the problem. Sixth, teacher assessed the learning outcomes of each group, and guided all of the students to reflect and evaluate their ideas.

Data analysis

Both qualitative and quantitative data analyses were performed. For the quantitative data analyses, SPSS 10.0 statistical software package was used. To answer the research questions, three data analysis methods were involved. For the purpose of checking the effect of the experiment treatment, an analysis of covariance (ANCOVA) was used to compare the difference of the two groups on their SDSLRS and SMTSL scores. Furthermore, Thompson (2002) argued the effect size (ES) should be included in the quantitative data analysis of social science quantitative research. According to Cohen (1988), the effective value of ANCOVA was f. It actually reveals the degree to be low when the f value is smaller than 0.1, the degree to be low to medium when the f value is between 0.1~0.25, the degree to be medium to large when the f value is between 0.25~0.4, and the degree to be large when the f value is higher than 0.4. For the qualitative data analyses, researcher applied the describes of the subscales in SDSLRS and SMTSL to be the coding schema, for the purpose of analyzing students' behaviors and performances during the learning process.

Results and discussions

The effectiveness of the problem-based learning teaching model on the self-directed science learning readiness and science learning motivation

An analysis of covariance (ANCOVA) was conducted to detect if significant difference between students' post-test performance. The scores on the pre-test of SDSLRS and SMTSL were used as covariates. Table 1 shows the ANCOVA results of SDSLRS. It appears that the treatment has resulted significant impact on the experimental group students' self-directed science learning readiness. To realize the effect extent of this treatment for self-directed science learning readiness, we calculated the effect size. The effect size is 0.35. According to

Cohen (1988), the degree of effect is medium to large. Table 2 displays the ANCOVA results of SMTSL. It appears that the treatment has made a difference on the two groups' science learning motivation. The effect size is 0.81, the degree of effect is large. Both results show a striking effect of PBL teaching model on students' self-directed science learning readiness and science learning motivation. The results reveal that the PBL teaching model produced significantly greater self-directed science learning readiness and science learning motivation of eighth-grade students than the traditional teaching method. Overall, the results have been very positive.

Table 1: *ANCOVA results of SDSLRS*

Source of variation	SS	df	MS	F	P
Covariates	7.95	1	7.95	79.75	.000*
Between groups	0.85	1	0.85	8.58	.005*
Within groups	7.23	73	0.10		

*p<.05

Table 2: *ANCOVA results of SMTSL*

Source of variation	SS	df	MS	F	P
Covariates	6.50	1	6.50	76.95	.000*
Between groups	4.05	1	4.05	47.92	.000*
Within groups	6.17	73	0.08		

*p<.05

The self-directed science learning and science learning motivation behaviors

According to the interview, students' responses were generally positive. The result showed that PBL teaching model was generally well received by the students. Furthermore, the students' self-directed science learning behaviors in the PBL process included: (a) the students can present the related conceptions about their solving problem actively. (b) the students showed the analyzing and planning behaviors in their problem-solving process. (c) the students can manage their learning resource well. (d) the students performed the team work behaviors in their groups. (e) the students liked to research the science via PBL teaching model. (f) the students can frame the plans for solving problem and finish them practically. (g) they felt satisfied with their learning outcomes and showed high self-efficacy. Otherwise, the students' science learning motivation behaviors in the PBL process included: (h) they felt they have enough competence to learn the science well. (i) the students realized the learning issues via data collecting actively. (j) they became goal-directed in science learning. (k) in the PBL learning process, students got achievement feeling because of peer identification. (l) the students can promote the science learning motivation via group discussing.

Discussions

The aim of this research is to examine the effect of PBL teaching model on self-directed science learning readiness and science learning motivation. The research findings above are in line with previous studies. Gordon, Rogers, Comfort, Gavula, and McGee (2001) found that the PBL students realize the nature of PBL, including information seeking, high levels of challenge, small group work, and personal relevance of the material. Karabulut (2002) argued that PBL creates an environment where students participate in the learning process actively. Further, they can take responsibility for their own learning, become better learners to manage their learning time, identify their learning issues, and access resources. Galand, Bentein, Bourgeois, and Frenay (2003) pointed out, the PBL students use more deep-processing strategies and fewer surface-processing strategies. Furthermore, they indicated that PBL students use more adaptive strategies than students from a traditional curriculum. Our findings seem to support the other empirical studies above.

