UNIVERSIDAD COMPLUTENSE MADRID

Proyecto de Innovación

Convocatoria 2018/2019

Nº de proyecto: 292

IMPLEMENTACIÓN DEL APRENDIZAJE BASADO EN PROBLEMAS (ABP) EN LA ENSEÑANZA PRÁCTICA DE LA FISIOLOGÍA DEL SISTEMA DIGESTIVO

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1. Objetivos propuestos en la presentación del proyecto

A fin de poder adaptarse al nuevo concepto de aprendizaje personal y autónomo del alumno, el proceso de Convergencia Europea ha exigido una renovación profunda de la metodología de la enseñanza universitaria para permitirle en todo momento el acceso a la información y a una constante actualización de conocimientos (De Miguel M (2005b)). La planificación de la enseñanza debe estar centrada en el estudiante para que éste "aprenda a aprender", asumiendo la responsabilidad del desarrollo de su trabajo académico, de tal modo que el profesor no sea sólo un mero transmisor de conocimientos, sino un verdadero gestor de los procesos de aprendizaje de sus alumnos. La metodología de aprendizaje basado en problemas (ABP) puede ser una herramienta excelente para cumplir estos objetivos. El ABP pretende que el alumno aprenda a desenvolverse como un profesional capaz de identificar y resolver problemas, de comprender el impacto de su propia actuación profesional y las responsabilidades éticas que implica, de interpretar datos y diseñar estrategias. Se trata de un enfoque particular de la metodología docente activa que consiste en que los alumnos, en grupo, de forma autónoma y guiados por un profesor (tutor), deben encontrar la respuesta a una pregunta o problema de forma que, el conseguir hacerlo correctamente, suponga tener que buscar, entender e integrar los conceptos básicos de la materia de estudio. Los estudiantes deben comprometerse en aprender autónomamente; punto de partida para la reducción de horas presenciales que impone la implantación de los estudios de Grado dentro del marco del EEES (Gómez-Lucas, M.C. & Grau-Company, S. (2010)). Este sistema de aprendizaje requiere una inversión en recursos (libros, nuevas tecnologías de comunicación y de información (TICs), materiales adaptados, campus virtual, enseñanza integrada, aulas para reuniones, etc…), así como la preparación específica de los profesores. La Sección Departamental de Fisiología tiene una amplia experiencia en la aplicación del ABP en el aprendizaje de la asignatura de Fisiopatología obtenida de la consecución de Proyectos de Innovación Educativa (PIE nº 154 (2011), nº 257 (2016), nº381 (2017)) implementados a alumnos de tercer curso del grado de Farmacia y cuyos resultados han sido enviados a congresos internacionales y publicados en revistas de innovación educativa (Recio P, y col. 2012, Hernández M y col. 2016, Martínez AC y col. 2017). En la presente solitud nos proponemos implementar la metodología ABP en la asignatura de Fisiología que se imparte en segundo curso del grado de Farmacia de la UCM. Las diferencias en las competencias específicas de las dos asignaturas y también el grado de conocimientos y madurez del alumnado constituyen un reto docente para el profesorado de Sección Departamental de Fisiología. Por sus características, la enseñanza de la Fisiología, resulta idónea la aplicación del método de aprendizaje basado en problemas (ABP) (Morales y Landa, 2004; Rodríguez-Barbero y López-Novoa, 1999). Sus competencias genéricas, favorecen el desarrollo del pensamiento científico básico que permite a los estudiantes establecer una hipótesis sobre los hechos observados, la utilización de las diferentes fuentes de información para la adquisición del conocimiento y su aplicación en la resolución de los casos presentados. En cuanto a las competencias específicas, la Fisiología contribuye a conocer los conceptos y principios fundamentales en los que se basa la vida, comprender el significado del organismo como una unidad, como un todo integrado y definir los mecanismos de las regulaciones funcionales. La Fisiología es una disciplina eminentemente integradora de los fenómenos biológicos lo que implica necesariamente la coordinación e incorporación de conocimientos de otras asignaturas básicas para la formación de un farmacéutico como la bioquímica, la biología celular, la histología o la anatomía como se recoge en el Plan de Estudios de Grado en Farmacia y en el Libro Blanco de la ANECA todas ellas bajo el epígrafe de "morfología, estructura y función del cuerpo humano" Libro blanco ANECA página Web. En la actualidad no hay una metodología de enseñanza claramente definida que dé indicaciones claras y precisas para orientar a los estudiantes de Fisiología hacia el

análisis de situaciones problemáticas, la aplicación de su conocimiento en la solución eficaz de problemas y de la conceptualización científica, y la fusión teórico-práctica en la enseñanza de los contenidos. El objetivo general del presente Proyecto es la implementación del ABP en la docencia de Fisiología, asignatura Troncal del Grado en Farmacia de la UCM, con una visión integradora del funcionamiento del cuerpo humano.

Los objetivos concretos persiguen:
. Mejorar el entorno de aprendizaje con el fin de incrementar el interés del alumno por la materia al involucrarle directamente en el proceso.
. Conseguir una mayor implicación de los alumnos en su propio aprendizaje. El profesor se sitúa en una posición de moderador del flujo informativo que se mueve por el entorno de comunicación y forma parte del proceso de aprendizaje. De esta manera, el profesor se asegura, a tiempo real, de que el alumno progresa de manera adecuada hacia el logro de los objetivos del aprendizaje.
. Potenciar la participación entre equipos de trabajo, mediante el intercambio de información entre grupos de alumnos y entre los alumnos-profesor, lo que permite la comparación de casos prácticos entre estudiantes que les conduce a desarrollar habilidades, formar capacidades genéricas y específicas y generar un pensamiento crítico de mayor claridad para la adquisición de nuevas competencias.
. La retroalimentación del aprendizaje tanto por parte del profesor hacia el alumno como del propio alumno (autoevaluación).

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2. Objetivos alcanzados

Todos los objetivos propuestos se han alcanzado de manera muy satisfactoria y se han conseguido en su totalidad. Los resultados se han enviado a dos Congresos Internacionales especializados en Innovación Docente y han sido publicados en los Procceding.

Previamente a la realización del Proyecto se elaboraron los siguientes materiales docentes que han sido utilizados para implementar el método docente o para medir el impacto de la inclusión del ABP en la práctica de Fisiología Digestiva:

- Guía de la Práctica donde se explica la metodología y se dan instrucciones.
- Guía histológica y citológica con las estructuras que deberán caracterizar y diagnosticar.
- Guía de la simulación PhysioEX 9.0.
- Presentación Power Point de esquemas y breve descripción de los conceptos.
- Enlaces de sitios Web como recurso bibliográfico y otras fuentes.
- Cuestionario de compresión y resultados de la práctica para trabajar en el aula y en grupo para cada uno de los apartados.
- Guía del Profesor que permite la retroalimentación del aprendizaje donde se indican los objetivos de aprendizaje específico, los recursos de aprendizaje y las líneas de actuación necesarias para el manejo de problemas que pudieran aparecer durante el proceso de aprendizaje.
- Cuestionarios pre- y post-test para la valoración de los conocimientos aprendidos antes y después de la práctica.
- Estadillo de satisfacción del método aplicado y valoración del aprendizaje.

