A Model of Small-Group Problem-Based Learning In Pharmacy Education: Teaching in the Clinical Environment

Jeerisuda Khumsikiew, Ubon Ratchathani University, Thailand
Sisira Donsamak, Ubon Ratchathani University, Thailand
Manit Saeteaw, Ubon Ratchathani University, Thailand

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Abstract
Problem-based Learning (PBL) is an alternative method of instruction that incorporates basic elements of cognitive learning theory. Colleges of pharmacy use PBL to help students achieve anticipated learning outcomes and practice competencies. The purpose of this study was to implement and evaluate PBL in small groups of fifth year pharmacy students in the clinical environment. A PBL model was implemented for one day per week over a period of 15 weeks at clinical practice sites. PBL activities consisted of the provision of pharmaceutical care, collection of patients' base clinical data, evaluation of therapeutic regimens, and development of SOAP notes, peer feedback, and case wrap-up sessions. Data were collected from 36 students who participated in the model by the completion of a 17-item questionnaire using a 5-point Likert scale about their competencies before and after finishing the course (Cronbach's Alpha 0.96). The students also completed an 11-item questionnaire using a 5-point Likert scale about their satisfaction with the course (Cronbach's Alpha 0.87). This data of competencies and satisfaction were analyzed by paired sample t-test and descriptive statistics respectively. The findings of this study indicated that the students' competencies increased after the implementation of the PBL course. Also, it was found that all the clinical skills regarding the application of didactic knowledge to direct patients' care activities, such as the identification, prioritization, and solution of therapy drug-related problems, and clinical communication with patients and/or other members of the interdisciplinary team, were statistically significant ($P < 0.05$). In regard to satisfaction, the mean scores of the responses ranged from high to the highest levels and most of the modes were 4. Overall, it was concluded that the PBL model enhanced the pharmacy students' competencies and the students were satisfied with the course.

Keywords: Pharmacy education: Problem-based learning: Clinical environment

1. Introduction

Problem-based Learning (PBL) is an alternative method of instruction that incorporates basic elements of cognitive learning theory. It is a student-centered approach that empowers self-directed learning through the development of problem-solving skills in real-world practice situations (Savery, 2006).

PBL has been increasingly used in pharmacy education since 2000 when the American Council on Pharmaceutical Education indicated that "the educational process should promote lifelong learning through the emphasis on active, self-directed learning and the curricula should include teaching strategies to ensure the adeptness of critical thinking and problem-solving" (American Council on Pharmaceutical Education, 2000: p. 52-53). The American College of Clinical Pharmacy (ACCP) also suggested that pharmacy educators need to place more emphasis on the preparation of students in problem-solving, critical thinking, ethics, communication, and self-directed learning because of the expansion of the scope of pharmacy practice, resulting in pharmacists' involvement in more patient care responsibilities. Pharmacists' roles in today's health care system requires greater problem-solving capabilities, effective thinking abilities, sound decision-making skills, and effective communication (ACCP, 2000, pp. 991-1020). As a result, many schools and colleges of pharmacy use PBL to help students achieve anticipated learning outcomes and practice competencies while developing problem-solving, critical thinking, and decision-making skills (Culbertson, Kale & Jarvi, 1997, pp. 18-25).

PBL has been used in a number of pharmaceutical education courses and there have been many reports published that describe the experiences with this method (Culbertson, Kale & Jarvi, 1997, pp. 19-26). Several studies showed the positive impacts of PBL on students' learning behavior, knowledge, skills, and attitudes (Hamoudi, Nagavi & Al-Azzawi, 2010, pp. 206-219). The results of current meta-analysis indicate that the PBL curriculum seems to improve the academic performance of pharmacy students when compared to traditional methods of instruction (Galvao, Silva, Neiva, Ribeiro & Pereira, 2014, pp. 1-7).

The purpose of this study was to implement and evaluate PBL in small groups in an elective course for fifth year pharmacy students in the clinical environment.

