ALM Program: Ten years of educational technology interventions at the Faculty of Medicine at the oldest National University in Perú

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SUMMARY

Due to its benefits to promote student participation, develop skills, and strengthen the relationship with the teacher; Active learning methodologies (ALM) must be a priority in the university system. However, its optimal and massive use is still low.
Since 2008, a program was initiated to facilitate the correct implementation of ALM in the Faculty of Medicine of the National University of San Marcos (UNMSM). In this paper, we explain holistically the interventions and results of multiple projects: Innovations in Problem Based Learning (PBL) and Information and Communication Technologies (ICT).
Significant achievements were made among students and empowering teachers in the use of computer databases and design of competency-based evaluation matrix. A virtual simulation laboratory was created, fostering a transdisciplinary exchange that strengthened the academic activity. We show the methodologies used and student perception in subjects such as Pharmacology, one of the most difficult in the medical career and which served as an intervention model.

***Keywords*:** Teaching competences, Active Learning methodologies (ALM), ICT, PBL, medical education

INTRODUCCIÓN

The achievement of active and meaningful learning is a priority in any current university system [1]. This learning occurs when the person interacts with their environment and elaborates personal representations and value judgments that allow them to make decisions based on reference parameters [2]. Achieving this requires not only having an instructional pedagogy, but incorporating contributions from other fields, in addition to educational research for constructivist and sociocultural learning. However, the current system of university education is very diverse and fragmented [3], with traditional teaching predominating, centered on the unidirectional transfer of knowledge. To position active and meaningful learning, authors like Dee Fink [4] bet on key aspects such as teaching: "*how to learn, use the scientific method, perform self-learning and analyze the nature of the courses*".

Especially in careers such as Human Medicine which must have a high level of learning [5, 6], these innovations are more effective when associated with experiments, reflexive dialogues, self-evaluations and the application of ICTs [7, 8, 9]. The empowerment of medical students through ALM is a primary objective that requires a moral and ethical commitment for both teachers and students [10]. An empowered student is an element with a high value not only for its high level of knowledge but also because it becomes a reference when engaging in topics beyond those offered by the university.

At the National University of San Marcos (UNMSM), the oldest national university in Peru, various factors led to a lack of deepening of meaningful learning: Teachers with little predisposition to change, poor knowledge of the method and absence of authorities to promote the acquisition of competences; have avoided to a certain extent that the student can be more proactive when taught with innovative methodologies [11], such as problem-based learning (PBL) [12].

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In the present work, the development of the multiple investigations carried out is presented in a holistic way: We begin by showing information about the reality found 10 years ago, then a global description of what has been developed, focusing on the objectives and general guidelines of the interventions. Some indicators of processes and results are shown, and finally, a discussion and future perspectives are presented.

DIAGNOSIS OF THE INITIAL SITUATION

During 2008, a cross-sectional and descriptive study was conducted through an anonymous survey to determine the student's perception of the organization, academic management, and teaching-learning. The students were volunteers of the third year of Human Medicine (n = 30). We identified deficient areas, and gaps where an intervention could be generated.

- 44% did not reach a high level of learning (According to the Bloom scale) [5]
- 37% attended theoretical classes by obligation.
- The technique of least use of learning was the problematization and integration of information
- 50% attended methodologies different from the traditional ones for overcoming and actively participating in it.

INTERVENTIONS FOR CREATING CONTENT

The information found was disseminated and in the following years, several isolated initiatives were carried out. In 2012, the same diagnosis was made again, this time to 59 students, to evaluate changes. The results were similar, including that 47% of students did not use electronic resources in their learning.

Thus, the design of structured interventions during Pharmacology was initiated, whose objective was initially the systematic creation of own content based on three pillars:

- Problem Based Learning (**PBL**)
- Use of Virtual Simulation Software (**VSS**) and
- Information and Communication Technologies (**ICTs**)

Table 1 summarizes the initiatives in which educational resources were created according to the area and objectives set.

INTERVENTIONS FOR THE PROMOTION OF ACTIVE METHODOLOGIES

The development of the "ALM Program" involved creating learning that promotes analysis, reflection, and intuition with the development of science and research; besides generating pleasure to educate, to learn and to build knowledge.

