



Original research

Practice and effectiveness of web-based problem-based learning approach in a large class-size system: A comparative study



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ABSTRACT

Problem-based learning (PBL) is an effective and highly efficient teaching approach that is extensively applied in education systems across a variety of countries. This study aimed to investigate the effectiveness of web-based PBL teaching pedagogies in large classes. The cluster sampling method was used to separate two college-level nursing student classes (graduating class of 2013) into two groups. The experimental group ($n = 162$) was taught using a web-based PBL teaching approach, while the control group ($n = 166$) was taught using conventional teaching methods. We subsequently assessed the satisfaction of the experimental group in relation to the web-based PBL teaching mode. This assessment was performed following comparison of teaching activity outcomes pertaining to exams and self-learning capacity between the two groups. When compared with the control group, the examination scores and self-learning capabilities were significantly higher in the experimental group ($P < 0.01$) compared with the control group. In addition, 92.6% of students in the experimental group expressed satisfaction with the new web-based PBL teaching approach. In a large class-size teaching environment, the web-based PBL teaching approach appears to be more optimal than traditional teaching methods. These results demonstrate the effectiveness of web-based teaching technologies in problem-based learning.

1. Introduction

In problem-based learning (PBL), the learning process integrates a series of complex and meaningful problems with students gaining scientific knowledge by problem solving in small groups (Dolmans and Schmidt, 1996). Using multifarious real-life situations to cultivate critical and analytical thinking, PBL inspires students to “learn how to learn.” This teaching strategy encourages students to learn energetically and cooperatively in small groups. The approach allows students to find the correct answers to posed problems using enquiry-based learning skills (Barron et al., 2008).

The aforementioned PBL approach is a student-centered methodology that is characterized by interactive collaboration between students where information is independently sourced (Neville, 2008). This approach invokes the use of real-life scenarios and group work as a means of learning. It has also been shown that PBL can allow students to achieve the required learning outcomes in an interactive format. The strategy also offers additional advantages that alleviate problems normally associated with scheduling conflicts and incurred costs (Nicholl and Lou, 2012). Online PBL formats have been trialed with varying degrees of success and although PBL approaches have been shown to be beneficial to students in many different disciplines, the outcomes

associated with this strategy are inconclusive in nursing education (Zhang, 2014). One such study compared the use of a conventional classroom education strategy with asynchronous problem-based learning for part-time public health students. The authors observed that the latter strategy did not disadvantage the associated students (de Jong et al., 2013). Greater affirmation of the approach was published following research conducted by Critz and Knight (2013) where the authors demonstrated that a collaborative learning approach that encompasses interactive activities can result in tangible benefits in graduate nursing education. In order to generate a better understanding of the effectiveness of web-based PBL approaches in learning and teaching, we attempted to investigate the effects of this teaching methodology in nursing management students.

Dr. Daniel Tosteson, Dean of Harvard Medical School, has referred to PBL as an effective and highly efficient teaching approach (Yiou and Goodenough, 2006). It is currently applied extensively in education systems across a variety of countries (Mogre et al., 2014). However, the PBL approach requires significant teaching resources and this usually necessitates restrictions on class size (McLean et al., 2006; Nanda and Manjunatha, 2013). Class-size reduction was not a viable option at our college where students majoring in clinical medicine and nursing are still taught in large-sized classes (150 students in a class). The necessity

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for large classes has historically been caused by high enrollment numbers and limitations with respect to teaching resources.

The development of web-based technologies has resulted in new ways to implement PBL in large classes. New teaching methods that are facilitated by web-based technologies have been applied in nursing education using the web-based PBL method with promising effects (McLean et al., 2006; Wang et al., 2007; Yao and Jiang, 2008; Zhao and Liu, 2011). These approaches foster real and virtual problem scenarios, real-time and time-delayed communication platforms for large cohorts, and the establishment, acquisition and organization of knowledge resources on a global scale. Web-based PBL also enables better communication between teachers and students. When deployed with conventional PBL teaching methods, web-based PBL facilitates the cultivation and promotion of greater self-learning and innovation in nursing and other professional education systems. As a consequence of these advantages, web-based resources have been utilized in nursing management teaching practices to improve the assimilation of important information in the health sciences. During the process of course construction we designed and implemented an experiment to evaluate the effectiveness of web-based technologies in facilitating student achievement and self-learning. The following is a description of the experiment that was conducted including the subjects that were recruited, the techniques that were used to improve their learning, the methods that were utilized to measure the effectiveness of the teaching strategies employed and the results of the web-based technologies efficacy experiment.