2. Literature Review

Overview: definition, characteristics, effectiveness of Problem-based Learning

PBL represents a major development and change in educational practice that continues to have a large impact across multiple disciplines worldwide. It has been used successfully for over 30 years and has been endorsed by a wide variety of national and international organizations, such as medical education and medical colleges (Muller, 1984; Walton & Matthews, 1989, pp. 542-558), the World Health Organization (WHO, 1993), nurse education (English National Board, 1994), and pharmacy education and pharmacy colleges (Ross, Crabtree, Theilman, Ross, Cleary & Byrd, 2007).

PBL has been defined in many ways to refer to a number of contextualized approaches to teaching and learning anchored in concrete problems (Evenson & Hmelo, 2000). Barrows, a pioneer in the field of PBL, defined it as:

> the learning that results from the process of working toward the understanding or resolution of a problem. The problem is encountered first in the learning process and serves as a focus or stimulus for the application of problem solving or reasoning skills, as well as for the search for or study of information or knowledge needed to understand the mechanisms responsible for the problem and how it might be resolved (Barrows, 1986: p. 481-486).

Albanese and Mitchell (Albanese & Mitchell, 1993: p. 52-81) provided a much-quoted definition stating that "PBL at its most fundamental level is an instructional method characterized by the use of patient problems as a context for students to learn problem-solving skills and acquire knowledge about the basic and clinical sciences." Vernon and Blake (Vernon& Blake, 1993: p. 550-563) defined PBL by its instructional design components, students' cognitive processes, and teacher's role, saying that it is:

> a method of learning (or teaching) that emphasizes (1) the study of clinical cases, either real or hypothetical, (2) small discussion groups, (3) collaborative independent study, (4) hypothetico-deductive reasoning, and (5) a style of faculty direction that concentrates on group progress rather than imparting information.

In general, PBL is an instructional (and curricular) learner-centered approach that empowers students to integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem (Savery, 2006, pp. 9-20).

Barrows suggested that PBL consisted of six essential elements (Barrows, 1986: p. 481-486). These are: (1) it is student-centered, (2) it involves small student group environments, (3) the tutor works as a facilitator or guide, (4) authentic problems are primarily encountered in the learning sequence, before any preparation or study has occurred, (5) the problems encountered are used as a tool to acquire knowledge and the problem-solving skills necessary to eventually solve the problems, and (6) new information needs to be acquired through self-directed learning.

Positive effects of PBL on student learning have been shown in several previous studies, including optimal learning performance, particularly in the area of knowledge retention, integration of basic science knowledge for the solution of clinical problems, self-directed learning skills, and increased intrinsic interest in subject matter (Major & Palmer, 2001, pp. 4-9). Statistical analyses in one study in East Asia, an area known for its reliance on traditional approaches to teaching and learning, suggested that PBL can exert a positive impact on instructional effectiveness, especially in action-directed learning, student engagement, and assessment and feedback (Hallinger & Lu, 2011, pp. 267-285). Galvao, Silva, Neiva, Ribeiro and Pereira showed that it improved the academic performance of pharmacy students when compared to traditional methods of instruction (Galvao, Silva, Neiva, Ribeiro& Pereira, 2014).

3. Design of a Problem-based Learning Model for Small Groups in a Course titled *Special Problems in Pharmacy Practice*

3.1 Course description

Special Problems in Pharmacy Practice is an elective course of three credit offered to fifth year pharmacy students. The course is designed to allow students to apply didactic knowledge to direct patient care activities and practice their pharmacy knowledge in real-life sites. Students apply their knowledge of patho-physiology, pharmacology, pharmacokinetics, and pharmacotherapy to optimize patient care in a variety of specialty settings, concentrating on patient-specific pharmacotherapy, evidence-based medicine, medication use evaluation, and effective communication with patients and healthcare professionals.