Although each intervention pursued specific objectives, they all had three moments in common:

a) **Awareness stage**, which was a constant battle to raise awareness among students, teachers and faculty authorities to allow, generate and be part of the changes

b) **Creation of ad hoc resources** and

c) **Teacher training** using new resources and new technologies

ALM Program Overview

The program is the result of a gradual process initiated with teacher awareness activities in the use of ALM and the use of virtual simulation software to initially learn experimental pharmacology and research on medicinal plants.

The target audience were students of different years and teachers. To carry out the projects, a multidisciplinary team of physicians, researchers, teachers, administrative staff, and student was formed. The methodology used was based on an International ALM course led by Dr. Hendrik Van Wilgenburg (University of Amsterdam) who provided the software used [13]. There, it was defined as "active participation of learning" to the review of knowledge (pharmacokinetics and pharmacodynamics) with respect to a practical result (pharmacological effect of drugs), continuing with the discussion of results for the consolidation of knowledge and the virtual presentation of knowledge. Figure 1 summarizes in a timeline the interventions made during the 10 years and then its methodology and results are briefly exposed

Table 1. Interventions for the creation of meaningful learning contents until 2014

Year	Objectives	(Area) and resource created	Training carried out
Pharmacology teaching with virtual simulators			
2012	Install software as an option to experiments.	(VSS) Creation of 4 guides for the use of software	Six trainings: respect for life, and virtual software
	Facilitate student-teacher access to new information	(ICT) Creation of a web portal Access to bibliography and information	
Inclusion of Active Methodologies			
2011	Create an educational platform for learning and as a support for interaction students - teachers	(ICT) First virtual classroom of Pharmacology with self-learning material, tutorial support, and record of activities.	Two asynchronous trainings to create virtual classrooms and how to direct them.
2012	Increase meaningful learning through modules based on problem-solving and discussion	(ICT) Virtual classroom with e-books and didactic material of each class	Three sessions to agree on PBL and common use of an evaluation matrix
		(ABP) Cases problems. Creation of a matrix to evaluate performance	
Creation of a Virtual Simulation Laboratory			
2013	Consensus on the correct use of the environment and software	(VSS) Guidelines for student use of the Laboratory	Two trainings for teachers for correct use of laboratory hardware and software and how to use new resources to achieve meaningful instruction in the student.
	Create virtual environments for use within the laboratory	(ICT) Renewal of a website with a virtual classroom in open source software.	
	Establish learning with new virtual simulators and more cases.	(VSS) Tutorials for solving problems with software and its practical application.	
Teaching new topics: Pharmacogenetics			
2011	Agree on learning by resolution and discussion of cases	(PBL) Design of 02 problem cases.	Training in cases: "Warfarin in genotypes CYP2C9 / VKORC1" and "Abacavir in genotypes HLA-B5701 in HIV"
2014	Establish pharmacogenetics learning through ALM	(ICT) Creation of a virtual classroom and use of email and Facebook as a learning tool.	

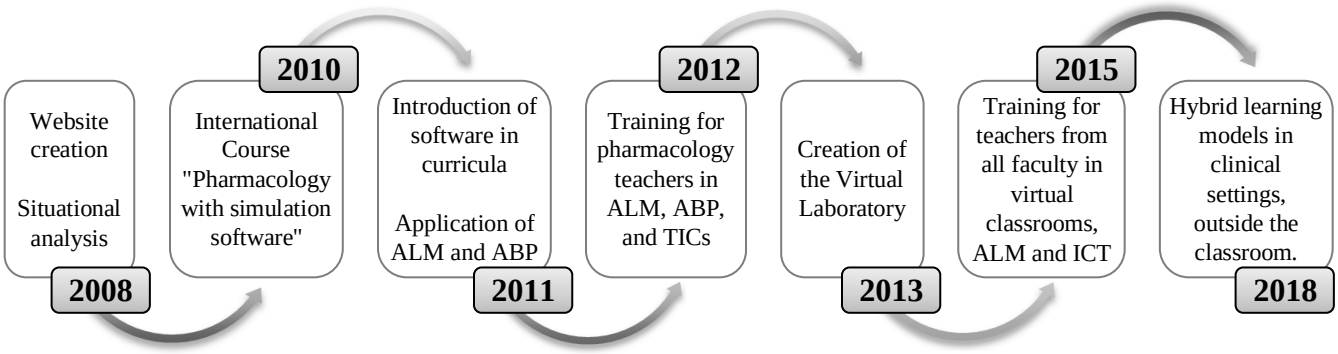

Figure 1: Timeline of the milestones during the ten years of educational technology interventions.