De los resultados obtenidos en este Proyecto se deduce, que la utilización de metodologías como el ABP, en las que el alumno se implica en su aprendizaje haciéndolo más constructivo, a la vez que realiza prácticas innovadoras y simulaciones en ordenador, ayuda a obtener mejores resultados en los procesos de enseñanza y aprendizaje. El análisis de las encuestas de satisfacción de los estudiantes mostró que todas las preguntas se calificaron en un rango de acuerdo al nivel de puntuación promedio y la mayoría de los modos fueron aproximadamente 2.5 (de acuerdo). Hubo un fuerte acuerdo en que la inclusión del método ABP fue mejor que las sesiones prácticas convencionales. La inclusión de ABP en la práctica de digestivo permitió una mejor definición del problema y la formulación de los objetivos del aprendizaje, fomentó la búsqueda de información fuera del grupo favoreciendo el autoaprendizaje, promocionó la participación en grupo para ordenar las ideas, sistematizar y profundizar en los conceptos, esclarecer las dudas analizando el problema y sistematizar y verificar nuevas ideas. ABP mejoró la adquisición de conocimientos y motivó a los alumnos a implicarse y discutir. Los mayores incrementos en el aprendizaje del alumnado se han producido al utilizar de forma combinada ambos métodos: simulación fisiológica con ABP. Además la inclusión del diagnóstico histológico ayudó a los alumnos a familiarizarse con las estructuras implicadas en los procesos fisiológicos digestivos permitiendo que con un enfoque metodológico mixto el alumnado adquiera mayores habilidades y competencias. Por tanto, se deduce de este estudio, que es mejor utilizar una metodología mixta, ya que permite un trabajo colaborativo, y se produce una mejora en el procesamiento de la información, tal como ocurre en la resolución de situaciones reales problemáticas. Estos resultados nos permitirán diseñar programas en los que se integren ABP con diferentes metodologías, en la proporción adecuada, para maximizar, tanto la adquisición de conocimientos como el desarrollo de competencias. Además, la estrategia didáctica ABP utilizada en esta propuesta aborda la enseñanza de Fisiología saliéndose del esquema tradicionalista y memorístico que ha permanecido arraigado en la enseñanza desde hace décadas. La incorporación de actividades de apoyo desde las TIC y el trabajo cooperativo en equipos de aprendizaje, incluidos en el diseño de esta propuesta didáctica, constituyen

claros ejemplos de la innovación educativa en términos instruccionales, para potenciar los procesos de aprendizajes en los estudiantes, consiguiendo una formación científica, crítica y responsable frente a su entorno, que les hace capaces de proyectarse en su futuro profesional como farmacéuticos. Los resultados de este proyecto han sido publicados en INTED2019 Proceedings ISBN: 978-84-09-08619-1 y EDULEARN19 Proceedings ISBN: 978-84-09-12031-4 y han sido incluidos en el anexo de esta memoria.

3. Metodología empleada en el proyecto

El ABP es un método de aprendizaje basado en problemas de la vida real. Este sistema se centra en la persona del estudiante como individuo y como miembro de un grupo. El ABP que permite diseñar actividades y procesos necesarios para incentivar a los estudiantes a que construyan su conocimiento y que, una vez adquiridos, perduren en el tiempo, para que después puedan aplicarlos en otros contextos y situaciones de la vida.

La metodología ABP aplicada en este Proyecto ha sido implantada siguiendo las siguientes fases:
1. Fase preliminar o motivación: presentación del tema, los objetivos, motivación y creación de expectativas e interés por el tema. Expuesto en el Campus Virtual.
2. Fase de identificación de ideas previas: momento en donde se exploran las ideas previas y el estudiante toma conciencia de sus conocimientos.
3. Fase de conflicto y reestructuración cognitiva: se cuestionan las ideas previas que poseen los estudiantes, se introducen los nuevos conceptos para comparar ideas previas con las teorías científicas adquiridas y toma de conciencia. Autoaprendizaje del estudiante a partir búsquedas de fuentes propias. Adaptación a la base de conocimientos.
4. Fase de generalización de conocimientos o aplicación: afianza los conocimientos adquiridos, se motiva para profundizar en nuevos conocimientos y se comprueba la funcionalidad y aplicabilidad del aprendizaje logrado.
5. Fase de revisión de aprendizajes: metaevaluación: se comprueba los objetivos logrados, se afianzan y refuerza los aprendizajes alcanzados. Se motiva a los estudiantes para que realicen procesos de metacognición. El estudiante es consciente de lo que piensa y de cómo lo piensa, para que lo analice y modifique de manera autónoma según sus necesidades.

4. Recursos humanos

El profesorado que forma parte de esta solicitud de proyecto de innovación educativa es el que imparte dicha disciplina en el Grado en Farmacia y que tiene una amplia experiencia en la impartición de ABP en las sesiones prácticas y seminarios de la asignatura de Fisiopatología. El grado de consecución de los objetivos alcanzados ha sido posible gracias al dominio que posee el profesorado de esta Sección Departamental de la materia impartida y su capacidad creativa lo capacita para transformar su experiencia en situaciones que le permitan llevar con éxito el proceso de enseñanza-aprendizaje. También destacamos la valiosa colaboración del personal de la Administración y Servicios de la sección Departamental de Fisiología y de los Servicios Generales de la Facultad de Farmacia, los cuales, asistieron con la preparación de las aulas y los equipos informáticos necesarios para el desarrollo del Proyecto y organizaron el material necesario para realizar la práctica.

5. Desarrollo de las actividades

El ABP fue presentado en la clase inaugural de la docencia teórica de la asignatura en el mes de septiembre de 2018, describiendo los objetivos y el desarrollo del mismo. Los participantes del proyecto fueron el conjunto de alumnos matriculados en la asignatura de “Fisiología” del segundo curso del grado en Farmacia, que se imparte en la Facultad de Farmacia de la UCM. El Proyecto se aplicó al tema de digestivo de las prácticas del Programa de Fisiología del grado de Farmacia de UCM, En la práctica elegida para este Proyecto se estudian los procesos químicos de la digestión analizando los distintos factores que influyen sobre la actividad de las enzimas hidrolíticas del tracto gastrointestinal y además, se estudia la función de las sales biliares en la digestión de los lípidos. Se destaca la importancia del mantenimiento de las condiciones fisiológicas de pH y temperatura para la función digestiva de las enzimas. El programa informático PhysioEX 9.0 permite a los alumnos utilizar un laboratorio virtual donde valoran la actividad de cada enzima sobre su sustrato demostrando la especificidad de la función enzimática. La práctica se completa con el estudio histológico de las distintas zonas del aparato digestivo (cortes histológicos: estómago, intestino delgado y grueso, glándulas salivares, páncreas e hígado). Se elaborarán guías de prácticas para el alumno con cuestiones relacionadas para el desarrollo de la práctica y se valorará el aprovechamiento de la misma.