3.2 Course Objectives

Upon completion of this course, students will be able to:

- Review patients' profiles and clinical data gathered from patients and patients' medical records, such as OPD cards and IPD charts
- Design an appropriate treatment plan and evidence-based therapeutics regimens for individual patients
    - Specify therapeutic goals for individual patients incorporating the principles of evidence-based medicine that integrate patient-specific data, disease and medication-specific information, ethics, and quality of life considerations
    - Design patient-centered regimens that meet the evidence-based therapeutic goals established for patients, integrate patient-specific information, disease and drug information, ethical issues and quality of life issues, and consider pharmaco-economic principles
- Design patient-centered, evidenced-based monitoring plans
    - Specify efficacy monitoring parameters for therapeutic regimens that effectively evaluate achievement of patient-specific goals
    - Specify toxicity monitoring parameters for therapeutic regimens for which adverse effects may occur
- Recommend or communicate evidence-based therapeutic regimens and corresponding appropriate monitoring plans to other members of the interdisciplinary team and patients in a way that is systematic, logical, accurate, timely, and secures consensus from the team and patients.
- Practice communication skills through the provision of counseling to patients and caregivers, including information on medication therapy, adverse effects, compliance, appropriate use, handling, and medication administration
- Refer patients to appropriate health care providers when they have health care needs that cannot be met by pharmacists based on patients' acuity and presenting problems
- Devise a plan for follow-up for a referred patient.

3.3 Educational Environment

A PBL model was implemented on one day per week for a total of 15 weeks for the elective course *Special Problems in Pharmacy Practice* to maintain compliance with the accreditation standard.

Strategies to promote student learning outcomes consisted of lecture-based teaching and problem-based learning in clinical practice sites with a teacher acting as a facilitator.

In the lecture-based teaching (3 weeks), clinical topics consisted of how to gather data, tips for the use of SOAP, introduction to the process of medication use, and medication evaluation in oncology, psychiatric, and community pharmacy.

In the clinical practice sites rotations (9 weeks), each student had the opportunity to provide clinical pharmacy services in three randomly assigned practice sites. The clinical practice sites included an acute care in internal medicine ward, oncology ward, psychiatric ward, and community pharmacy care in a community pharmacy. Each student spent three weeks at each of three sites.

In case wrap-up sessions (3 weeks), the student then completed a case presentation with a teacher in the faculty.

The following is a list of activities representative of pharmacy students' responsibilities during the rotations in the internal medicine ward and community pharmacy.

In the internal medicine ward:

- Complete pharmacists' ward rounds with hospital preceptor and faculty teacher
- Provide pharmaceutical care based on patients' needs by the identification and resolution of problems in individual patients
    - Review patients' profiles and clinical data-gathering from patients and patients' medical records, such as OPD cards and IPD charts
    - Review of laboratory data to monitor for appropriate dosage of drug therapy
    - Evaluation of all medication regimens for appropriateness and cost-effectiveness
    - Identification of and resolution of any drug-related problems
    - Proactive involvement in selection, modification, and monitoring of drug therapy
    - Provision of medication information to interdisciplinary team, such as physicians, nurses, and patients
    - Monitor and report adverse drug reactions
- Record and report pharmacists' SOAP notes for individual patients
- Discuss with the preceptor and teacher about drug-related problems and solutions.

In the community pharmacy:

- Provide pharmaceutical care based on patients' needs by the identification and resolution of problems in individual patients

    - Complete clinical data-gathering from patients
    - Perform differential diagnosis based on patients' presenting signs and symptoms
    - Design medication regimens for appropriateness and cost-effectiveness
    - Provide medication information about efficacy monitoring parameters and toxicity monitoring parameters to patients
    - Advocate lifestyle changes that can improve the outcomes of medicinal therapy
    - Monitor and report adverse drug reactions
- Record and report pharmacists' SOAP notes for individual patients
- Discuss with the preceptor and teacher about drug-related problems and solutions.

4. Method

This research was a quasi-experimental study of a one group pre-test/post-test design that aimed to study the effects of PBL in small groups in the elective course *Special Problems in Pharmacy Practice* for fifth year pharmacy students.

The PBL model was implemented for a period of one day per week for a total of 15 weeks for the elective course. Strategies to promote student learning outcomes consisted of lecture-based teaching and problem-based learning in clinical practice sites with a teacher acting as a facilitator. In the rotation of the clinical practice sites, each student had the opportunity to provide clinical pharmacy services in randomly assigned practice sites. Students were rotated every three weeks, after which they completed a case presentation to a teacher at the faculty.

