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PROBLEM-BASED LEARNING (PBL) AND CLINICAL REASONING IN NUTRITION BACHELOR STUDENTS

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Abstract:
Problem-Based Learning (PBL) method is based on activities that encourage several education competencies, making shorter the distance between real and hypothetical learning problems. To establish the relationship between clinical reasoning and PBL teaching, action research method was implemented in 32 Mexican second-year Nutrition Bachelor Students during a 16-week period. For measuring the level of clinical reasoning, the validated Comprehensive Integrative Puzzle (CIP) was applied in three different moments. PBL Teaching improves significantly clinical reasoning in Nutrition students ($p < 0.05$) mainly on the identification of the Clinical-Nutrition File, at establish a Nutritional treatment and on the assertiveness to emit a Nutritional diagnosis.

Keywords: clinical reasoning; comprehensive integrative puzzle; nutrition; problem-based learning

1. Introduction

Education competencies must be generated from the United Nations Educational Scientific and Cultural Organization (UNESCO,2002) requirements, strategies and standards, such as the Problem-Based Learning (PBL), Case Study-Based Learning and the Project-Based Learning, these methods try to reduce the distance between real life problems and the traditional learning method. (Tobón, 2015)

The current issue of Didactic in Mexico according to Irigoyen *et al* (2011) falls at the research of a new definition of Knowledge, which is not consider static and

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reproducible at this point can be observed that PBL must encourage epistemic and anthropological models.

According to the Pedagogical Thinking History, *Traditional* teaching seems to produced disputes in learning processes, making conflicts in the critical and effective curricular administration (Mbodila, 2015)

A quality education as it is mentioned at the current Mexican educational politics, must be reached by teaching professionalization, so, from the perfection of the Didactic, it acquires a main position in the improvement of teacher´s practice, considering this, knowledge fields that can be structure and restructure by the professor, employing useful tools and strategies for a significant learning (SEP, 2016).

This is how the importance of the following study come, trying to expose the results of PBL teaching in a Mexican Private University, where students need to be more likely to a real clinical environment, giving them tools and strategies to follow on their discover of their own professional practice for knowledge construction.

Next sections of the article are going to define the most important elements of the theoretical framework, with a deepest point of view referencing different positions, interpretations and authors.

2. Background

In Mexico the ITESM (Monterrey Institute of Technology and Higher Education, *Instituto Tecnológico de Estudios Superiores de Monterrey* in Spanish) System incorporates PBL as a didactic technique in the Faculties of Social Sciences and Medicine (ITESM, 2006). According to Martínez (2002) Medical School of the National Autonomous University of Mexico (UNAM), has been applying this strategy since 1993 with their Unique Study Planning in Bachelor and Postgraduate degrees as a main aspect for reaching the educational institute objectives in the same way as it has been applied into the Educational Quality Nucleus of the same University (Martínez, 2002)

Through a research of the current Literature it was found that the University of Colima (Mexico) has been applying the PBL in the Faculties of Psychology and Medicine since the beginning of 2000 (Márquez, 2011), getting a good student satisfaction level. Otherwise, the University of Guadalajara (Mexico) has done the proposal of working PBL with *B-learning*, providing strength to a not related Health Science Knowledge (Santillán, 2006).

In an official report file of The Autonomous University of Aguascalientes (Mexico) showed that it has been implemented PBL as a way to apply their Institutional Educational Model, but there are no research reports of PBL results in this University. (Universidad Autónoma de Aguascalientes, 2006)

This didactic and teaching strategy has been used also in basic education in Mexico, as it is mentioned by Morales and Pérez (2008) in a study realized in elementary at the Anahuac School (Villahermosa, Mexico), PBL was used in Math subject, getting an approval grade of the 56% with the maximal grade, this may show the effectiveness of this method.

In the knowledge field of Nutrition, Olivares and Heredia (2012) applied a study at the ITESM (Mexico) in Health, Biotechnology and Food Bachelor Programmes, specifically on Medical Surgeon, Nutrition, Food, Biotechnology and Biomedical-Enginnering; according to the previously report, PBL has been implemented in Health Bachelor Programs since 2001, the aim of the research was to compare the Critical Thinking levels between students obtained with the CCTST test (California Critical Thinking Skills Test) validated by Facione (2000), they applied this instrument on students formed at Health Bachelor Programs comparing them with those who were not PBL intervened, results showed a better balance in development of inductive and deductive thinking in PBL students, which suggest that PBL ameliorate skills in Health Bachelor students.