IMPACT OF ICT AND ABP IN THE ACADEMIC PERFORMANCE. YEARS 2010 TO 2012

By 2012, some methodologies such as PBL had already been applied. It was proposed to compare the academic performance of students, since 2010(n=139), 2011(n=132) and 2012(n=134).

Design and general description:

During 2010 there was no formal intervention, the teaching methodology used was the traditional one. In 2011, the use of ALM began and in 2012 the use of ALM methodologies with PBL was increased.

The intervention of the year 2012 involved laying the methodological foundations for achieving meaningful learning, which was improving year after year (see Figure 2).

The materials were published in the virtual classroom, to allow learning to the rhythm of the student, who received a digital disc (DVD) with programmed practices, E-Books of Pharmacology and teaching materials prepared by teachers.

Results:

No significant difference was found in the final averages of the course in the three years evaluated (p = 0.053). However, there was a significant increase in the scores for 2012 when evaluating the modules intervened separately (p = 0.001). The general perception of the students in 2012 was that the applied ALM allowed them a higher level of learning (according to the Bloom scale), allowing them not only to remember and understand but also to analyze and synthesize the information..

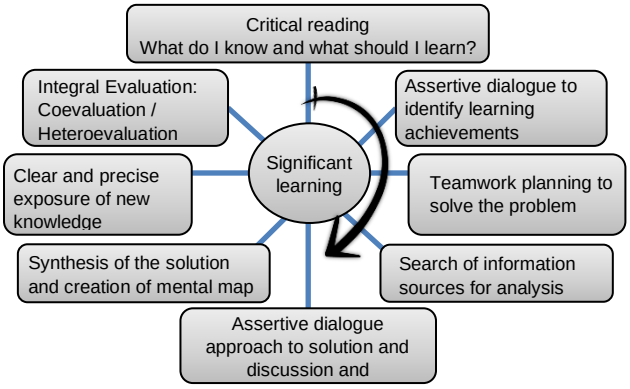

Figure 2: Bases of the plan to achieve meaningful learning.

INTRODUCTION OF SIMULATION SOFTWARE TO IMPROVE LEARNING.

The first introduction was made of the use of virtual simulations in experimental pharmacology to improve learning and respect the ethical norms in the handling of experimental animals motivating the student to be an active participant in their teaching at their own pace.

Design and general description:

The use of virtual simulators in the education of third-year medical students (n = 134) of the UNMSM was examined. Steps:

a) Raise awareness about the use of experimental animals.
b) Develop and apply didactic materials for the practices that included a web portal for the use of the software. (Figure 3)

Results and conclusions:

Six trainings were given to professors on the use of virtual simulators. Six practice guides were created for the use of the "Micro Labs" and "Cardiovascular Rat" software.

All the students of the year 2012, who used simulation software, had an average grade higher than the previous year with a significant difference (p = 0.01)

Figure 3: Web page created to train in the use of simulation software - *http://sanfer1.wix.com/microlabs*

CREATION OF A VIRTUAL LABORATORY IN PHARMACOLOGY. YEAR 2013

The proposal of a physical space was designed where students and teachers could interact and achieve interactive, creative and clear learning using simulators and accessing information.

Design and general description:

In addition to determining the technical requirements and the architecture of the virtual classroom to be used, a pedagogical and administrative structure (guides and didactic tutorials) was created for training in 4 short sessions with the use of software.

Results:

An area of 58 m2 was implemented with an electrical system necessary for the operation of 27 computers. During the inauguration, a workshop was held with students of the Toxicology course, which showed a high level of satisfaction with the organization, infrastructure, and learning achieved.

INSERTING NEW "PHARMACOGENETIC" EDUCATIONAL TOPICS. 2014

With the implementation of the virtual laboratory, an intervention was planned to include important topics in the medical career that are not included in the curriculum.