Outcomes were evaluated before and after the implementation of PBL in two domains, pharmacy students' competencies and satisfaction.

The participants were 36 students who registered for the elective course. The students were divided into 7 groups of 5 students.

Data were collected from the students' completion of a 17-item self-assessment questionnaire using a 5-point Likert scale about their competencies (Cronbach's Alpha 0.96). In addition, they also completed an 11-item questionnaire using a 5-point Likert scale about their satisfaction (Cronbach's Alpha 0.87).

In the case of students' competencies, inferential statistics (pair t-test) was used to compare the mean scores before and after the course. Descriptive statistics such as mean scores was used to describe students' satisfaction. Rating scales were scaled to provide equal intervals. Interpretation of the mean scores included:

Range of mean scores	Meanings
4.21 - 5.00	Highest
3.41 - 4.20	High
2.61 - 3.40	Medium
1.81 - 2.60	Low
1.00 - 1.80	Lowest

5. Results

Table 1 shows the demographic data of the 36 students who registered in the elective course. There were 8 males (22.2%) and 28 females (77.8%). The mean age and Grade Point Average (GPA) were 22.58±1.02 and 3.18±0.48 respectively.

Table 1 Demographic data of students

Characteristics	Students
Gender	
Male	8 (22.2%)
Female	28 (77.8%)
Age (years)	
Mean ± SD	22.58±1.02
Grade Point Average	
Mean ± SD	3.18±0.48

Table 2 shows the pharmacy students' competencies before and after the 15 week implementation of PBL.

Table 2 Self-assessment rating scores in pharmacy students' competencies

Items	Before		After		Mean Differences	P value
	Mean	SD	Mean	SD		
1. Provide pharmaceutical care according to Good Pharmacy Practice concept	2.44	0.88	3.50	0.77	1.06	< 0.05
2. Review patients' profiles and clinical data-gathering from patients and patients' medical records, such as OPD cars and IPD charts	2.22	0.64	3.42	0.69	1.20	< 0.05
3. Recommend individual lifestyle modifications that can improve the outcomes of medicinal therapy	2.22	0.48	3.47	0.56	1.25	< 0.05
4. Identify and refer patients who met referral criteria to an appropriate health care provider	2.31	0.75	3.58	0.55	1.27	< 0.05
5. Design appropriate pharmacologic regimens and non-pharmacologic treatment regimens for individual patients	2.31	0.89	3.69	0.52	1.38	< 0.05
6. Apply didactic knowledge including diseases and pharmacotherapy to direct patient care activities	2.39	0.77	3.64	0.64	1.25	< 0.05
7. Initial assessment of disease severity in individual patients	2.31	0.75	3.69	0.58	1.38	< 0.05
8. Evaluation of all medication regimens in four domains including appropriate indication, efficacy, safety, and cost in individual patients	2.31	0.75	3.72	0.61	1.41	< 0.05

Items	Before		After		Mean Differences	P value
	Mean	SD	Mean	SD		
9. Interpret and analyze patients' medical information for development of pharmaceutical care plans	2.36	0.80	3.67	0.79	1.31	< 0.05
10. Identify risk factors and underlying causes in the development of patients' diseases	2.47	0.81	3.64	0.80	1.17	< 0.05
11. Identify patients' medical problems list	2.28	0.85	3.44	0.61	1.16	< 0.05
12. Prioritize patients' problems list based on urgency and severity of diseases	2.33	0.89	3.61	0.77	1.28	< 0.05
13. Identify patients' drug-related problems	2.25	0.87	3.36	0.68	1.11	< 0.05
14. Solve drug-related problems in individual patients	2.28	0.85	3.42	0.81	1.14	< 0.05
15. Communicate appropriate evidence-based therapeutic regimens through pharmacists' notes on medical records to other members of the interdisciplinary team, such as physicians and nurses	2.14	0.83	3.50	0.77	1.36	< 0.05
16. Encourage patients' medication compliance	2.31	0.82	3.42	0.65	1.11	< 0.05
17. Design patient-centered, evidenced-based monitoring plans including efficacy monitoring parameters and toxicity monitoring parameters	2.39	0.80	3.53	0.65	1.14	< 0.05

Table 2 shows that students' competencies increased after the use of PBL in all items and all the increases were statistically significant ($P < 0.05$).