2.1 Problem-based Learning (PBL)

Problem based learning is a method of teaching and learning originated at McMaster University (Canada), Medical Program, in the mid-60s. This method's founding *fathers* were a group of physicians and basic scientists from Toronto-Hamilton area who were recruited by the McMaster School of Medicine. They all shared a negative view of their undergraduate experiences and thought they could do better (Norman, 1992).

Based on McMaster University (2016) this method of teaching and learning spread fairly fast in the World, there were PBL curricula exists now days in the Netherlands, Australia, Israel and the United States.

Now several hundred schools offer some form of problem-based learning, PBL has been used in America since 1968 and in Europe since 1974 (Martínez, 2002).

In accordance to Woods (2006) from McMaster University, PBL is defined like "*any learning environment in which the problem drives the learning*". McMaster University has long been internationally known for its problem-based learning approach in health science education. (McMaster University, 2016)

There are different definitions for PBL, for this research it was used the Díaz-Barriga (2006) definition which is: PBL is an integrative focus activities-based that encourages thought, complex thinking, cooperation, and decision-making, that surrounds in front of authentic and significant problems. PBL has been used in America since 1968 and in Europe since 1974 (Martínez, 2002).

2.2 Clinical reasoning

According to Viesca (n.d) the terms: clinical reasoning, clinical making-decisions, clinical problem solutions and diagnostic reasoning can be considerate by professionals as synonyms and could be used in a similar context.

It is important that all the terms for clinical reasoning mentioned before by Barrows (1980) referred to the same idea, standing out the concept, the author mentioned before define clinical reasoning as: *the cognitive process needed for evaluate and manage the medical problem of a Patient*.

Clinical reasoning process is dependent of the attitude in front of critical thinking (Scheffer & Rubenfeld, 2000, in McCarthy, 2003) and it's influenced by personal attitude, philosophical perspective and preconceptions (McCarthy, 2003).

As stated by Morán (2010), clinical reasoning is the sum of thinking and cognitive processes of making-decision, associated with the clinical practice; is a critical skill of Health professionals with importance for acquiring an autonomous and professional practice, that allows a more assertive decision-making on Health Bachelor students, which implies a better action based on a judgment inside an Specific context.

2.3 Clinical reasoning process

The clinical reasoning cycle, requires from a health professional that aware people´s health, with the goal of examine and discuss the included steps on the cycle model, the proposed model must be explained with clock hands order, with the objective to ease the decision-making, and enable a more precise treatment and screening. (Levett-Jonnes, 2010, in University of Newcastle, 2009).

This cycle has been applied in common scenes that involve patients with different characteristics, with the aim of explore each one of the cycle stages, and in this way show how decision-making is useful at clinical practice (University of Newcastle, 2009).

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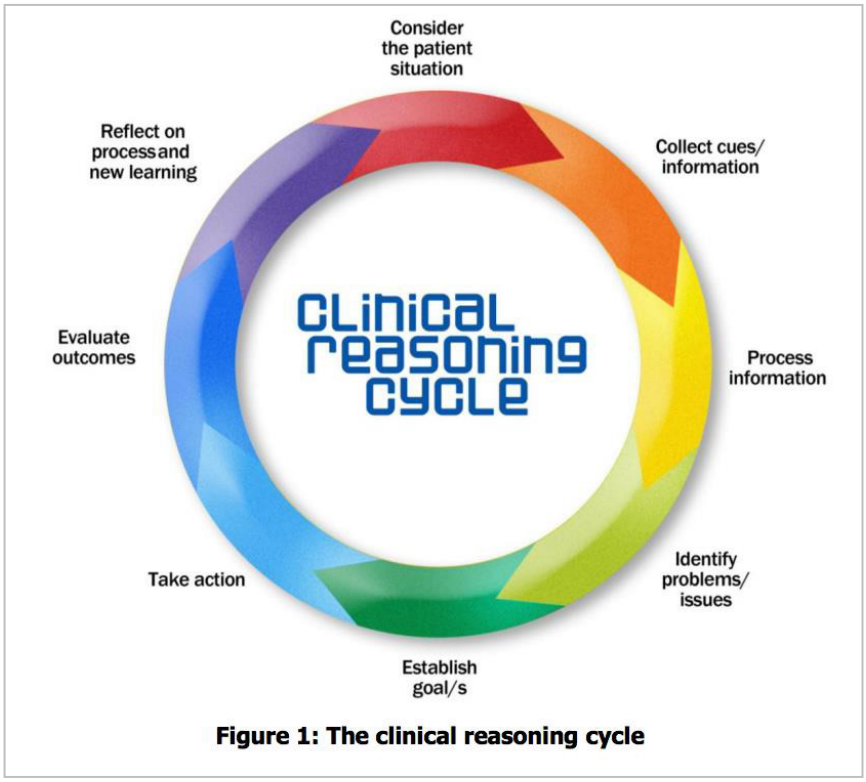