La retroalimentación del aprendizaje se realizó mediante la elaboración de una guía del profesor, en la que se indican los objetivos de aprendizaje específico, los recursos de aprendizaje (libros de texto, artículos científicos y bases de datos a utilizar) y las líneas generales de actuación necesarias para el manejo de problemas que pudieran aparecer durante el proceso de aprendizaje. La dilatada experiencia docente de los profesores implicados, fue una garantía para la consecución de los objetivos de aprendizaje planteados.

Durante la implementación de ABP se plantearon dos caso-problemas, una situación real fisiológica, previamente preparada por el profesor en base a los objetivos (educativos, de conocimiento, integración, capacidad crítica, etc.). Los estudiantes pudieron acceder, a través del Campus Virtual, a la descripción de la lección práctica y a los cuestionarios de generación de hipótesis con suficiente antelación para poder documentarse para su posterior cumplimentación. El día de la práctica, después de realizar las simulaciones fisiológicas y las observaciones microscópicas comenzó la sesión. En cada sesión, el grupo eligió un moderador -que se encarga de controlar el tiempo de la sesión y asegurar la participación de todos- y de un “notario” -que tiene tuvieron los estudiantes y el profesor tuvo una función relativamente pasiva, sirviendo exclusivamente de orientador de la marcha de la sesión para que ésta no se desvíe excesivamente de los objetivos educativos planteados para cada caso-problema. Su función fue garantizar que el grupo aborde el problema de una forma metódica favoreciendo la interacción y las preguntas entre los miembros del grupo, con el fin de estimular el pensamiento crítico científico y un aprendizaje profundo y duradero de los conceptos a tratar. El orden de la sesión se diseñó de la siguiente manera:

1º Lectura del caso-problema e identificación de las ideas clave del texto relacionado con la Fisiología del aparato digestivo y con la realización de la práctica en concreto (10-15 minutos).

2º Discusión de ideas durante la cual se debate sobre los aspectos de la Fisiología y disciplinas afines aportando ideas, conocimientos y también dudas sobre lo que el alumno conoce o dude sobre el tema (45-60 minutos).

3º Planteamiento de preguntas y consolidación del conocimiento (10-15 minutos).

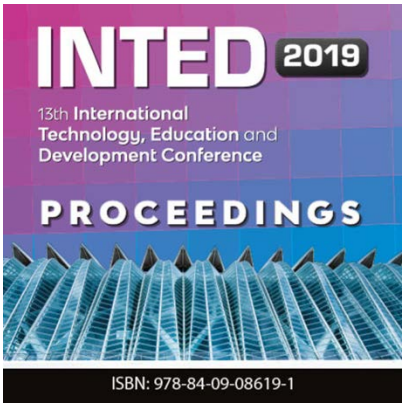
La evaluación de la metodología se realizó al final de la docencia práctica de cada grupo de estudiantes mediante encuestas sobre la idoneidad de cada uno de los diferentes materiales utilizados, así como de las actitudes generadas por la implementación del sistema ABP en la enseñanza práctica de Fisiología. Para el estudio se utilizaron 10 variables numéricas obtenidas de la encuesta realizada y que el alumno valoró del 1 al 10. Se valoran los siguientes conceptos: el grado de motivación que tienen los alumnos asistiendo a las prácticas, la motivación de los alumnos en la aplicación de nuevas tecnologías docentes, la motivación de los alumnos respecto al proyecto de ABP, la utilidad percibida de la realización de proyectos, si los alumnos prefieren realizar trabajos de manera grupal o individual, si los alumnos prefieren o no elegir a sus compañeros de trabajo, la implicación del alumno en la exposición oral. También se valoró la integración de conocimientos básicos de la lección práctica, el desarrollo de pensamiento crítico científico, la potenciación de habilidades de comunicación y de defensa pública y el aprendizaje autónomo, perdurable y cooperativo. Los datos obtenidos de las encuestas, fueron recogidos en una hoja Excel para realizar un estudio preliminar de los resultados, posteriormente se realizó un estudio estadístico utilizando para ello el programa SPSS vs 25.1. Además, los resultados de dichas encuestas fueron analizados y discutidos con los alumnos. Asimismo, al final del periodo de docencia práctica y una vez llevado a cabo el examen de la misma, se realizará un estudio comparativo entre la calificación global obtenida por los estudiantes que han participado en la metodología ABP y aquellos que no han participado. Por último, se han comunicado los resultados de este Proyecto en la sesión científica en 13th Annual International Technology, Education and Development Conference en Valencia, 11, 12 and 13 de marzo de 2019 y en 11th Annual International Conference on Education and New Learning Technologies en Palma de Mallorca del 1 al 3 de julio de 2019.

6. Anexos

PUBLICACIÓN 1

INTED2019 Proceedings,

ISBN: 978-84-09-08619-1



DIGESTIVE SYSTEM PHYSIOLOGY TEACHING THROUGH THE EXPERIENCE OF PROBLEM BASED LEARNING

A, Agis-Torres, A. Sánchez, C. Contreras, M. Muñoz, A.C. Martínez, B. Climent, P. Recio, R. Raposo, S. Benedito, A. García-Sacristán, L. Rivera, D. Prieto, M. Hernández, M.E. López-Oliva[1]

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Abstract

Problem based learning (PBL) is teaching methodology that gives precise indications to guide students' Physiology towards the analysis of situations and problem solving. In this project, 60 second year undergraduate pharmacy students were divided in small groups of 12 students each. They were exposed to PBL activities led by facilitators. Real situations related to the Physiology of the digestive system as case-problem were presented in the Virtual Campus. Students were provided with clear guidelines for aims and objectives of the debate and related questions for the development of the practice. One week later, on the day of the debate, students analysed the clinical problems, formulated hypothesis, and undertaken self-directed learning tasks. In addition, the PhysioEX 9.0 software allowed students to use a simulation virtual laboratory where they assessed the activity and enzymatic function as a replica of actual case-problem. Also, histological study of the different areas of the digestive system (stomach, small and large intestine, salivary glands, pancreas and liver) were carried out. At the end of the week, the students completed a questionnaire regarding their PBL experience and on the suitability of each of the different materials used, as well as the attitudes generated by the implementation of the PBL system in the Physiology practical teaching. The obtained results indicated that the incorporation of PBL as a learning strategy in the physiology practices had a positive impact on learning. The use of simulation coupled to PBL improved the acquisition of critical assessment and management skills, increased the interest and involvement of students in their own learning, encouraged participation among work teams, generated a critical thinking of greater clarity for the acquisition of new competences and allowed feedback of learning (self-evaluation). Thus, the student will deepen the practical physiological mechanisms that are the basis of their knowledge as future pharmacists, which will allow them to propose effective therapeutic strategies. All this PBL experience will help to better understand an integrating vision of the functioning of the digestive system.

