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# Which levels of education in medical sciences utilize most the Problem Based Learning?- A citation analysis study

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# Which Levels of Education in Medical Sciences Utilizes Problem Based Learning (PBL)?- A citation analysis study

## Running title:

PBL in medical education

Objectives: The main aim of this study was to illustrate the implementation of Problem Based Learning (PBL) at the levels of curriculum, course, or lesson of medical education through the Scientometrics analysis of articles indexed in both world and national databases in order to create evidence for changing the curriculum of medical education into PBL.

Methods: The Electronic databases of Web of Science (WoS) and PubMed, and Iranian Databases of Iran Medex, SID and MagIran were searched during the period of 2003-2013 for related articles using rigorous search strategies. All related articles were extracted and critically appraised based on the levels of education.

Results: The study revealed that PBL is mostly applied in educational level of lesson rather than the curricula or courses around the world. The U.S. and the field of medicine were identified as the leading national and active fields in implementing and reporting the use of PBL among others. Few studies have provided evidence to implementation of PBL in medical education

Conclusions: This study suggests the use of hybrid model of PBL with other methods instead of total curriculum change. It also suggests conducting rigorous studies on the utilization of PBL in medical education in Iran to fill the considerable gap of studies among the published literature.

**Key Words:** Problem Based Learning, Evidence based education, Scientometrics, Medical Education

## Introduction

In recent years, crucial changes have taken place in the field of clinical education. Now, the emphasis of medical education is on applying learner-centered approaches based on problem solving and students' active learning.[1] The aim of such methods is to involve students in teaching-learning process in order to make learning more effective, tangible, reflective, self – directed,[2] and community based[3-5]. Problem Based Learning (PBL), as one of learner centered adult-like based methods of education, tries to involve students' persuasion and encouragement to determine their learning goals and peer-learning and teaching[6]to increase their ability in deep learning[7- 8] and decision making.[9, 10] Since 1990, various studies have investigated the effectiveness of PBL, [11-14] even on medical competencies of students after their graduation, especially with regard to their social and cognitive skills[15], to achieve basic knowledge, critical thinking.[16] Since 2008, the PBL has gradually entered Iranian medical education, but there are still doubts about shifting all the curriculum to PBL or the use of PBL partially. A need for a basic scientometric analysis of the contribution of world literature may create evidence for this dilemma in Iran or other countries with a similar history of implementing PBL in medical education.

Scientometrics visualizations bring in the light whether other different countries have changed all of their medical education curriculum to the problem-based learning or have applied PBL in some courses beside traditional curriculum. In this study, the scientific production of PBL in medical education during the last 10 years from January 2003 to October 2013 in different countries has been investigated.

## Objectives

The main aim of this study was to visualize the implementation of Problem Based Learning (PBL) at the levels of curriculum, course, or lesson of medical education in the scientific productions indexed in Web of Science (WoS) and PubMed and Iranian Databases of IranMedex, SID and MagIran during 2003-2013, to create evidence on most implemented level of education concerning PBL.

**Key Words:** Problem Based Learning, Evidence based education, Scientometrics, Medical Education

**Methods**

A cross sectional observation and descriptive method was employed to measure the scientific productions of PBL in medical education with scientometrics and bibliometrics perspective. Focus question:

Which levels of medical education (curriculum, course or lesson) mostly utilize the Problem Based Learning?

Secondary outcomes:

The proportion of articles with the primary aim of implementation of PBL in educational levels,

The leading country in producing the articles with the mentioned primary aim

The highly cited articles and active authors in the subject.

The Share of Iranian authors and journals in producing articles related to PBL in Medical education with the emphasis on the educational levels of curriculum, course, and lesson.

Search Strategy:

Pub Med and ISI Web of Science / WoS (world's largest citation database) and Iranian Databases of IranMedex, SID and MagIran were searched in order to extract all the studies about PBL in medical education on 24th of September 2013. The 'problem based learning' AND 'Medical education' terms with appropriate search strategies and phrases were searched in both the databases; 'all field' feature was applied to explore all of works in the subject. The confounding phrase of 'problem solving' was excluded.

Inclusion and Exclusion Criteria: only studies were eligible to inclusion that reported use of PBL in one of three levels (curriculum, course and lesson) of medical education without limitation in study design.