Figure 1: The clinical reasoning cycle

Reference: University of Newcastle, Australia (2009)

With the theory exposed before, Figure 1 explains the clinical reasoning mechanism, representing each stage involved in the process that is related with:

- Gathering clinical clues or vignettes
- Collecting the proper clues
- For the correct Patient
- In an appropriate time
- Take the correct decision

3. Research Question and Hypothesis

As the above, the main research question for this study is: How Problem-Based Learning (PBL) impacts the stages or clinical vignettes, in the clinical reasoning of Mexican second-year Nutrition Bachelor students?

Based on the theoretical framework research, the hypothesis was: PBL Teaching in Nutrition Bachelor Students impacts the clinical reasoning at improving the diagnosis ability.

4. Method

4.1 Context

PBL was used in the subject of Nutritional Pathology I, during the 16 weeks course (May- August 2015), Nutrition Bachelor students were working in groups of 8 to 10 people according to the *7 steps PBL method* of the University of Maastricht (Maurer, 2012) (Holland), sessions were divided in three phases: tutorial working, individual working and feedback. The programme is taught in Spanish but some of the resources provide by the tutor were in English.

4.2 Study Design

Action research method was used, the teacher or tutor design the total intervention and defined the methodological line for PBL teaching.

4.3 Participants

31 Mexican students of second-year of Nutrition Bachelor from León, Guanajuato (Mexico) were included in the study (*N=31; males, 5, Mage*= 20.6; *females, 26, Mage*=20.4; SD= 1.07, RANGE= 19-23)

4.4 Instruments

Assessment tools were used to evaluate the performance of the students during the PBL intervention, three different instruments were included:

- Comprehensive Integrative Puzzle (CIP), has a format of an *extended matching,* it has rows and columns, columns contain clinical vignettes and rows different medical diagnosis, validated by Ber (1997) with a Cronbach´s alpha value of 0.91.
- Student´s performance in problem-based learning tutorial sessions Questionnaire (Valle, 1999; in Martínez, 2007) a 24-item rating scale, divided into three categories: Independent study, Group interaction, and Reasoning skills, with Cronbach´s alpha values of 0.96 for the total scale.
- Tutor´s assessment in Problem-based learning sessions Scale (Dolmans,1994), mixed scale with 16 items, from item 1 to item 13 there are different values, item 14 to 16 are open questions.

4.5 Procedure

First two weeks of the course, the subject was managed with a traditional teaching style, then the first CIP was applied, after this, students were informed of the PBL project, and discussed the method that were used for the study (Maastricht University, 2016), at week 3 students started working with PBL method, the course was divided into 10

clinical cases according to the content and topics established by the program. At week 6 was applied another CIP, and the last one was examined at the end of the course.

Each clinical case was evaluated by the tutor, taking care of grading all the dimensions of each instrument, at week 16 the Tutor´s assessment in Problem-based learning sessions Scale was used. Every clinical case was involved in an auto-evaluation of students.

4.6 Data Analysis

Data was first analysed with descriptive statistical, trough the help of the SPSS Software (v.20 for Macintosh). To prove the normal statistical behaviour of data, it was used the Saphiro-Wilk test, after the first analysis, data shown not to be normal, therefore to obtain the statistical significance of the relation between Traditional and PBL teaching with the Clinical reasoning, Friedman test was applied.

5. Results

Results are shown by categories, ordered by the instrument applied in each time of the research.

5.1 CIP results

Mean values of CIP are shown in Table, these results explain the data obtained in each measure during the course of Pathological Nutrition I, each clinical vignette had a total a maximal score of 20 points.

Table 1: Mean values of CIP in each phase of application

Clinical Vignette	Mean Values in points of Pre-test (Week 2)	Mean values in points of Post-test (Week 6)	Mean values in points of post-test (week 16)
Nutritional-Clinical File	14.84375	7.8125	19.42810458
Laboratories	17.8125	6.25	14.00326797
Nutritional diagnosis	14.375	9.09375	17.14052288
Nutritional Treatment	18.28125	12.5	18.85620915
Screening	18.7096	6.875	12.2875817

After organizing the information in Table 1, the hierarchy in each measure moment is exposed at Table 2.