Keywords: Problem based learning (PBL), Digestive Physiology, critical thinking, campus virtual, Virtual Physiology simulation.

INTRODUCTION

The pharmacist plays an important role in the healthcare system. In the late twentieth century, the global pharmacy profession shifted from a product-oriented to a patient-centred practice. Pharmacy education must be in line with pharmacy-training needs to prepare professionals for clinical practices. The aim of teaching practical physiology curriculum is to provide students with necessary understanding, knowledge, skills, behaviours, and attitudes that prepare them for professional practice and enable them to be good practicing pharmacists. This expanded professional interaction will require pharmacists to utilize effective problem solving skills. Practical sessions are employed to provide demonstrations of theory and practice and to develop practical skills. In this sense, World Health Organization (WHO) recommended an appropriate balance of the curricular components of basic sciences such as pharmaceutical sciences with practical experience (1).The CIN/2137/2008 Ministerial order is the Spanish transposition of the European directives, established the requirements of the curriculum and competencies that students should acquire for the practice of pharmacy (2). Noble et al. (3) suggested that pharmacy educators must consider including significant practical skills throughout the curriculum using simulations, actors, or real-life patients, enabling the students to perform the role of a pharmacist. To be in line with WHO and European recommendations, schools and instructors need to review their curricular content to ensure that graduates were competent in clinical sciences (4). The practical physiology program provided students with the opportunity to gain a first-hand laboratory experience of the structure, function, and development of the digestive system. Taking an integrative teaching methodology approach, the students enable to gain a detailed understanding of the processes involved in how the body works in health and in disease. So far teaching methodology has become more oriented towards the transmission of theoretical concepts by the teachers. We encourage learning of digestive system physiology developing a range of practical competencies based in the area of laboratory skills by using several teaching methods. Computer based learning (CBL) facilitates the resolution of case in the laboratory teaching practice in bioscience programs (5,6). The PhysioEX 9.0 software allows students to use a simulation virtual laboratory (7). Virtual laboratory exercises and tools enable students to learn at their own pace, revisit exercises, and at a time and location to suit themselves. As the function of an organ system depends on the integrated activity of its organs, the understanding of the different structural levels (cells, tissues, organs and systems) will contribute to the knowledge of the function of the body. Thereby chart, model and histological slides help to consolidate basic knowledge necessary to learn physiology (8). In the addition, Problem-based learning (PBL) is an excellent tool for the development of analytical and organization capacities, decisions, task planning and problems (9,10). The introduction of case-scenarios for classroom discussion/case-based learning would be more effective at helping them to learn physiological concepts compared with more traditional laboratory learning (10). PBL is being used in an increasing number of modules to promote the student's active participation in determining what they need to learn. In pharmaceutical sciences, use of PBL methods has been reported for higher-level classes, such as Physiopathology (9,11,12) and Pharmacology (13,14,15,16), whereas fewer reports address the use of PBL methods for basic science courses, such as physiology. Thus, we propose to design an integrated teaching method consists of multiple human physiology learning resources including virtual laboratories, histologic study, handheld physiology models, external online resources and study guides with clinical case studies with student-led discussions (PBL). Some of these teaching styles employed were previously done independently of each other. This was done with the goal of aiding students in developing and retaining critical human physiology knowledge and let to practice their profession as pharmacists in the management of digestive issues. The teaching methodology discussed here combines PB Learning, virtual laboratories, histological study methods that lead to the resolution of the clinical case by the student and to training them as future pharmacist.

METHODOLOGY

Description of the context and the participants

Physiology is a required subject in the second semester of the PharmD curriculum. The Physiology practical module consists of 10 practical sessions with a total of 25 hours long (1 ECTS credit) which are imparting during 3 hours every day along 2 weeks. The present pilot experience has been carried out in groups of 8-10 students in the Physiology practical sessions.

Our Department of Physiology incorporated PBL/small group learning in the laboratory session about digestive system, expecting that combining it with both simulations and histologic study methods could help students to achieve meaningful learning.

Suitability of the proposed topic and preparation of teaching materials

The study of digestive system was the chosen practice for including of PBL method. Students were informed about PBL method in the inaugural theory class of Physiology. We utilized the existing infrastructure in our department to design and implement a PBL module. A related to a real physiological situation problem about digestive system was prepared by lectures and presented to the students in the UCM Virtual Campus. During the preparatory phase, implicated teachers were oriented about PBL methodology and the clinical case and tutor guides were prepared. The PhysioEX 9.0 computer program allows to the students to use a virtual laboratory. PhysioExTM 9.0 software consists of 12 exercises containing 66 physiology lab activities that allow complementing the theoretical and practical contents previously taught in Physiology. Each 2-3 students shared a computer to carry out the practice collaboratively and discuss the results between them. The chemical processes of digestion are studied by analyzing the different factors that influence into the activity of the hydrolytic enzymes of the gastrointestinal tract (GI).The importance of the maintenance of the physiological conditions such as pH and Tª for the digestive function is emphasized. The activity of each enzyme on its substrate is measured, demonstrating the specificity of the enzymatic function. The practice is completed with the histological study of the different areas of the digestive system (Histological sections of the stomach, small and large intestine, salivary glands, pancreas and liver). Students were introduced to advanced histology techniques to illustrate the physiological functions of organs and systems and their pathologies, providing a microscopy study of the tissues on which students can make observations while promoting their critical thinking skills. Practice Guidelines for the students were designed with related questions for the development of the practice and the use of it was valued. Feedback from the learning was done through the development of a Teacher's Guide, in which indicate the specific learning objectives, the learning resources and the lines of necessary action to handle problems that may appear during the process of learning. The extensive teaching experience of the teachers involved is a guarantee for the achievement of the learning objectives set.

Impartition of the practice and implementation of PBL

Prior to the ‘laboratory’ session a case-problem about digestive physiology was considered, as a real physiological situation, previously prepared by the teacher. For that, students could access, through the UCM Virtual Campus, to the description of the practical lesson and questionnaires with enough time for its completion by autolearning using bibliography on their own. Students were required to answer questions about the case by autolearning using themselves bibliography sources. Thus, before the practical session students ought to analyze a case-problem about digestive physiology, as a real physiological situation, formulated hypothesis, and undertook self-directed learning tasks (physiology books, videos, PowerPoint slides, online resources, etc…..). Students were provided with clear guidelines for aims of the debate and related questions for the development of the practice session. In each session, the group of student chooses a moderator, who was in charge for controlling the time of the session, and ensuring the participation of the rest of the students and a "notary" who collected the contributions of the session, taking the notes of the session on the board. Students brought the answers to the questions about the case-problem resolving to debate. In addition, students consolidated and searched for the answers to the questions of the clinical case, carrying out the virtual simulation and studying the histological sections of the digestive system under a microscope. At all times debate is established in small groups and the student who acts as "notary" takes note of the results. During the sessions, the case was discussed in details, ensuring the participation from every student by the facilitators. The teacher had a passive role. Students have an active role discussing aspects of digestive physiology and providing ideas, knowledge and also doubts about what the student knows and what is not understood on the subject.