Design and general description:

The implementation of PBL and ICT in Pharmacogenetics in Medicine students were evaluated: 2012 (n = 134), 2013 (n = 8) and 2014 (n = 150). Theoretical session were implemented using the ABP to solve the cases about: "Dosage of Warfarin in genotypes CYP2C9 / VKORC1" and "Dosage of Abacavir in genotypes HLA-B5701 in patients with HIV" The development of the intervention is summarized in Figure 4.

Results:

The materials were shared online five days before the face-to-face class. Great capacity for synthesis and creativity in the design was observed. The level of learning estimated on a score of 10, was 8.24 ± 0.8.

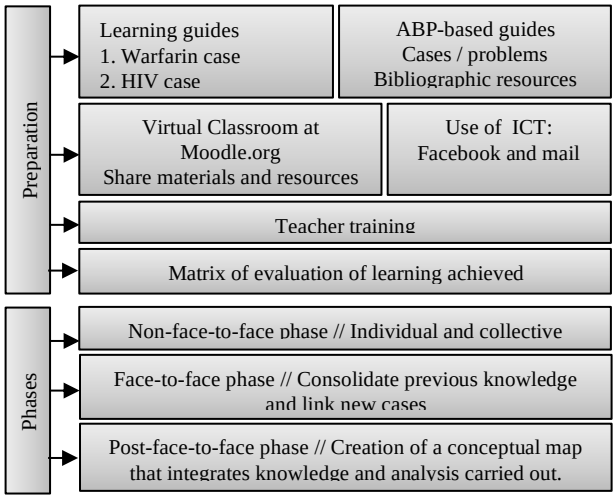

Figure 4. ALM Planning for Pharmacogenetics.

INTERMEDIATE SITUATIONAL DIAGNOSIS – 2014

At the end of 2014, the learning situation was explored again:

- More than 75% of the students declared to achieve high levels of learning.
- 90% attended classes for learning motivation
- Only 11% did not use electronic resources for self-learning

We also find different proposals for change.

Opinion about the improvement of the classes: *"I would ask for more interest in the development of the theoretical classes, they are monotonous and many of them with little information".*
Opinions about the methodology*: "Greater horizontality" "Modules must have a good PBL, if they are not used correctly, it causes confusion, train all teachers equally"*

TRANSDISCIPLINARY TRAINING IN THE USE OF ICT. YEARS 2015, 2016

After 2014, we began with interventions throughout the Faculty of Medicine. Training was initiated to develop ICT competencies according to the UNESCO model. In the end, although 78% achieved high levels of competence, only 25% of teachers created and implemented virtual classrooms. There were important limitations concerning the technological conditions and university policies to integrate it into their teaching activity [7].

Figure 5: Transdisciplinary training in the use of ICT

INTRODUCTION OF ACTIVE METHODOLOGIES IN HOSPITAL ENVIRONMENTS - 2017, 2018

In the year 2017, the intervention in hospital environments began. Because the form of evaluation could vary from the subjective (based on experiences) to the quantitative (based on a test); an evaluation instrument was developed to standardize the evaluation based on achievement of competences.

Resistance to change was shown; however, the critical point was the constant teacher training and a follow-up plan.

"We are just being aware that we must work as a team and change the traditional methodology"
"We are using the new active methodologies and we feel the difference, I am changing the strategy, with satisfaction"

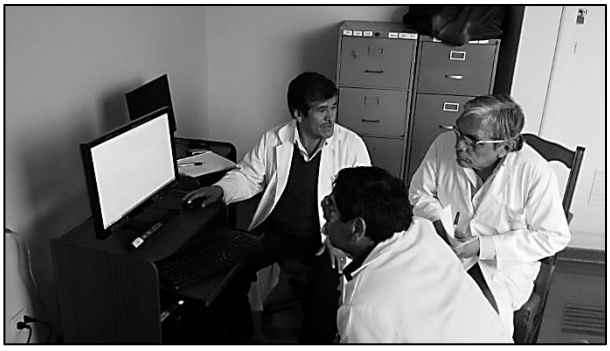

Figure 6. Teaching ALM in Hospitals

Finally, in 2017, a project for conducting the course "Surgical Techniques and Anesthesiology" was presented, using the Blended Learning methodology. The design was quasi-experimental research applied to 210 fifth-grade medical students. Among the results of relevance is the continuous use of virtual classrooms, the production of videos by teachers, a restriction of the theoretical content, the evaluation by competencies and the evidence of the improvement of the surgical skills achieved through the use of virtual simulations and face-to-face simulations (laparoscopy or endoscopy).