Table 2: Hierarchy of clinical vignettes, after the CIP application

Clinical Vignette	Traditional teaching	PBL Teaching (week 6)	PBL Teaching (week 16)
Nutritional-clinical file	D	C	A
Laboratories	C	E	D
Nutritional Diagnosis	E	B	C
Nutritional treatment	B	A	B
Screening	A	D	E

Based on data of Table 2, it can be inferred that after the intervention of PBL during the course, the clinical vignette of the Nutritional-clinical file improves at first place (19.42 points), in a second place the establish of a Nutritional treatment improved was outstand (18.85 points), then the skill of the nutritional diagnosis was found in third category (17.14 points) each clinical vignette had a total score of 20 points**.** Statistical significance given by the Friedman test in the SPSS was 0.000000007**.**

5.2 Student´s performance in problem-based learning tutorial sessions Questionnaire Total Score

The instrument was applied by the PBL tutor in each clinical case, the total score of instrument was measured in each clinical case and with the SPSS software, statistical data was obtained. The results of each clinical case are present in Table 5. Clinical Cases were dealt according to the subject course, providing the properly time to each stage of the PBL method; 11 cases were evaluated during the PBL phase.

At the end of the 16-week course, students improved some of the skills measured by this instrument.

Table 3: Student´s performance in problem-based learning tutorial sessions Questionnaire Total Score

Clinical Case	*N*	Minimal score	Maximal score	Mean	Standard Deviation
Dyslipidaemia	32	93.00	138	125.4063	11.49996
Pancreatitis		93.00	138	123.7500	13.56704
Ulcerative Colitis		32.00	138	115.9688	22.36138
SPRUE		30.00	138	113.7500	22.09364
COPD		93.00	138	127.7500	12.67968
Cirrhosis		81.00	138	125.5625	16.91714
Chron Disease		68.00	136	117.8438	17.75662
Diverticulitis		85.00	137	121.6875	14.49680
Hypertension		93.00	138	130.8125	11.55753
IBS		31.00	136	112.8750	24.58789

COPD = Chronic Obstructive Pulmonary Disease, IBS = Irritable Bowel Syndrome

Based on Table 5 data, the highest mean value was for the clinical case of Hypertension (130.81 +/- 11.55) and the lowest mean value for IBS (112.87 +/- 24.5). Making a Synthesis of the exposed results on table 5, it can be inferred that the best evaluated case by tutor in PBL sessions was the Hypertension, standing out the different factors involved in the assessment, such as: course period, lacks of PBL method phases or strategies, and in this way, the evaluation of PBL by tutor, becomes a complex topic, because of the solutions that approach to the development of education competencies, and it´s necessary influence to include the ones that are related with clinical reasoning.

5.3 Tutor´s assessment in Problem-based learning sessions Scale

The instrument is a mixed scale with 14 quantitative items and 2 open questions for item 15 and 16. The results are shown in table 4 were mean values were obtained through the help of SPSS. The tool is designed as a Likert scale with values from insufficient, neutral, sufficient and non-apply item 14 takes values from 1 to 10 in order to grade tutor´s PBL performance. Application was in pairs, which means that the 32 Mexican students were divided into pairs, all the pairs answered except one, considering at the end only 15 pairs.

Table 4: Item mean values of the Tutor´s assessment in Problem-based learning sessions Scale

Item number	*N*	Maximal score	Minimal score	Mean value	Standard Deviation
1	15	3	3	3.0000	0.00000
2		2	3	2.4000	0.50709
3		1	3	2.2000	0.56061
4		2	3	2.6667	0.48795
5		2	3	2.4000	0.50709
6		2	3	2.6000	0.50709
7		2	3	2.8000	0.41404
8		2	3	2.7333	0.45774
9		2	3	2.8000	0.41404
10		2	3	2.1333	0.83381
11		2	3	2.5333	0.51640
12		2	3	2.3333	0.48795
13		2	3	2.4000	0.50709
14		7	85	13.5333	19.78407

As it is exposed at table 4, the highest mean value was for item one that evaluates if the tutor is well-informed about PBL (3 +/- 0.0), which suggest that students were agree

about the performance and preparation of the teacher, and it is implied that tutor had a domain of the PBL method. Otherwise the lowest mean value was for item ten, that evaluate if the tutor contributed to a better comprehension of PBL sessions, what means that this was an important opportunity area for the tutor, with these result opportunities may be clearer for future PBL interventions.