As problem based medical education is a new educational method for Iranian medical education, and it emerged since 2008, we limited our search to 5 years before and after PBL was introduced into Iran's medical education (from 2003 to 2013). Publication types on WoS may vary from journal articles to letters, book reviews and proceeding papers or editorials; therefore, we included only journal articles; the other types of publications were excluded in the primary assessment of the results of search. All the citations of conferences were excluded and just the published articles in scientific journals were included.

Analysis:

All the selected articles from the pool of data were critically reviewed by two experts and then categorized in three educational levels (curriculum, course, and lesson) when their subject domain was identified as relevant. Unrelated and duplicated titles were omitted; discrepancy regarding the inclusion or exclusion of specific articles between the reviewers was resolved by discussing. The analysis was done based on scientometrics and bibliometrics indicators like

number of publication, citation counts and Journal Impact Factor, on the remaining purely screened articles. Scientometrics is the study of quantitative status of research through which the frequency of each country's researchers, scientific courses, authors, impact of articles on scientific community [6,7,8,9,10,11,12,] and the authors' contribution, subject dispersion and core journals in each course can be determined [13]. **Bibliometrics** is also the statistical analysis of written publications, such as books or articles. In this study, we have focused on the articles rather than books. The indicators which were employed in this study are subject for both of the bibliometrics and scientometrics analysis.

**Results**

A total number of 468 articles were found about PBL from the Web of Science (WOS), ; among them 158 articles were unrelated and omitted from this study. Also, 1103 articles were retrieved from PubMed, and 325 articles were deleted due to disagreement with the objective of study. After primary review of titles and abstracts and elimination of ~~the~~ articles which were unrelated to medical education and levels of education, altogether from the two databases a total number of 1088 articles were found eligible to study; all the data from Pubmed and WoS were mixed, and the duplicated items were eliminated; hence, analysis was done on a total number of 843 articles (Figure 1).

A total number of 114 articles from Persian/Iranian databases of SID (11), IranMedex (54) and MagIran( 49) were found; among them 30 were duplicated articles in primary assessment of titles, and 42 unrelated articles in the process of critical appraisal were omitted; finally, 37 articles were included in the study. The analysis of world databases and local Persian databases is presented separately.

Of all 843 articles regarding the application of PBL in levels of education, the biggest proportion of 338 articles (42.7%) were related to lesson, followed by curriculum with a slight differences, 335(42.3%), and the smallest portion was related to course level with 119 (15%) articles. It is notable that all Iranian PBL related articles were about lesson. This represents that the educational level of lesson is the dominant level in the implementation of PBL, in the global publications of the last 10 years from 2003 to 2013, (in international and local databases). Although the level of curriculum is very close to lesson in ranking, the level of course shows a significant interval with both of the preceding levels of lesson and curriculum.

Furthermore, the studies related to PBL in Medical Education have an increasing trend at 3 levels of curriculum, course and lesson, and this progressive trend is impressive about lesson. A little downfall occurred in curriculum and course in comparison with lesson in 2013 compared to 2012 which is the representative of more application of PBL as a single lesson, not applying it in all the educational plan or special educational period (Figure1).