Evaluation of the learning method

To know the assessment of the students after the practice, a voluntary questioner about inclusion of PBL teaching methodology was carried out. The students had to classify

numerically to each sentence, taking into account a five-point Likert scale of 1 to 5, being 1 ‘strongly disagree’ and 5 ‘strongly agreeing’. The data was collected, compiled, and analyzed.

The survey was composed by 10 questions about the efficiency of PBL inclusion to diverse teaching and learning strategies for physiology practical lesson:

Question 1. Increased my motivation to participate in class

Question 2. Helped to understand the concepts covered in the clinical case.

Question 3. Helped to refine my creative and critical thinking skills.

Question 4. Promoted discussion.

Question 5. Promoted my self-learning.

Question 6. Encouraged my ability to seek information.

Question 7. Increased my comfort level in working in groups.

Question 8. Enabled to synthesize complex, but clinically meaningful information.

Question 9. is useful for my success as a future pharmacist.

Question 10.My level of satisfaction is …..

RESULTS

In this work the teaching methodology discussed here combines PB Learning, virtual laboratories, histological study methods that lead to the resolution of the clinical case by the student. The answers to the questions on the impact of the combination of the PBL methodology with other traditional teaching methods applied in the digestive physiology study are shown in Table 1. Figure 1 represents the degree of satisfaction in percentage calculated from the survey.

Table 1. Student's satisfaction.

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Strongly agree	14	9	18	35	14	12	5	11	9	10
Agree	19	36	30	15	34	30	20	36	36	32
Neutral	24	15	9	10	9	12	30	11	10	12
Disagre	3	0	3	0	3	6	4	2	5	5
Strongly Disagree	0	0	0	0	0	0	1	0	0	1

The most of students were satisfied with PBL model in various aspects. The majority of the students believed that the combination of diverse teaching methods coupled to PBL teaching enhanced conceptual understanding (60.5/15%, agreed/strongly agreed), improved the acquisition of critical assessment and management skills (55.6/38.9%, agreed/strongly agreed), increased the interest and involvement of students in their own learning (55.6/22.2%, agreed/strongly agreed), encouraged participation among work teams (55.6/16.7%,agreed/strongly agreed). Over 70% of students agreed/strongly agreed that case studies focused on clinically significant learning issues. Over 80% of students felt that solving cases helped them sharpen creative and critical thinking skills and synthesize complex clinical information. The in-class group discussion/activities helped them take responsibility for their own learning, and enhanced their overall learning. In addition, over 75% of students agreed/strongly agreed that the implementation of clinical case as PBL was useful for their success as a future pharmacist and to facilitate the learning outcomes of pharmacy students needed to practice pharmaceutical care (Figure 1). Thus, the Q3, Q4, Q5 and Q8 questions were the best valued which indicates that the students understood the concepts and the clinical meaning of the practice better, valuing very positively the self-learning, the discussion and the debate. The least valued issues were those related to participation and relationship with fellow group (Q1 and Q7).Students manifested their satisfied with the role of the teacher who works as their facilitators

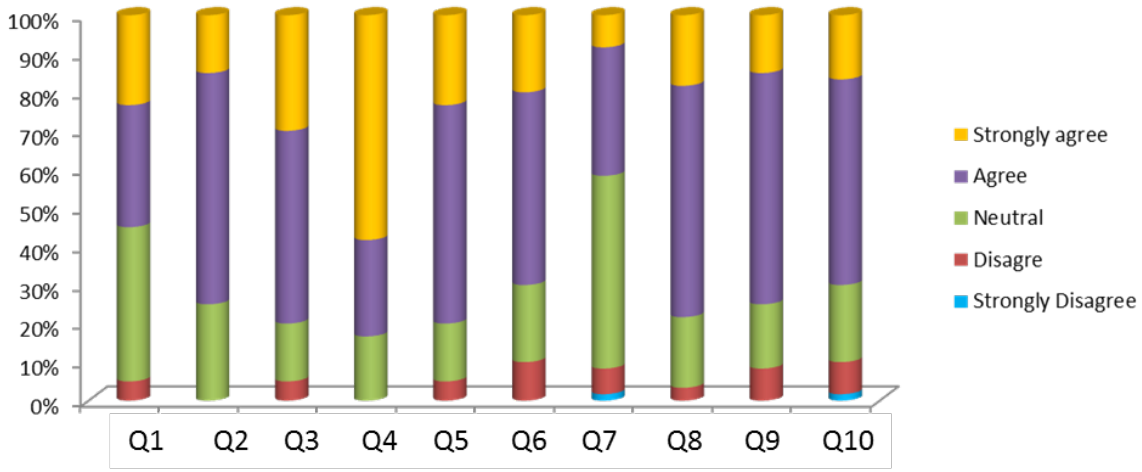

Figure 1: Results from the students on the voluntary opinion survey related to the combination of PBL with traditional practical learning (%).

CONCLUSIONS

The present study revealed that combined the PBL in a collaborative way with the use of computer software that simulates real physiology situations and the histologic study of structures of digestive system favoured the learning ability of the students. PBL in the clinical environment give students the opportunity to apply their knowledge and skills with problem and case based in real world practice. Moreover, PBL module within the framework of conventional teaching helps the student to integrate the knowledge of basic science subjects and to understand the important relationship between basic sciences and real clinical cases. The interaction between the designed materials for learning promoted creative and critical thinking, the acquisition of critical assessment and management skills, synthesized complex, but clinically meaningful information, debate and self-learning. It was an appropriate tool for the teaching, being well accepted by the students. Students actively participated in the PBL modified practical sessions. Their perceptions on satisfaction and usefulness of this integrated learning method toward achievement of skills which can be applied in the professional context as future pharmacist were very positive. Introduction of PBL in conventional practical lessons encourages both the teachers and the students to experiment with a new approach to learning. We demonstrated that a combination of teaching methods encourage for effective and efficient teaching.

ACKNOWLEDGEMENTS

This study was supported by grant nº292 from Innova-Docentia of Complutense University of Madrid 2018.