2. Subjects and methods

2.1. Subjects

A cluster sampling method was used to select 328 student nurses from the graduating class of 2013 at the College of Nursing at Shanxi Medical University. The former class was divided into two groups with 162 students designated as Class 1 and 166 students as Class 2. The participants were all second-year students; they had completed relevant common courses and basic nursing courses with a certain degree of knowledge application pertaining to the subject matter. Class 1 was assigned to the experimental group while Class 2 was the control group. For students' ages and previous grade point average, there was no significant difference between the groups ($P < 0.05$).

2.2. Ethics statement

Ethical approval for this investigation was obtained from the Ethics Committee of Shanxi Medical University.

2.3. Content of courses

The two groups of students received exactly the same course content. Both groups were provided with the same nursing management teaching resources and course-related information; a total of 40 teaching hours were allocated to each group. The course was completed in 6 weeks.

2.4. Teaching organization

Students in the control group were taught with conventional teaching methods that encompassed the use of previews, expository teaching and revision assignments. The students in the experimental group were taught using the web-based PBL method. This latter group used the internet for information acquisition and dissemination. The internet was also used to perform learning activities that are normally employed in traditional PBL classes. These process activities included:

(1) Web-based PBL assignments based on the content of the teaching

material and problem presentation case studies. Multimedia elements such as text, pictures, animations, videos, and audio were incorporated into problems that were presented on a website. This web-based presentation format also included concepts, principles, and knowledge points as well as tasks and requirements pertaining to cooperative problem solving. In addition, reference learning resources and tools were accessible online as well as examples and cases from similar case study problems.

- (2) Group discussion: Students were divided into small groups consisting of 8–10 persons. A group leader organized members to search for appropriate information and related documents. Each group leader also facilitated discussions aimed at solving case study problems through self-learning and group cooperation. The instructor, using either a student management platform website or the WeChat group, joined in discussions with each group for 1 h each week. This discussion period was used to answer student questions. This opportunity to interact with students allowed the instructor to understand the approach that the group was taking along with the progress towards resolution of the assigned case study. Throughout the process, the instructor led discussions pertaining to course goals, objectives and course content. The discussion format provided a structural framework for the assignments; they also afforded the opportunity to give direction to the students, thereby avoiding excessive diversion from the problems at hand.
- (3) Outcomes report: In the next class, each group presented the discussion results in the form of PowerPoint slides in the classroom. Students from other groups could freely ask questions and initiate further discussion. Meanwhile, the instructor identified and corrected any shortcomings or mistakes and then asked the students to analyze the causes behind those mistakes. This prevented misdirection and misinterpretation of the key questions.
- (4) Instructor conclusions: the instructor subsequently provided comments in relation to the discussions. Students were provided with comments in relation to knowledge acquisition. The conclusions were orderly and transversely connected with other relevant subjects. The knowledge points were organized in a manner that enabled students to assimilate the knowledge that was required to underpin the goals and objectives of the course. Additionally, the discussion results for each group and the instructor's conclusions were released on the course website for the purpose of inter-student and inter-instructor assessment.

2.5. Teaching outcome evaluations

- (1) Testing nursing management theoretical knowledge: after the teaching process, students were tested with the same examinations with respect to their knowledge of nursing management. The test questions were chosen from a question bank that was generated by the teaching-research group. The best possible score was 100. The total mark was broken down as follows: 40% for knowledge level (20% concept and 20% basic theory), 30% for understanding level, and 30% for application and analysis level.
- (2) Self-learning ability was assessed using an “instrument to measure the self-learning abilities of nursing students”. The latter learning instrument was developed by Cheng in 2010 (Cheng et al., 2010) and consisted of 20 items across the following four domains: learning motivation (5), planning and implementation (5), self-monitoring (4), and interpersonal communication (4). The 5-point Likert 5 system issues scores ranging from 20 to 100, with higher values indicating higher self-learning ability. The scale was adjusted by Wu and Luo (2013) with the results of the reliability test meeting survey demands, thereby enabling its use in mainland China. The electronic version is now available online (Wu and Luo, 2013).
- (3) Satisfaction assessment of the web-based PBL teaching mode: a self-designed questionnaire was used to survey student satisfaction in

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