Although we did not intend to examine the relationship between self-directed science learning readiness and science learning motivation in PBL teaching model, we suggest this issue as a next step for further study.

Conclusions

In conclusion, PBL is a positive teaching model for popularizing. Nowadays, we emphasize the lifelong learning under the rapid changed social environment and should not ignore this education tide which is raising the individual to keep the motivation and ability of learning. After researching, we find that PBL teaching model is helpful to raise the self-directed science learning readiness and science learning motivation. Otherwise, the participants also show the specific self-directed science learning readiness and science learning motivation behaviors in the PBL learning process. Therefore, introducing PBL teaching model is worth in education needs and tide now and future. Our research results revealed that PBL enhances the self-directed learning skills and learning motivation of eighth-grade students. Up to this point, we suggest that junior high school teachers use PBL teaching model to improve students' learning affection component and to teach students how to learn.

References

Barrows, H. S. (1996). Problem-based learning in medicine and beyond: a brief overview. *New Directions for Teaching and Learning, 68*, 3-12.

Barrows, H. S. (1998). The essentials of problem-based learning. *Journal of Dental Education, 62*(9), 630-633.

Blumberg, P., & Michael, J. A. (1992). Development of self-directed learning behaviors in a partially teacher-directed problem-based learning curriculum. *Teaching & Learning in Medicine*, *4*(1), 3-8.

Cohen, J. (1988). *Statistical power analysis for the behavioral science.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Delisle, R. (1997). *How to use problem-based learning in the classroom*. Alexandria, VA: Association Supervision and Curriculum Development.

Gallagher, S. A., Stepien, W. J., Sher, B. T., & Workman, D. (1995). Implementing problem based learning in science classrooms. *School Science and Mathematics, 95*(3), 136-146.

Galand, B., Bentein, B., Bourgeois, K., & Frenay, E. M. (2003, August). *The effect of PBL curriculum on students' motivation and self-regulation*. Paper presented at the Biennial Conference of the European Association for Research on Learning and Instruction, Padova, Italy.

Gordon, P. R., Rogers, A. M., Comfort, M., Gavula, N., & McGee, B. P. (2001). A taste of problem-based learning increases achievement of urban minority middle-school students. *Educational Horizons, 79*, 171–175.

Hmelo, C. E., Gotterer, G. S., & Bransford, J. D. (1997). A theory-driven approach to assessing the cognitive effects of PBL. *Instructional Science, 25*, 387-408.

Huang, M. H. (2003). The research on developing self-directed science learning readiness scale. Unpublished master's thesis, National Kaohsiung Normal University, Kaohsiung.

Karabulut, U. S. (2002). *Curricular elements of problem-based learning that cause developments of self-directed learning behaviors among students and its implications on elementary education*. Unpublished doctoral dissertation, The University of Tennessee, Knoxville.

LeJeune, N. F. (2002). *Problem-based learning instruction versus traditional instruction on self-directed learning, motivation, and grades of undergraduate computer science students*. Unpublished doctoral dissertation, University of Colorado, Denver.

National Research Council (1996). *National Science Education Standards.* Washington, DC: National Academy Press.

Sungur, S., & Tekkaya, C. (2006). Effects of problem-based learning and traditional instruction on self-regulated learning. *The Journal of Educational Research, 99*(5), 307-317.

Thompson, B. (2002). What future quantitative social science research could look like: confidence intervals for effect sizes. *Educational Research, 31*(3), 25-32.

Tuan, H. L., Chin, C. C., & Shieh, S. H. (2005). The development of a questionnaire to measure students' motivation towards science learning. *International Journal of Science Education, 27*(6), 639-654.