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PUBLICACIÓN 2

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EVALUATION OF THE IMPLEMENTATION OF THE STRATEGY OF PROBLEM-BASED LEARNING (PBL) IN DIGESTIVE SYSTEM PHYSIOLOGY TEACHING

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Abstract

As a basic science discipline of the Pharmacy curriculum, Physiology could be used as a starting point with respect to incorporating clinical relevance as well as developing problem-solving skills of the pharmacy student. PBL methodology makes students more creative and constructive and helps them to develop knowledges, skills, behaviours, and attitudes that prepare them in their professional life to be good practicing pharmacists. Our current practical Physiology program provides students with the opportunity to gain a first-hand laboratory experience of the structure, function, and development of the digestive system. By using of both the simulation PhysioEX 9.0 software as a virtual laboratory and the histological analysis of the digestive structures, students learn to integrate human anatomy and physiology. In this study, a mixed-methods approach was adopted including PBL as a planning practical course strategy. We compared the degree of satisfaction and academic achievement of students from second-year pharmacy students enrolled in the practical physiology course, one group including problem-based learning (PBL) and another one without PBL (Non-PBL) method. Students performed the tasks in small groups of 3-4 students. All of them used the simulation virtual laboratory where they evaluated the activity and function of the digestive enzymes and also carried out the histological study of the different areas of the digestive system. For the PBL group, a case problems were designed and delivered in the Virtual Campus with enough time for its completion by self-learning using students own bibliography. During the practical session, the students with PBL clarified case-problem terms with a brainstorm about the possible explanations, identified learning solutions and questions and the subsequent discussion to integrate the individual results from their self-study with those found from simulation and histological analysis. The non-PBL students were enrolled in the traditional class conducted by lectures. Student feedback was received based on a questionnaire in the five-point Likert scale format. The satisfaction questionnaire evaluated and compared the opinions of the students in ten fields of learning and the interaction between the applied learning methods. The feedback revealed a majority agreement that PBL helped students create interest, better understanding and promotes critical thinking. Cronbach's alpha reliability coefficient were 0.825 (PBL) and 0.929 (not PBL), respectively. The results of our study clearly showed that PBL condition had significantly higher mean scores. In addition, to evaluate whether the mixed PBL method helped to solve the posed clinical case-problems, Pre and Post-test score statistical analysis was performed. A substantial improvement in post-test results clearly revealed PBL's acceptance. Students learned to correlate relevant enzymatic mechanisms, histological, and clinical features with the clinical signs and symptoms, to learn the digestive physiology. PBL integrated with conventional learning methods would be more effective at helping student to learn and to have an integrating vision of the functioning of the physiological systems which can be applied in the professional context as future pharmacist.

Keywords: Problem based learning, Physiology simulation, Histological analyses. Virtual Campus.

INTRODUCTION

Nowadays, there is a need for an increased emphasis on in-class active learning activities in the curricular delivery in Pharmacy (Pharm) schools in order to perform the directories' European Higher Education Area. Pharmacy programs employ diverse active teaching and learning strategies in the delivery of physiology contents to graduate of Pharm students. Active learning is the notion that students must read, write, discuss, and engage in problem solving to maximize their potential for intellectual growth [1]. Among other, flipping the classroom, team-based learning, simulation-based education, in-class discussion/recitation, projects, problem-based learning (PBL), or team-based learning are some strategies commonly employed as active learning methods in health studies [2]. The active learning methodologies have been reported to improve students' learning outcomes compared with conventional physiology lecture [3, 4]. Studying Physiology requires selecting or creating teaching strategies that helps students to learn, thus being indispensable for the teacher to become a mediator of the process of knowledge construction, stimulating participation and understanding the uniqueness of those involved in the process. Understanding physiology also requires students to have the facts and the ability to utilize effective problem solving skills [5]. Human Physiology is an example of area knowledge that has been significantly transformed in higher education [6]. These changes aim mainly to develop professional profiles that include abilities beyond the well-established technical skills, to prepare students for the real world. Students need opportunities to see how experts analyze problems, to get feedback on their actions, and to get suggestions during the process. The active PBL methodology derives from the theory that learning is a process in which the learner actively constructs knowledge, developing analytical and organization capacities, decisions, task planning and problem solutions [5]. The higher education can be more effective if teaching takes place in the context of real-world problems or professional practice [7,8]. The integration of science and practice curricula within pharmacy is crucial in generating graduates capable of applying basic science principles to solve therapeutic problems [9]. In PBL, students are put in an active learning environment by giving them problems and training them to identify what they need to learn to solve those problems [5]. It has been demonstrated that the use of PBL strategy during didactic lectures and practical session improves students' ability to learn physiology [10,11] and physiopathology [12,13,14]. The introduction of case-scenarios for classroom discussion/case-based learning would be more effective at helping them to learn physiological concepts compared with more traditional laboratory learning. The integration of various active learning activities allows the students to improve the students' skills and gain a detailed understanding of the processes involved in how the body works in health and in disease [7]. Previously, we have described the development and the implementation of an innovative trilayer approach of teaching to deliver digestive physiology in an integrated pharmacy course [10]. This recent experience, implemented in the practical physiology program of Pharm degree of UCM, provided students with the opportunity to gain a first-hand laboratory experience of the structure, function, and development of the digestive system [10]. We encourage learning of digestive system physiology developing a range of practical competencies based in the area of laboratory skills by using several active conventional teaching methods. Computer based learning (CBL) facilitates the resolution of case in the laboratory teaching practice in physiology programs [10,15]. The PhysioEX 9.0 software allows students to use a simulation virtual laboratory [16]. Virtual laboratory exercises and tools enable students to learn at their own pace, revisit exercises, and at a time and location to suit themselves [15]. Through the histological study of the structures of the digestive system, students learn to integrate human anatomy and physiology and consolidate basic knowledge [10,17]. Some of these teaching styles employed were previously done independently of each other. In this study, we evaluated the efficiency of the implementation of PBL combined with active conventional learning method. The two main objectives proposed in this study were to assess student perception of PBL as a teaching methodology implemented in a conventional practical class setting and to measure improvements in problem-solving skills due to the inclusion of clinical case using PBL in addition to standard practical strategies.

METHODOLOGY

PBL was introduced in the Physiology course taught to second-year undergraduate during the second semester of the Pharm curriculum. The Physiology practical module consists of 10 practical sessions with a total of 25 hours long (1 ECTS credit) which are imparting during 3 hours every day along 2 weeks. The present pilot experience has been carried out in practical groups of 30-36 students divided into smaller groups of 2-4 students. In this study, PBL was introduced to mixed-methods approach to traditional practical lectures session. In order to evaluate the efficiency of the implementation of PBL, we obtained two experimental groups: one group including problem-based learning (PBL) to conventional teaching and another one without PBL (Non-PBL). We compared both groups to know the degree of satisfaction and academic achievement of the students.