Table 3 shows the students' satisfaction with various aspects of the 15 week implementation of PBL.

Table 3 The students' satisfaction

Issues	Mean	SD	Mode
1. Satisfied with the role of teacher who worked as their facilitators	4.22	0.54	4
2. Satisfied with students' role as self-directed learner	3.64	0.68	3
3. Satisfied with students' activities in PBL model	4.00	0.79	4
4. Satisfied with interesting PBL cases selected by the teacher in the sites	4.03	0.70	4
5. Satisfied with PBL cases which led to knowledge application	3.94	0.71	4
6. Satisfied with duration of course	3.53	0.70	4
7. Satisfied with chance to independently practice pharmaceutical care	3.89	0.82	4
8. Satisfied with practice sites	3.67	0.83	3
9. Satisfied with the evaluation of this course	3.75	0.84	4
10. Satisfied with overall quality of teaching and learning	4.08	0.60	4

Table 3 shows that most students were satisfied with the use of PBL. The mean scores of the responses ranged from high to highest level (3.41 - 5.00) and most of the modes were 4. The two issues that were mode 3 were satisfaction with students' role as a self-directed learner and appropriateness of practice sites.

6. Discussion

Pharmacy educators will play a significant role in the development of the required knowledge and skills of persons who wish to practice pharmaceutical care. Curriculum modifications and various instructional strategies will have to be considered to facilitate the learning outcomes of pharmacy students. One such instructional strategy and/or curriculum model is PBL (Fisher, 1994, pp. 183-189).

The purpose of this study was to implement and evaluate the use of PBL in small group contexts in the elective course *Special Problems in Pharmacy* for fifth year pharmacy students in the clinical environment facilitated by pharmacy instructors. PBL is an important part of the curriculum that integrates content and prepares students to provide patient-centered care, as indicated by the Blueprint for Pharmacy and WHO patient safety curriculum guide. In the clinical environment, it gives students the opportunity to apply their knowledge and skills to problems and cases in real-world practice, learning environments in which students feel they are able to express their thoughts and ideas (Blueprint for Pharmacy, 2008; WHO, 2011).

The small group instructional method has multiple benefits. Active small group discussion encourages application, analysis, synthesis, and evaluation of facts and concepts. This process is essential for the development of competence in clinical reasoning and critical thinking. Working in small groups allows students to take an active role in their own education. Students learn facts and concepts best when they use them to solve problems. Small group teaching with mixed levels of learners also offers the opportunity to set expectations of learners at all levels and demonstrate expectations for progressive competence in the continuum of medical education (Dennick & Exley, 1998, pp. 111-5).

PBL small group sessions in clinical environments can also complement information presented in lectures by allowing students time to ask questions in non-threatening environments and to think critically. This allows the students to detect and correct errors (their own and sometimes those of the facilitators) and also offers students opportunities to solve problems, make clinical decisions, and practice clinical skills, especially communication skills. These are also useful in the promotion of student reflection, independence, and life-long learning (White & Manfred, 2010).

As pharmacy practice promises to incorporate a greater patient care component, pharmacists will be held responsible for the identification and solution of higher order clinical problems and/or encounter patient care problems that will require critical thinking skills and precise decision-making abilities. Pharmacists will be involved in the clinical treatment of patients (pharmaceutical care) that requires more detailed communication with patients and health care providers. This expanded professional interaction will require pharmacists to utilize effective problem-solving skills.

This study indicated that pharmacy students' competencies increased after the implementation of PBL, mainly in clinical skills regarding the application of didactic knowledge to direct patients' care activities, such as the identification, prioritization, and solution of therapy drug-related problems, as well as clinical communication with patients and/or other members of interdisciplinary team. These increases in competencies are consistent with the study of Fisher (1994) of the potential for PBL in pharmacy education that found that practice competencies of pharmacy students can be increased by this approach. Results of meta-analyses of PBL in pharmaceutical education also found that pharmacy student's knowledge was improved by the PBL method. PBL students performed better in mid-term examinations (odds ratio [OR] =1.46; 95% CI:1.16, 1.89) and final examinations (OR =1.60; 95% CI:1.06, 2.43) compared with students in traditional learning style groups, but no differences were found between the groups in subjective evaluations (Galvao, Silva, Neiva, Ribeiro & Pereira, 2014).