In case of item 15 and 16, answers were codified with the help of Nvivo software (V. 10.0 trial for Macintosh), they were registered and codified into nodes, and those nodes were measured trying to find the most common answer pattern. Nvivo showed the coverage percentage of each codified answer, taking this as the base of a qualitative analysis. Question of Item 15 is: What is the most valuable judgment of tutor´s behaviour? For this item, the codified nodes were: Knowledge, motivation, practice and responsibility.

About item 16, the main codified nodes were: explanation, feedback and cases time; tutor´s work perception from students were synthesized in two main nodes explanation and feedback, students exposed a lack on a deeper feedback, noticing that the tutor must work in this phase or stage.

Finally, a correct administration of contents bust me keep by PBL tutor, suggesting a better didactic planning, and trying to establish a better student´s performance, avoiding excessive perfection, and designing more specified purposes in each session.

6. Conclusions and Discussion

After a teaching intervention with PBL method in Mexican Nutrition Bachelor students can be concluded that, PBL may improve Clinical reasoning mainly at the clinical vignettes of Nutrition-clinical file, nutritional treatment and assertiveness of establishing a nutritional diagnosis, therefore PBL must be an effective tool that ameliorates skills in Health Bachelor students.

One of the challenges on the study was the definition of PBL method, because of the current theoretical framework, it exists many authors, Universities and theories with varieties of PBL methods and applications, differing at the number of stages, the knowledge field, and number of students in classrooms. Finally, and keeping these characteristics Maastricht University method was choice.

PBL interventions in Nutrition students must be done in other countries and in several study designs, even it must be in different academic grades. Longitudinal studies have to be done, where PBL may show other skills approaches and development. Sample size could be an important issue; thus reliable population should be included in future researches of PBL.

The quantity of study reports about PBL in Mexico is still low, so it could be convenient to amplify the number of investigations and a deepest research about the skills developed by PBL, such as critical thinking, self-direction, creative thinking etc. Some of the professionals are agree with the usage of PBL with other knowledge fields such as the Social Sciences, so and opportunity area could be standing out in those.

Different contexts may be consider as another limitation, considering the teaching experience of tutor, the planning of PBL lessons, registration of evidences, data sources, curriculum, age, country and subjects.

From the present study the next suggestions were generated:

- It is recommendable that the PBL tutor, spend more time with the feedback method part, as it is reflected on the results, this area may provide strength resources for future PBL interventions.
- To invite other Universities for applying PBL in different knowledge fields, not just in Health grades, even in Social Sciences such as Law students, and in Math, with the purpose of improve the professional education competencies in each different profile.
- A common proposal is exposed about PBL effectiveness in Schools where teachers does not have the knowledge or preparation in this kind of methods, so, teaching skills may be created by experiencing PBL such as: critical and creative thinking, and more didactic abilities.
- Promote PBL researchers in other similar contexts must be a current issue to work on, especially in Mexico where education may still improve in many different aspects.

Finally, the students experience was acceptable, but it was shown some resistance to work with PBL method, Higher education Mexican teachers must train to this kind of methods, this would change the way of students in Higher Education prospect.

References

1. Ber, R. (1997) Design of an integrative course and assessment method: the CIP (Comprehensive Integrative Puzzle), in: .A.J.J.A. Scherpbier, C.P.M. van der vleuten, J.J. Rethans & A.F.W. Van der Steeg (Eds) *Advances in Medical Education*. 84-86 (Dordrecht, Kluwer Academic Publishers). Retrieved from 8th August 2016 from: http://link.springer.com/chapter/10.1007%2F978-94-011-4886-3_23#page-1
2. Díaz Barriga, F (2006). Reseña de: "Aprendizaje basado en problemas. De la teoría a la práctica "de Carlos Sola Ayape. *Perfiles Educativos*. XXVIII (111), 124-