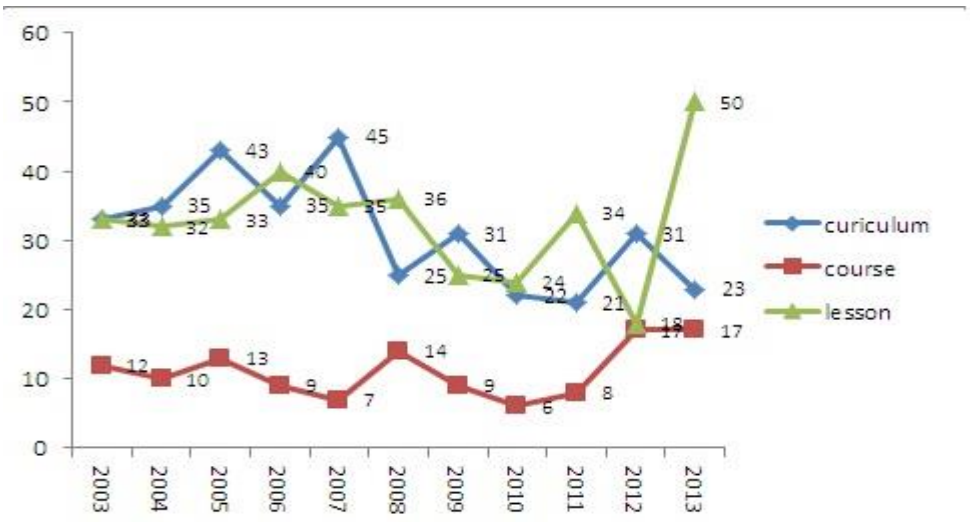


Figure1: Trend of PBL articles in different levels of education 2003-2013

**Contribution of different fields of health and medicine to PBL articles in Medical Education**

All the articles regarding health and medical educational fields are divided into seven fields including Medicine (Anatomy, Physiology, Surgery, Internal Medicine, Pediatrics, Anesthesiology); Dentistry; Pharmacology; Midwifery; Nursing; Health and Paramedicine (Radiology, Anesthesia, Laboratory Sciences). Generally the greatest portion of articles on PBL in Medical Education (569, 67.5%) was published in the field of medicine followed with Nursing (192 articles out of 843). Analysis based on the levels of education showed that, in all three levels the field of medicine was dominant, in curriculum which is the largest portion among other levels, the field of Dentistry ranked second, and in the level of course the field of Nursing stood in the second rank after Medicine (Table 1). All of 37 articles extracted from Iranian databases were related to the implementation of PBL in level of lesson, and the field of medicine was known as the leading field. Statistically significant relationship was found between the fields of education and the educational levels (P=0.0001)

Table1. Distribution of PBL articles by fieldand education level

| Field | Curriculum N (%) | Course N (%) | Lesson N (%) | Total | P |
|---|---|---|---|---|---|
| Medicine | 262(46%) | 66(11.6%) | 241(42.4%) | 569 | P=0.0001 |
| Nursing | 33 (31.4%) | 18 (17.2%) | 54 (51.4%) | 192 | |
| Dentistry | 38 (59.3% ) | 7(10.9%) | 19(29.7%) | 188 | |
| Pharmacology | 11 (20.8%) | 24(45.2%) | 18(34%) | 42 | |
| Health | 11 (36.6%) | 5(16.7%) | 14 (46.7%) | 59 | |
| Para medicine | 3(19%) | 4(25.0%) | 9(56.3%) | 16 | |
| Midwifery | 3(50.0%) | 0 | 3(50.0%) | 6 | |
| TOTAL | 335(42.3)% | 119(15.0)% | 338(42.7)% | 843(100.0%) | |

**The proportion of the continents in scientific production of the PBL article in 3 levels of curriculum, course and lesson**

All the scientific productions (843 articles) on the application of PBL in Medical Education were divided into 5 continents of Asia, Africa, America, Europe and Oceania or Australia according to geographical affiliation. Out of 843 articles, 78 had not determined their geographical affiliation; therefore, 765 articles with identified affiliations were analyzed to show the continents' share in scientific productions related to PBL in levels of curriculum, course and lesson.

America with 284 (37.12%) articles was known as the leading continent in sharing scientific productions with all three levels of education; in other words, they reported the use of PBL in medical education in each three levels. In level of curriculum and Course Asia and Europe respectively were known to have the second rank, but in the level of lesson, Europe and Asia both stood in the second rank with equal number of articles. The study found no statistically significant relationship between the geographic distribution of articles and the use of PBL in different levels of curriculum, course and lesson (P=0.93) in medical education. (Table2)

Table2. Distribution of PBL articles by educational level and continent

| Educational Level | America N (%) | Europe N (%) | Asia N (%) | Africa N %) | Australia (%) | Total N (%) | P |
|---|---|---|---|---|---|---|---|
| Curriculum | 107(33.5%) | 80 (25%) | 88(27.6%) | 25(7.8%) | 19 (2.8%) | 319(41.7) | P=.093 |
| Course | 45 (%40.5) | 32(28.8%) | 20(18%) | 4(3.6%) | 10(9%) | 111(14.5%) | |
| lesson | 132(39.4%) | 80(23.9%) | 80(23.9%) | 13(3.8%) | 30(8.9%) | 335(43.8%) | |
| TOTAL | 284(%37.1) | 192(25%) | 188(24.6) | 42(5.5) | 59(7.7%) | 765 (100%) | |

**Iran's share in scientific productions as a result of the implementation of PBL in medical education**

About 235 journals contributed in the publication of total number of 853 articles; among them only one Iranian journal was listed with publications in PBL on medical education, i.e.*The Journal of Medical Ethics and History of Medicine*. Iran shared 6 articles in the subject and ranked 17 among 21 countries like Singapore and Nepal, preceding the countries Egypt, Hawaii and Korea (with 4 articles). Pakistan and Denmark proceeded Iran with 7 and 8 articles, respectively.