Recent meta-analyses comparing PBL to conventional approaches indicated that PBL was superior when it comes to long-term retention, skill development, and satisfaction of students and teachers, while traditional approaches were more effective for short-term retention as measured by standardized board exams (Strobel & van Barneveld, 2009, pp. 44-58). In a Thai pharmacy and medical education context, a one group pre-test/post-test designed study of PBL effectiveness found that it can also increase students' competencies, practical skills, self-directed learning skills, and lifelong learning skills (Chuangchum, Pholchan, Nopkesorn & Pannarunothai, 2011, pp. 34-40).

Another advantage of PBL is that the teacher works as a facilitator of discussion rather than as an instructor. The facilitator's primary function is to allow students to deal with a problem, providing guidance, reinforcing what is right, correcting errors, and giving individualized feedback on students' performances (White & Manfred, 2010). Students challenged by the teacher who works as a facilitator are likely to progress their learning more rapidly (WHO, 2011).

Although most students were satisfied with the implementation of PBL at high and the highest levels, there were two issues that scored lower, satisfaction with their role as self-directed learners and appropriateness of practice sites. The result related to a role as a self-directed learner is consistent with the study that found that 35% of students were satisfied with traditional passive learning compared to the self-directed learning of PBL (Chuangchum, Pholchan, Nopkesorn & Pannarunothai, 2011, pp. 34-40). Regarding the appropriateness of practice sites, the feedback process between teachers and students may be limited by lack of space in these sites.

Interpretation and generalization of the study's results needs to consider some limitations. First, the main data in this study were subjective based on the students' self-assessment rating scale and these are difficult to verify. However, the questionaire used in the study was tested and considered as reliable before use. Second, the assessment of outcomes of this study was based on perceived skills or perceived knowledge, and not based on actual knowledge measured by a score in an examination. Third, this study was of a one group pre-test/post-test design and there was no use of a control group, such as a group exposed to traditional teaching, for comparison purposes.

7. Conclusion

The results showed that the pharmacy students' competencies increased after the implementation of PBL and these increases were statistically significant ($P < 0.05$).

Most of students were satisfied with the implementation of PBL. The mean scores of the responses ranged from high to highest level (3.41 - 5.00) and most of the modes were 4.

It is concluded that the implementation of PBL enhanced the pharmacy students' competencies and that generally the students were satisfied with the PBL course.