127. Retrieved 19th of June 2016 from: http://www.redalyc.org/articulo.oa?id=13211107

3. Dolmans, D., Wolfghagen, I. y Snellen-Belendong, H. (1994). "Improving the effectiveness of tutors in problem-based learning". *Medical Teacher*. 16 (4). pp.369-377
4. Facione, P. (2000). *Test California de Destrezas en Pensamiento Crítico CCTST-2000 versión española (translated by* Guisado, S. J). Berkeley: Insight Assessment/The California Academic Press
5. Irigoyen, J. Jiménez, M. Acuña, K. (2011). Competencias y Educación Superior. *RMIE*. *16*(48).pp.243.
6. Jones, M. (1995). Clinical reasoning and pain. *Manual Therapy*. pp.17-74. Retrieved from: https://www.physio-pedia.com/images/c/cd/Jones_-_1995_-_Clinical_reasoning_and_pain.pdf Accesed 25.08.16.
7. Márquez, C. Uribe, C. Montes, R. Monroy, R. Ruiz, C. (2011). Satisfacción académica con el ABP en estudiantes de Licenciatura de la Universidad de Colima. México. *Revista Intercontinental de Psicología y Educación*. *13* (1), pp. 29- 44
8. Martínez G.; Gutiérrez, A.; Piña G.; (2007). *Aprendizaje Basado en Problemas en la enseñanza de la medicina y ciencias de la salud*.1ªEd. México. UNAM. pp. 118 < http://www.redalyc.org/pdf/802/80218382003.pdf Accessed 25.08.16
9. Martínez, N. Cravioto, A. (2002). El aprendizaje basado en problemas. *Rev. Fac. Med*. *45* (4). pp.185.
10. Maurer, H and Neuhold C. (2012). *Problems Everywhere? Strengths and Challenges of a Problem-Based Learning Approach in European Studies.* PBL in European studies-Maastricht Experience. pp 7. Retrieved from: http://www.mcegmaastricht.eu/pdf/MCEG_part%20PBL_link2_%20PBL%20implementation%20challenges.pdf
11. Mbodila M.and Muhandji,K. (2015). *The use of ICT in Education: a comparison of traditional pedagogy and emerging pedagogy enabled by ICT´s*. Conference: Proceedings of the 11th International Conference on Frontiers in Education: Computer Science & Computer Engineering (FECS'12, At Las Vega, Nevada, USA. (Volume 2).
12. McCarthy, M. (2003). Detecting Acute Confusion in Older Adults: Comparing Clinical Reasoning of Nurses Working in Acute, Long-Term, and Community Health Care Environments. *Research in Nursing and Health*. 26. pp. 203–212.
13. Morales, P. Pérez, J. (2008). El aprendizaje basado en problemas: una estrategia para promover el aprendizaje significativo. *Perspectivas Docentes*. (40) .pp. 145

14. Morán, L. Espinosa, A. Paredes, L. (2010). Habilidades de Razonamiento Clínico en estudiantes de Enfermería. Un estudio comparativo entre novatos y avanzados. Memorias X Congreso Nacional de Investigación Educativa.
15. Norman, G. R. and Schmidt, H. G. (1992). The psychological basis of problem-based learning: a review of the evidence. Acad. Med., 67(9), 557–565
16. Olivares, S. Heredia, Y. (2012).Desarrollo del pensamiento crítico en ambientes de aprendizaje basado en problemas en estudiantes de educación superior. *RMIE*. *17* (54). pp. 759.
17. Santillán, F. (2006). El Aprendizaje Basado en Problemas como propuesta educativa para las disciplinas económicas y sociales apoyadas en el B-Learning. *Revista Iberoamericana de Educación. 2* (40). pp. 123
18. Secretaría de Educación Pública (SEP). (2016*). El modelo educativo 2016: el planteamiento pedagógico de la Reforma Educativa.* Méxicinter
19. Tobón, S. (2005). Formación basada en competencias: pensamiento complejo, diseño curricular y didáctica. Bogotá. 1º Ed. ECOE Ediciones pp. 195.
20. UNESCO, (2002). *La educación esconde un Tesoro,* informe de la Comisión Internacional sobre la Educación para el siglo XXI, Francia, 2002, UNESCO. Disponible en www.unesco.org/education/pdf/DELORS_S.PDF
21. Universidad Autónoma de Aguascalientes. (2006). Modelo Institucional.
22. University of Maastricht. (2016) Problem-Based Learning. https://www.maastrichtuniversity.nl/education/why-um/problem-based-learning Accesed 25.08.16
23. University of Mcmaster. (2016) Problem Based Learning. http://cll.mcmaster.ca/resources/pbl.html Accessed 24.08.16
24. Viesca, C .Ponce, M. Sánchez M. (s.f). Razonamiento Clínico: Seminario El eje actual de la Medicina. Facultad de Medicina de la UNAM. Retrieved 14 July 2016 from: http://www.facmed.unam.mx/sms/seam2k1/2006/ago_02_ponencia.html
25. Woods, R. (2006) Preparing for PBL. McMaster University. (3rd ed.). Canada.