Table 3: Highly cited articles and journals publishing scientific productions on PBL based on educational levels

| Title | Author | Country | Field | Type | Journal | IIF | Date | citation |
|---|---|---|---|---|---|---|---|---|
| ABC of learning and teaching in Medical - Problem based learning | Wood, DF | UK | Medicine | lesson | BMJ | 17.215 | 2003 | 541 |
| Problem-based learning: future challenges for educational practice and research | Dolmans | Netherlands | Medicine | lesson | Med Edu | 2.639 | 2005 | 439 |
| Psychiatr The effectiveness of problem-based learning compared to traditional teaching in undergraduate psychiatry. | McParland M | UK. | Psychiatry | lesson | Med Educ | 2.639 | 2004 | 419 |
| Medical Simulation-based training is superior to problem-based learning for the acquisition of critical assessment and management skills. | Steadman RH | USA | Medicine | lesson | Critcal Care Medical | 6.124 | 2006 | 256 |
| General competencies of problem-based learning (PBL) and non-PBL graduates. | Prince KJ | Netherlands | Medicine | lesson | Med Edu | 2.639 | 2005 | 206 |
| A comparison of the effects of problem-based learning and lecturing on thedevelopment of students' critical thinking | Tiwari A | China | Nursing | Course | Med Edu | 2.639 | 2006 | 201 |
| Problem-based learning outcomes: Ten years of experience at the University of Missouri-UK School of Medical | Hoffman, K | UK | Medicine | Curriculum | Academic Medical | 3.292 | 2006 | 196 |
| Experience-based learning: a model linking the processes and outcomes of medical students' workplace learning | Dornan, T | | Medicine | Curriculum | Med Edu | 2.639 | 2007 | 175 |
| First year medical student stress and coping in a problem-based learning | Moffat, KJ | UK | Medicine | Curriculum | Med Edu | 2.639 | 2004 | 171 |
| Faculty development for problem-based learning. | Farmer EA. | South Australia | Dentistry | Curriculum | Eur J Dent Educ | 1.01 | 2004 | 147 |

The leading country, the core journal, and highly cited author were assessed for scientometrics purpose. The most cited article in level of lesson as well as the level of Curriculum belongs to

UK with 541 and 196 citations, respectively. But regarding the course, the most cited article is related to the field of Nursing and China with 201 citations. (Table 4)

Table4. The most cited authors and their cooperation in problembasedlearning with emphasis on educational level

| row | Author | N of papers | Country | Subject | Level | < Year> | Citation |
|---|---|---|---|---|---|---|---|
| 1 | Azer SA | 17 | Australia | Medicine Dentistry | lesson =8 Curriculum =6 Course =3 | 2004-2013 | 17.76 |
| 2 | Dolmans DH | 8 | Netherlands | Health, Medicine | lesson =5 Curriculum =3 | 2005-2013 | 88.57 |
| 3 | McLean M | 7 | South Africa | Medicine | lesson =1 Curriculum=6 | 2003-2007 | 17.57 |
| 4 | Papinczak T | 7 | Australia | Medicine | lesson =3 Curriculum=3 Course =1 | 2007-2011 | 26.57 |
| 5 | Jacobs J | 6 | USA | Medicine | lesson =3 Curriculum =3 | 2003-2008 | 16.4 |
| 6 | Watmough S | 4 | UK | Medicine | | 2006 | 22.25 |
| 7 | Williams B | 4 | USA | Nursing | lesson =3 Curriculum =1 | 2004-2013 | 19.75 |
| 8 | Shankar PR | 4 | Nepal | Medicine Pharmacology | lesson =3 Curriculum=1 | 2007-2014 | 7.5 |

The core journal for PBL, in this study, was journal of *Medical Education* from Wiley publication. (Table 4)

Considering more than 3 articles per author in PBL, 8 authors were chosen as prolific/active authors in PBL in different subjects and from different countries in PubMed and WOS (Table 5). Azer SA with 17 articles from Australia was the most prolific author in PBL, with considerable difference with the other authors. Azer has cooperated in scientific productions of 3 educational

levels based on PBL respectively in lesson, curriculum and course. Azer's articles in average had 17.78 citations from 2004 to 2013. Dolmans were the second active author with 8 articles in Health and Medicine whose citation was on average 88.56 from 2008 to 2013. The least number of citations in this group belongs to Shankar from Nepal with 4 articles whose citations were averagely 7.5 in Medicine and Pharmacology from 2007 to 2013.