DISCUSSION

The creation of the Faculty of Medicine of the UNMSM was in 1856. And because it was the first faculty in Peru, it led to the establishment of all the foundations of national medical training in its classrooms since the end of the vice regal period [14]. During the first years, the learning methodology was focused on the teacher considered as the wise and inspiring, and with an educational plan with international bases of anatomy, galenic botany and art [15]. Then, the academic structure was oriented to solve national problems and the use of natural resources [16] but with the same pedagogical form.

Already during the twentieth century, the curricular system was changing due to international and world wars so teaching began to have non-vertical teaching models. But it was not until the 21st century when dizzying changes occurred thanks to the introduction of the Flexner educational process [17] with its methodology of meaningful learning and learning by doing. The construction of meaningful learning then became a transcendental matter in our university system [18].

In this context, the need to give more dynamism to the role of teachers is considered, who should focus much more on the student [19]. However, to empower the great change of this new era, it is necessary to implement more technology and interactivity in educational media, encourage teachers to optimize the teaching process and awaken in students an active participation in their self-learning. Thus, the university would assume its role of training professionals with the capacity to develop their potential based on their career [20].

The success of the application of the MLA seen in the interventions presented here, is due to the motivation and usefulness of the problematization for self-learning in the students, who became stimulators of their own process. They determine the objectives of the solution, develop the strategic plan and discuss what was learned. Although the teachers are guides and received training in the PBL methodology [16], in these 10 years it was striking that the students were the true drivers of this methodology [21].

It can be affirmed now that in the UNMSM, the teaching-learning in some courses of the health sciences, have adopted the model of learning centered on the student and the achievement of this goal contribute the ALM. Especially competency-based education that allows designing curricula based on the health needs of the population and integrate the achievement of skills and attitudes required.

These educational advances have already been implemented and reported in the local environment by private universities and in countries such as Colombia and Mexico [22, 23, 24]. It is necessary that the teaching staff of a public university also know the bases of education by competence and have an active participation in the design of the tools and in their correct implementation [25]. Support the above, the new educational taxonomy of Dee Fink [4], made explicit in 6 categories, essential to learn something: Initially "**Know**" what it is to remember specific information. For this you need to have basic knowledge of the subject. The "**Application**" that consists of learning new social, physical and intellectual actions of daily life through critical and creative thinking. The "**special value**" that is to create awareness that learning will provide intellectual and practical power. "**Integration**" is when the student understands the connection between different things. The "**human dimension**" is to understand that what is learned will interact effectively with social and personal implications. And the "**Application of learning**" which is the effective use to solve problems.

Likewise, to design the interventions presented in this report, the Rickenmann didactic was incorporated [26], where it is important to plan the cognitive activity and the tasks that the students must perform. First, the model of teaching materials related to the teaching-learning contents is created and then the stimuli for the critical analysis of the problem and the search for the solution are intensified. Finally, the problem is solved, with teamwork, with argumentative debates based on scientific evidence [27].

In most of the educational blocks developed initially, there was a deficit in the use of ICTs and some potential causes were found: 1. Faculty directors do not add to the academic load of teachers who develop ICTs (the hours spent on tasks of virtual teaching-learning). 2. Lack of confidence of teachers to teach in virtual spaces. 3. Resistance to change, cultural and organizational barriers, which do not differ from other countries. According to Kirkup and Kirkwood, advances in the use of ICTs in higher education have been gradual rather than revolutionary [28]. In the present case, ICTs played an important role as technological tools from acquisition to presentation of information [7].

An important event that favored the educational intervention was the curricular reform of the Human Medicine career that began in 2014, where a curriculum based on the achievement of competences was established. The group of researchers developed training for teachers in Active Learning Methodologies, thanks to their greater benefit for the achievement of basic skills in metacognition and ability for argumentative communication [11]. It is important to emphasize that the ABP is considered as ALM that uses the scientific method for its execution [16] and that after routinizing it as a didactic method, it was used as a key didactic strategy in the learning process.