Teaching methods and preparation of materials

The study of digestive system was the chosen practice for including of PBL method. A related to a real physiological situation problem about digestive system was prepared by lectures and presented to the students in the UCM Virtual Campus. During the preparatory phase, implicated teachers were oriented about PBL methodology and the clinical case and tutor guides were prepared. The conventional teaching method consisted in the implementation of physiological simulation and histological analysis [10]. The PhysioEX 9.0 computer program allowed to the students to use a virtual laboratory. PhysioEx^{TM} 9.0 software consists of 12 exercises containing 66 physiology lab activities that allow complementing the theoretical and practical contents previously taught in Physiology [16]. Each 2-3 students shared a computer to carry out the practice collaboratively and discuss the results between them. The focus of this lab exercise was the chemical digestion, essential for breaking food into particles that can be absorbed by the epithelium of the small and large intestine. The chemical processes of digestion were studied by analyzing the different factors that influence into the activity of the hydrolytic enzymes of the gastrointestinal tract. Influence of the changes in the pH and temperature on the rates of enzyme-catalyzed reactions was emphasized. The activity of each enzyme on its substrate was measured, demonstrating the specificity of the enzymatic function for each substrate. The practice is completed with the histological study of the digestive system structures by using slices from histological sections of the stomach, small and large intestine, salivary glands, pancreas and liver. Students were introduced to advanced histology techniques to illustrate the physiological functions of organs and systems and their pathologies, providing a microscopy study of the tissues on which students can make observations while promoting their critical thinking skills [10]. Practice Guidelines for the students were designed with related questions for the development of the practice and the use of it was valued. Feedback from the learning was done through the development of a Teacher's Guide, in which indicate the specific learning objectives, the learning resources and the lines of necessary action to handle problems that may appear during the process of learning. The extensive teaching experience of the teachers involved is a guarantee for the achievement of the learning objectives set [10,12,13,14].

Implementation of PBL

Students were informed about PBL method in the inaugural theory class of Physiology. We utilized the existing infrastructure in our Department to design and implement a PBL module. Before the 'laboratory' session, a real case-problem about digestive physiology was considered. The students could access, through the UCM Virtual Campus, to the description of the practical case-problem and questionnaires with enough time for its completion by autolearning, searching bibliography on their own. Students were required to answer questions about the case by self-learning using themselves bibliography sources. Thus, before the practical session students ought to analyze a case-problem about digestive physiology, as a real physiological situation, formulated hypothesis, and undertook self-directed learning tasks (Practical Guidelines,

physiology books, videos, PowerPoint slides, online resources, etc…..). Students contributed to the resolution of the practice with the knowledge previously learned. Students were provided with clear guidelines for aims of the debate and related questions for the development of the practice session. During session, the group of students chose a moderator, who was in charge for controlling the time of the session, and ensuring the participation of the rest of the students and a "notary" who collected the contributions of the session, taking the notes of the session on the board. Students brought the answers to the questions about the case-problem resolving to debate and discussion. In addition, students consolidated and searched for the answers to the questions of the clinical case, by carrying out the virtual simulation and studying the histological sections of the digestive system under a microscope. This served as a feedback mechanism for the self-learning carried out by students. At all time, debate was established in small groups and the student who acts as "notary" takes note of the results. During the sessions, the case was discussed in details, ensuring the participation from every student by the facilitators. The teacher had a passive role, resolving doubts derived from debate and the discussion of the case. Students had an active role discussing aspects of digestive physiology and providing ideas, knowledge and also doubts about what the student knows and what is not understood on the subject.

Assessing problem-solving skill: Satisfactory survey

To know the assessment of the students after the practice, a voluntary questioner about inclusion of PBL teaching methodology was carried out. Responses about their pharmacy student competencies after finished experience were scored using a five-point Likert scale, where 0= strongly disagree, 1 =disagree, 2= neither agree nor disagree, 3= agree, and 4= strongly agree. These competencies were evaluated in a survey composed by 10 questions to evaluate the efficiency of PBL implementation in a combined teaching and learning strategy for physiology practical lesson. The final questionnaire was composed of the following ten questions: Question 1.Did PBL increase my motivation to participate in class? Question 2. Did PBL help to understand the concepts covered in the clinical case? Question 3. Did PBL help to refine my creative and critical thinking skills? Question 4. Did PBL promote discussion? Question 5. Did PBL promote my self-learning? Question 6. Did PBL encourage my ability to seek information? Question 7. Did PBL increase my comfort level in working in groups? Question 8. Did PBL enable to synthesize complex, but clinically meaningful information? Question 9. Was PBL useful for my success as a future pharmacist? Question 10. My level of satisfaction is …..

Assessing knowledge enhancement: pre and post-test

The assessment of the acquired knowledge from the clinical case consisted of both pretest and posttest which were adopted as an additional measuring tool. A pretest/posttest developed by the teacher was administered to the students to evaluate the knowledge enhancement base on PBL. These consisted of a 10-items examination in relation to digestive clinical case. The pre-test was distributed before practical session and the post-test was administered at the end of the practical class along with the student satisfaction assessment course survey. This test needed each participant to have both pre- and post-test scores. Due to this, some students (n=2) were dropped from the analysis because they had only one score.

Data Analysis

SPSS software (version 25.0, SPSS, Chicago, IL) and Graphpad Prim 6.0 were used to conduct the statistical analyses and graphics of the data. Individual student answers to the same questions showing the student perception survey data respect to PBL and conventional teaching styles were collected, and differences in student answers assessed by the nonparametric paired sample sign test. In the case of the problem-solving exercises, experiments were designed to allow pairwise comparisons between the score of pre- and post-PBL of individual students by a Student's t-test for paired observations. *P* values less than 0.05 were considered to be statistically significant. Reliability was described as the internal consistency of the dimensions and determined using the Cronbach's alpha coefficient. The expected alpha coefficient was estimated at 0.75. [18,19].

RESULTS

Analysis of Student Survey

Anonymous post practical session questionnaires were completed by students of both groups to elicit survey rankings. Student feedback about the inclusion of PBL strategy was very positive. Table 1 represents the means of the degree of satisfaction of the students calculated from the survey (non-PBL n=36; PBL n= 28).Ten questions on the impact of the combination of the PBL methodology with conventional teaching methods applied in the digestive physiology study were analysed in the survey. Cronbach's alpha reliability coefficient were 0.825 (PBL) and 0.929 (not PBL), respectively indicating a very good reliability of the rating scale.