**Discussion**

The main aim of this study was to illustrate the share of PBL in medical education with special emphasis on the educational levels of curriculum, course, and lesson in the scientific productions indexed in WoS and PubMed and Iranian databases of Iran Medex, SID, MagIran during the years 2003-2013. The findings of the present study revealed that the greater portion of scientific productions is related to curriculum; therefore, it can be inferred that most of countries have implemented PBL in their curriculum.

Analysis of extracted articles showed that Medicine has the most citations on PBL, and Nursing, Dentistry and Pharmacology are in next ranks. So it can be declared that PBL was applied more and in Medicine compared to other health fields.

Among world's different continents, America has the most scientific productions related to PBL , and Europe is the second continent. This clearly represents that developed countries have surpassed developing countries in implementing and presenting their use of PBL in scholarly publishing; it also implicitly refers to change in educational approach from traditional (lecture-based) to problem-based method in these continents. Altogether, most scientific productions in every three levels of curriculum, lesson and course belonged to America. There is statistically a significant relationship between the application of PBL and the educational levels of curriculum,

course and lesson (p=0.000). It may be inferred that the fields with more applied lessons such as Medicine and Dentistry have entered PBL into their educational plan. As Colliver says, if the entire educational plan is involved, PBL's effects will be clearer, and the clinical and educational skills will be invigorated. [17]and will merge basic and clinical sciences; hence, learning occurs in community and will be independent and reflexive[18].

This investigation showed that there is a gap between researches and scientific productions related to PBL in Iran very little number of articles are affiliated to Iran or indexed in Persian databases which reveal that PBL is not prevalent in Iranian medical education. We infer that PBL is implemented in Iranian medical education but not reported in the literature.This inconsistency between the implementationand publication may be addressed in feasibility of implementation of PBL in developingcountries like Iranthat requires more educators and staff training.[19] As Vahidi (2007) and Dianati (2012) numerated, the students' reluctance and lack of acquaintance with team work as basic problems and the barriers of PBL application from nursing professors' viewpoint in Iran.[20, 21]

The trend of publication about PBL in Iran is rising and about 50% of Iranians' scientific productions in PBL have published in the latest year, 2013.

This study showed that there is no significant relationship between the average count of citations and the mean of cited items. It means that having more articles does not represent receiving more citations and author's reputation. For example, Azer has most articles in all 3 levels, she is the fifth out of eight active authors considering the mean of citations, but Dolmans' cooperation, as the second author, was half of Azer's article and almost 5 times more than Azer's citations

(Table 4). The mean range of the publication of Azer's articles' in years was older than Dolmans', and it cannot be concluded that the number of citations increases as timepasses. This can be considered as the weak point of scientometric indications and the shortage of using citations in the length of a period to judge about the efficacy of an article; In other words, getting 14 citation does not mean the author's or article's efficiency. Therefore, there is a need to use other such as the number of downloads, reference, marking, tweeting and bookmarking as used in Altmetricsin order to determine efficiency, effectiveness, and validity..

This article suggests that Medical Education in Iran should enter PBL into the curriculum of practical fields of Medicine, Dentistry and Nursing. And a mixed/hybrid method can be used in theoretical fields. As Armstrong says, education will be more effective if different models are applied.[22]

This study also suggests rigorous research studies on the utilization of PBL in medical education in Iran to fill the evidence gap.

**Limitations**

Scientific production on medical education may be scattered in various international databases such as CINHAL, EMBASE, Psychinfo, Web of Science, and Medline (/PubMed) as well as national databases of every country and gray literatures. Also publication types may vary from an editorial, letter , book chapter , proceedings, to articles .We just selected Pubmed and Web of Sciences due to limitations in access to other databases, and only articles published in journals indexed in the mentioned databases; this can be known as access or publication bias , especially in systematic reviews and limitation for this study. Therefore, more studies may be

conducted to figure out the more visible depiction of scientific production in international databases.

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