References

1. ACCP. (2000). A vision of pharmacy's future roles, responsibilities, and manpower needs in the United States. In Pharmacotherapy (pp. 991-1020).
2. Albanese, M.A., & Mitchell, S. (1993). Problem-based learning: A review of literature on itsoutcomes and implementation issues. Academic Medicine, 68, 52-81.
3. American Council on Pharmaceutical Education (2000). Accreditation manual. In (9 ed., pp. 52-53). Chicago, Illinois.
4. Barrows, H. S.(1986), A Taxonomy of Problem-based Learning Methods, Medical Education, 20, 481-486
5. Barrows, H.S. (1996). Problem-based learning in medicine and beyond. In L. Wilkerson, & W.H.Gijselaers (Eds.), Bringing problem-based learning to higher education: Theory andpractice. New directions for teaching and learning, 68, 3-13.
6. Blueprint for Pharmacy. (2008). The vision for pharmacy. Retrieved June 1, 2014,from: http://blueprintforpharmacy.ca/docs/pdfs/2011/05/11/BlueprintVision.pdf?Status=Master.
7. Chuangchum, P., Pholchan, T., Nopkesorn, T., Pannarunothai, S. (2011). Effects of Using an Integrated Team-Based and Problem-Based Learning Approach for Developing Lifelong Learning Characteristics of First Year Medical Students.South-East Asian Journal of Medical Education. South-East Asian Journal of Medical Education, 5, 34-40.
8. Crisneros, R. M., Salisbury-Glennon, J. D., & Anderson-Harper H. M. (2002). Status of problem-based learning research in pharmacy education: a call for future research. American Journal of Pharmaceutical Education, 66, 19-26.
9. Culbertson, V. L., Kale M., & Jarvi, E. J. (1997). Problem-based learning: a tutorial model in corporating pharmaceutical diagnosis. American Journal of Pharmaceutical Education, 61(1), 18-25.
10. Dennick, R. G., & Exley, K. (1998). Teaching and learning in groups and teams. Biochemical Education, 26(2), 111-115.
11. English National Board. (1994). Creating Lifelong Learners: Partnerships for Care. London: English National Board.
12. Evenson, D.H. & Hmelo, C.E. (eds) (2000). Problem-Based Learning: A research perspective onlearning interactions. Lawrence Erlbaum Associates.
13. Fisher, R. C. (1994). The Potential for Problem-Based Learning in Pharmacy Education: A Clinical Therapeutics Course in Diabetes. American Journal of Pharmaceutical Education, 58, 183-189.
14. Galvao, T. F., Silva, M. T., Neiva, C. S., Ribeiro, L.M., & Pereira, M. G. (2014). Problem-Based Learning in Pharmaceutical Education: A Systematic Review and Meta-Analysis. The Scientific World Journal. Retrieved June 1, 2014, from:http://dx.doi.org/10.1155/2014/578382
15. Hallinger, P., & Lu H. (2011). Implementing problem-based learning in higher education in Asia: challenges, strategies and effect. Journal of Higher Education Policy and Management, 33(3), 267-285.
16. Hamoudi, N. M., Nagavi, B. G., & Al-Azzawi, A. M. J. (2010). Problem based learning and its impact on learning behavior of pharmacy students in RAK medical and Health Sciences University. Indian Journal of Pharmaceutical Education and Research, 44(3), 206-219.

17. Major, C. H., & Palmer, B. (2001). Assessing the effectiveness of problem-based learning in higher education: Lessons from the literature. Academic Exchange Quarterly, 5(1), 4-9.
18. Muller, S. (1984). Physicians for the twenty-first century. Report of the Project Panel on the General Professional Education of the Physician and College Preparation for Medicine. Journal of Medical Education, 59, 1-208.
19. Ross, L. A., Crabtree, B.L., Theilman, G.D., Ross, B.S., Cleary, J.D. & Byrd, H.J. (2007). Implementation and refinement of a problem-based learning model: a ten-year experience. Am J Pharm Educ, 71(1), 17.
20. Savery, J. R. (2006). Overview of Problem-based Learning: Definitions and Distinctions. Interdisciplinary Journal of Problem-based Learning. Spring, 1(1). Retrieved June 1, 2014, from http://dx.doi.org/10.7771/1541-5015.1002
21. Strobel, J. , & van Barneveld, A. (2009). When is PBL More Effective? A Meta-synthesis of Meta-analyses Comparing PBL to Conventional Classrooms. Interdisciplinary Journal of Problem-based Learning, 3(1), 44-58
22. Vernon, D.T.A., & Blake, R.L. (1993). Does problem-based learning work? A meta-analysis ofevaluative research. Academic Medicine, 68, 550-563
23. Walton, H. J., & Matthews, M. B. (1989). Essentials of Problem Based Learning. Medical Education, 23(6), 542-558.
24. White, C., & Manfred, L. (2010). Alliance for clinical education. In Guidebook for Clerkship Directors. Retrieved June 1,2014, from: http://familymed.uthscsa.edu/ACE/chapter5.htm
25. World Health Organization. (1993). Increasing the relevance of education for health professionals : report of a WHO Study Group on Problem-Solving Education for the Health Professions. Geneva: World Health Organization.
26. World Health Organization. (2010). Patient Safety Curriculum Guide: Multi-professional Edition. Retrieved June 1, 2014, from: http://whqlibdoc.who.int/publications/2011/9789241501958_eng.pdf

Contact email: oat_otani@hotmail.com