There was a statistically significant difference between the two groups regarding their overall satisfaction with the implementation of PBL. The analysis of surveys showed good agreement on the response to the most of the questions. The students satisfaction survey found that all of questions were scored range from agree level of mean score and most of modes were about 2.5 (agree). There was strong agreement that the educational outcome of PBL was better than conventional practical sessions. The Q4 (PBL=3.03, agreed), Q7 (PBL=3.54, strongly agreed) and Q9 (PBL=3.03, agreed) questions were the best valued showing the highest scores which indicates that the students understood the concepts and the clinical meaning of the practice better by valuing very positively the discussion and the debate (Q4-36,58%, *P*=0.004; Non-PBL vs PBL), increasing the interest and involvement of students working in groups and encouraging participation among work teams (Q7-42.90%, *P*=0.000; Non-PBL vs PBL) and emphasizing the importance of PBL for their professional future as a future pharmacist (Q9-26%, P=0.006; Non-PBL vs PBL). The highest differences between the non-PBL and PBL groups were observed in Q1 (Q1=73.45%, *P*=0.000; Non-PBL vs PBL) indicating that PBL implementation improves student motivation to participate in class despite the low opinion scores recorded in this item (Non-PBL=1.07 (disagree) vs PBL= 2.48 (agree)). Students agreed/strongly agreed that case studies focused on clinically significant learning issues (Q2- 31.43%, *P*= 0.001; Non-PBL vs PBL), felt that solving cases helped them sharpen creative and critical thinking skills (Q3-46.03%, *P*= 0.000; Non-PBL vs PBL) and synthesized complex clinical information (Q8-36.90%, *P*= 0.000; Non-PBL vs PBL). Non-significant differences between Non-PBL and PBL groups in the Q5 were found (Q5: 15.97%, *P*= 0.153; Non-PBL vs PBL) indicating that PBL did not promoted self-learning's students, reaching neutral opinion scores (Non-PBL= 2.22 vs PBL= 2.57). According to Q10, the overall opinion of the PBL strategy (Non-PBL= 2.09 (disagree) vs PBL= 2.74) (agree)) showed a higher level of satisfaction than non-PBL (Q10-31.43%, *P*= 0.011; Non-PBL vs PBL). In summary, Q4, Q7 and Q9 questions were the best valued which indicates that the students understood the concepts and the clinical meaning of the practice better, valuing very positively the discussion and the debate, involving students to work in groups and encouraging participation among work teams and emphasizing the importance of PBL for their future as pharmacist. The promotion of self-learning (Q5) was the least valued issue.

Table 1: Student's satisfaction to the Implementation of PBL to the conventional practical teaching calculated from the surveys.

Items	**non-PBL**	**PBL**	***P***	**%**
Question 1. Increased my motivation to participate in class	1,57 ± 0,23	2,71 ± 0,16	0,000	73,41
Question 2. Helped to understand the concepts covered in the clinical case.	2,13 ± 0,16	2,80 ± 0,12	0,001	31,43
Question 3. Helped to refine my creative and critical thinking skills.	1,96 ± 0,19	2,86 ± 0,11	0,000	46,03
Question 4. Promoted discussion.	2,22± 0,18	3,03± 0,19	0,004	36,58
Question 5. Promoted my self-learning.	2,22 ± 0,19	2,57 ± 0,15	0,153	15,97
Question 6. Encouraged my ability to seek information.	2,00 ± 0,20	2,66 ± 0,13	0,005	32,86
Question 7. Increased my comfort level in working in groups.	2,48 ± 0,22	3,54 ± 0,09	0,000	42,96
Question 8. Enabled to synthesize complex, but clinically meaningful information.	2,09 ± 0,17	2,86 ± 0,12	0,000	36,90
Question 9. It was useful for my success as a future pharmacist.	2,39 ± 0,20	3,03 ± 0,13	0,006	26,65
Question 10. My level of satisfaction is …..	2,09 ± 0,23	2,74 ± 0,14	0,011	31,43

Non-PBL group: conventional learning without including problem-based learning (n=36). PBL group: combination of conventional learning and the implementation of PBL (n=28). Values are mean and SEM of score in response to the survey questions. Responses were scored using a five-point Likert scale, where 0= strongly disagree, 1= disagree, 2 = neither agree or disagree, 3 =agree, and 4 =strongly agree. Statistical significant differences $P<0.05$ by a Student's t-test for paired observations. Also the percentage of satisfaction score increase was showed (%).

Problem-Solving Exercise: Analysis of pre and post-test

Pre-test and post-test practical session questionnaires were completed by students of both groups to elicit survey rankings (Figure 1). The results showed that students had scored considerably higher on the problem solving skills post-test than on the pre-test. For the PBL pre-test, the mean score was 7.19, with a standard deviation of 1.60 and a range of 2.5 to 10, while for the PBL post-test, the mean score was 8.11, with a standard deviation of 1.42 and a range of 5 to 10. The average rating significantly increased by 19.8%, $P= 0.0055$ (Paired t-test).The number of students who obtained the highest score (score=10) in the post-test (n=10) was much higher than in the pre-test (n=2), showing the effectiveness of PBL strategy.

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Figure 1: Scores from pre-test and post-test from PBL students

CONCLUSIONS

Instructors in our Department of Physiology have been challenged to propose teaching-learning methods that allow the development of students' competencies. Active learning helps to create new possible settings of professional training in superior education. In the present report, we demonstrate that PBL implementation in addition to both the use of real physiology simulations and the histologic study of structures of digestive system enhances positively the outcomes on student opinion and the competences acquired with the learning process. Data from student satisfaction survey and question scores showed that student achieved the subject-specific skill development and new subject knowledge. PBL implementation significantly increased the ability' students to develop transversal competences related to working in teams such as critical thinking or problem solving or communication. Also the interaction between the designed materials for learning promoted improvements in creative thinking, acquisition of critical assessment and management skills which leading to synthesize and to understand complex information. Beside, this study proves that the students were very motivated to understand the concepts clinical posed. Establishment of PBL strategy in clinical scenarios might help students discuss and explain the physiological process in a professional context. Although the results of the survey do not suggest that PBL helped to the students to take a higher responsibility for their own learning that control group, we found that students could construct the information in their minds and comprehend the subject better by actively searching the information themselves to resolve the posed problem. In this sense, the intervention by instructors should be kept under consideration to improve self-directed learning PBL-induced. The integrated histologic learning conducted in this study could be able to guide students to conclude the findings about the clinical case from data collection process and also from both the simulation experiment and histological diagnosis that they have carried out. Also, student performed their own learning feedback. Students' became aware of their mistakes especially in areas of communication and knowledge sharing, and so learnt not to repeat the mistake in the future. In relation to academic competences in PBL students, the scores of pre-test and post-test showed significantly different. The post-test attained higher scores on the problem solving skills respect to the pre-test, demonstrating greater knowledge acquisition. As the results of our study, the PBL groups showed a more positive learning attitude and higher motivation in comparison with the control group who were subjected to traditional-based method of learning. . Students learned to correlate relevant enzymatic mechanisms, histological, and clinical features with the clinical signs and symptoms, to learn the digestive physiology. These results suggest that the combined implementation of PBL could be used as an alternative method in teaching Pharm students because it is more effective and motivates the students. We believe that combined PBL strategy could be used in a practical classroom setting to instruct subject related to the biomedical field including pharmacology, physiology, and biochemistry and/or in similar courses in other professional programs. Overall concluded that the combined PBL strategy enhances pharmacy student competencies and students were satisfied with the new mixed PBL methodology.

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