For the achievement of competencies, academic strengths were important, such as the interdisciplinary nature of the teachers, the transdisciplinary (members of different careers in the educational research team, teacher educators); a computerized infrastructure and the acquisition of basic laboratory equipment that has allowed the practical development of cognitive, procedural and attitudinal capacities; for the sustainability of these elements in the curriculum. As well as the commitment of the students to develop them, exercising their own responsibility [5, 11]. In the same way, more updated methodologies such as Blended learning (B-Learning), in face-to-face surgical learning (surgical skills), supported by electronic means, in medical education have been started [29, 30].

CONCLUSION

In this decade (2008-2018), important educational changes have been achieved, highlighting the commitment of teachers in the development of ALM methodologies, the use of ICTs, the political support of the authorities of the Faculty of Medicine, which facilitated the training teachers to develop their pedagogical skills, educational management and student satisfaction in the development of their skills with assertive communication and the achievement of meaningful learning for life.

BIBLIOGRAPHY

[1] F. Diaz, G. Fernández, Estrategias docentes para un aprendizaje significativo. Una interpretación constructivista. 3raedición. México: Editorial McGraw-Hill-México, 2010, p. 405.

[2] J. Rivera, El aprendizaje significativo y la evaluación de los aprendizajes. Tecnología educativa. Revista de investigación educativa, 8(14), 2004, pp: 47-52.

[3] P. Paucar, Estrategias de aprendizaje, motivación para el estudio y comprensión lectora en estudiantes de la facultad de educación de la UNMSM. Tesis Magíster en Psicología con mención en Psicología Educativa. 2015,49 pp.

[4] L. Dee Fink. Creating significant learning experiences. An integrated approach to designing College Courses. 2nd edition. San Francisco. USA: Published by Jossey-Bass. 2013. p:334.

[5] W. Lorin, D. Krathwohl (Eds.), A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives, Complete Edition. Longman. (2000)

[6] Universidad Nacional Mayor de San Marcos UNMSM. Modelo Educativo, Vice Rectorado Académico 2015. http://viceacademico.unmsm.edu.pe/wcontent/uploads/2015/07/Modelo_Educativo_completo.pdf

[7] M. Placencia, R. Pando, V. Mechan, M. Quintana, J. Carreño, H. Mendoza, J. Silva, Y. Teaching competences using ICT, Faculty of Medicine: San Fernando UNMSM, Lima-Perú: Proceeding of The 22nd World Multi Conference on Systemic Cybernetics and Informatics (WMSCI2018)pp: 54-58.

[8] A, Pinto, O. Cortes, C. Alfaro. Hacia la transformación de la práctica docente: modelo espiral de Competencias. Depósito de Investigación Universidad de Sevilla. 2017; pp: 37-51.

[9] C. Ferro, A. I. Martínez, C. Otero. Ventajas del uso de las TICs en el proceso de enseñanza- aprendizaje desde la óptica de los docentes universitarios españoles. Revista electrónica de tecnología educativa (Edutece): 2009, 29. pp:1-12.

[10] Aneas. Transdisciplinary Design Education Framework. Transdisciplinary technology education: a characterization and some ideas for implementation in the University. Studies in Higher Education. 2015; vol 40 (9), pp: 1715-1728.

[11] G.Sanjay, N. Utsav , U. Parekh, J. Ganjiwale. Student's perception about innovative teaching learning practices in Forensic Medicine. Journal of Forensic and Legal Medicine.2017; 52(1), pp: 137-142.

[12] M. Placencia, C. García, H. Mendoza, L. Tenorio, J. Valencia, J. Escobedo. Nivel de satisfacción de estudiantes en el diseño e implementación del laboratorio de simulación virtual en la sección de Farmacología de la Facultad de Medicina de la UNMSM. Horiz Med. 2015; 15 (3), pp: 51-56.

[13] H.van Wilgenburg, P. Zillesen,I. Krulichova .Experimental design : computer simulation for improving the Precision of an experiment. Altern lab 2004 Jun;32 Suppl 1B, pp: 607-611.

[14] O. Salaverry. El inicio de la educación médica moderna en el Perú. La creación de la Facultad de Medicina de San Fernando. Acta Medica Peruana. 2006; 23 (2), pp: 122-131.

[15] H. Unanue. Oración inaugural que, para la estrena y apertura del Anfiteatro Anatómico, dijo en la real Universidad de San Marcos. Decadencia y Restauración del Perú. Mercurio Peruano; 3 febrero 1793, 7 (218), pp: 82-127.

[16] CE. Paz-Soldán. Heredia y sus discípulos. Biblioteca de Cultura Sanitaria. Lima: Instituto de Medicina Social; 1956, p. 63.

[17] A. Flexner. Medical Education in the United States and Canada. A report to the Carnegie Foundation for the advancement of teaching. Washington, DC: Science and Health Publications, Inc.; 1910.

[18] S. Tobón. Formación integral y competencias. Pensamiento complejo, currículo, didáctica y evaluación. Centro de Investigación en Formación y Evaluación CIFE, 3ª ed. Bogotá-Colombia. Ecoe-Ediciones, 2010.

[19] IHN. Sheriff, F. Ahmed, N. Jivraj, JCM. Wan JCM, J. Sampford, N. Ahmed. Student-led leadership training for undergraduate healthcare students. Leadersh Heal Serv. 2017. doi:10.1108/LHS-03-2017-0018

[20] L. Rodríguez. El aprendizaje basado en problemas, para la educación médica: sus raíces epistemológicas y pedagógicas. Rev Med. 2014;22(2):32-36

[21] I. Valdez. El enfoque de competencias en la virtualidad educativa. Apertura. 2006;6(4):20-30.

[22] D. Champin. Evaluación por competencias en la educación médica. Revista Peruana De Medicina Experimental Y Salud Pública [serial on the Internet]. (2014, July), [cited June 15, 2018]; 31(3): 566-571. Available from: MedicLatina.

[23] G. Risco. Educar por competencias a los profesionales de la salud para transformar la salud. Revista Peruana De Medicina Experimental Y Salud Pública [serial on the Internet]. (2014, July), [cited June 15, 2018]; 31(3) pp. 413-416. Available from: MedicLatina.

[24] A. González-Burboa, C. Acevedo. Percepción de estudiantes de la Salud acerca de la implementación de las macrocompetencias genéricas. Revista Cubana De Educación Médica Superior [serial on the Internet]. (2016, Oct), [cited June 15, 2018]; 30(4), pp: 349-360. Available from: MedicLatina.

[25] M. Durante, A. González, S. López, J. Lozano, M. Mendiola. Educación por competencias: de estudiante a médico. Revista De La Facultad De Medicina De La UNAM [serial on the Internet]. (2011, Nov), [cited June 15, 2018]; 54(6), pp: 42-50. Available from: MedicLatina.

[26] R. Rickenmann. Metodologías clínicas de investigación en didácticas y formación del profesorado: un estudio de los dispositivos de formación en alternancia. Actas del Congreso Internacional de investigación, educación y formación docente. 2006 pp: 1-16.

[27] A. Estrada. El aprendizaje por proyectos y el trabajo colaborativo, como herramientas de aprendizaje, en la construcción del proceso educativo, de la Unidad de aprendizaje TICs. Revista Iberoamericana para la investigación y el desarrollo educativo. 2012; 3 (5), pp: 123-138

[28] G. Kirkup, A. Kirkwood. Information and communications technologies (ICT) in higher education teaching a tale of gradualism rather than revolution. Learn Media Technol. 2005;30(2), pp:185-199. doi:10.1080/17439880500093810

[29] MJ. Cheesman, S.Chenb, M.L Machadia, T. Jacobb, RF.Minchina, PA. Tregloanb. Implementation of a Virtual Laboratory Practical Class (VLPC) module in pharmacology education Pharmacognosy Communications 2014, 4(1), pp: 2-10

[30] A. Estrada. El aprendizaje por proyectos y el trabajo colaborativo como herramienta de aprendizaje, en la construcción del proceso educativo, de la Unidad de aprendizaje TICs. Revista Iberoamericana para la investigación y el desarrollo educativo.2012;3 (5), pp:123-138.