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A RESEARCH VISION

Biomedical Engineering: experiences in the research formation with MOODLE

Ingeniería Biomédica: experiencias en la formación investigativa con MOODLE

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ABSTRACT

The work shows the didactic experiences reached in the research formation of biomedical engineers in the Technological University of Havana (Cujae), during the development of courses (Project of Research I and II) in the Biomedical Engineering program, that contribute to the scientific and methodological development of the Work of Diploma like act of culmination of the university studies, with the integrated employment of the resources of a Learning Management System: MOODLE (Forum, Dynamic Presentations, Videos, WIKI, Tasks, Surveys, Questionnaires, etc.) and the Teaching Based in Problems (EBP), to achieve the appropriate motivation and research formation in the students from the curriculum.

RESUMEN

Se El trabajo muestra las experiencias didácticas alcanzadas en la formación investigativa de ingenieros biomédicos en la Universidad Tecnológica de La Habana (Cujae), durante el desarrollo de la impartición semipresencial de cursos de pregrado (Proyecto de Investigación I y II), que contribuyen al desarrollo científico y metodológico del Trabajo de Diploma como acto de culminación de los estudios universitarios, con el empleo integrado de los recursos de un Sistema de Gestión del Aprendizaje: Plataforma MOODLE (Foro, Presentaciones Dinámicas, Videos, WIKI, Tareas, Encuestas, Cuestionarios, etc.) y la Enseñanza Basada en Problemas (EBP), para lograr la adecuada motivación y formación investigativa en los estudiantes desde lo curricular.



Palabras clave:

Ingeniería Biomédica

Sistema de Gestión del Aprendizaje

Formación investigativa

Pregrado

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1. Introduction

Nowadays, the professional education in Engineering [1] is limited by different factors such as the mobility toward the universities, the readiness of time and the costs in the education related with the

development of curricula, with a bigger essence of contents to reach certain objectives, competitions and abilities in the students, and a smaller number of present hours to achieve the professional appropriate formation [2-3].

Table 1. Relationship of subjects in the discipline of Bioengineering (Program of Biomedical Engineering in Cujae).

Subjects	Year	Main objective	Comments
Biomedical Engineering I	1	To characterize of the Program of Study and the university services	Annual subject developed by biweekly encounters that it includes visits to centers and institutions related with the profession and the design of biomedical technologies.
Biomedical Engineering II	2	To characterize the main devices (electric, optoelectronics and others) used in the design of biomedical technologies.	
Research Training Practice I	2	To carry out an instrumental rising in the assigned center (it includes a project for the use of energy payees) and to detect a scientific problem of the specialty.	Concentrated activity at the end of the second semester during 21 days, that it allows the association of the student with a scientific problem related with the speciality (Bioengineering)
Project of Research I	3	To carry out the bid of a research topic applying a scientific method (Waterfalls method).	The student begins with the elaboration of a contract for planning the research process and analysis the feasibility of the research project proposal.
Research Training Practice II	3	To carry out the experimental phase of the research project	Concentrated activity at the end of second semester during 21 days, that it allows the student and their tutor to develop the design of scientific experiments for the confirmation of the departure hypothesis
Project of Research II	4	To carry out the analysis of the research results (it includes economic analysis); as well as the divulgation of these in a scientific event.	The student prepares a POSTER for a scientific event, showing their research results (the best works can be sent to a scientific journal).
Thesis of Diploma Work	4	To prepare and to sustain the investigation results for the obtaining of the degree.	Development of public defense of the Thesis for the analysis of student's professional education.

Source: own.

A possible solution to this complex situation can be developed with the integrated employment of the resources of a Learning Management System (LMS), that which allows to guarantee the transmission of knowledge [4-6]. This alternative in occasions is limited

by the technical characteristics of the computer services in the university institutions (bandwidth and computation capacity) and the level of pedagogic preparation of the teachers and their experiences in the didactic appropriate employment of the means and

available resources. In particular, in the undergraduate program, the flexible transmission of the knowledge constitutes one from the most complex problems to solve by teachers and students, the first with the responsibility of being better directors in the development of study methods including the formation of human values, and the seconds, as main actors of the teaching-learning process in search of better education [7-8] that includes the self-preparation. As part of the educational services development by Department of Bioengineering (CEBIO) in the School of Automatic and Biomedical Engineering at Universidad Tecnológica de La Habana (Cujae), the educational community proceeded to introduce the combined employment of a LMS (MOODLE), the ICT (Information and Communications Technologies) and the techniques of LBP (Learning Based in Problems) for the development of several courses of the Integrative Discipline:

Bioengineering (Table 1), which drives the investigative education of the students from their first Research Training Practice in the middle of the curricula until the obtention of the corresponding degree as result of public sustentation of a thesis (exercise of culmination of the university studies) [9].

In these courses, numerous materials were included and diverse resources were used for the development of the participants, such as: dynamic presentations, scientific articles and patents, books, professional videos, surveys, questionnaires, forums, tasks and others (Table 2), that allowed the transmission and the exchange of experiences with more flexibility: "Any Time Any Where" [10-11], obtaining the best results in the research work and in the professional formation of the students [12-13].

Table 2. Resources of MOODLE used in the investigative formation of Biomedical engineering in Cujae.

Resources	Equivalence in the classic teaching	Comments
Dynamic expositions	Present activities with oral expositions (Ex.: conferences, seminaries and others).	Used tools: Power Point and Video editor (Ex.: Camtasia Studio).
Database	Control book (assistance and evaluation).	It is used for the control of students' data and tutors (internal or external to the university).
BLOG	Present activities for the professional argument (Ex.: Seminars, Practical classes and others).	It is used by the participants for the presentation of reports in engineering format (IEEE) and dynamic expositions.
CHAT	Activities related with the explanation of doubts on imparted topics.	It permits the explanation (personalized or team) without barriers of time or place.
WIKI	Present activities for the professional argument (Ex.: Seminars, workshop and others).	It allows the development of group during the elaboration of specific topics, beginning from a text written by the professor.
Questionnaires, Surveys and Consultations	Activities of systematic evaluation (Questions, works of partial control and others).	It facilitates the control of the individual performance of the students so that the teacher can exercise a personalized attention.
Labels	Methodological orientation for the development of educational activities.	It facilitates the orientation of the activities to carry out for the students during the phases of their investigative preparation.
Tasks	Activities of partial evaluation (Ex.: Reports of research, seminars, workshops and others).	It facilitates the control of the individual performance of the students.

Source: own.

In a Learning Management System exists other more specialized resources that facilitate the learning "On line", for example: Open-meetings: resource for the development of teleconferences, virtual encounters and/or development of individual or group evaluation (Ex.: defense of research projects). This type of resources is not always available due to limitations of bandwidth, cost and security of the computer services offered by the university institutions.

2. Materials and method

The tool basic employee was MOODLE (V3.2) mounted in a server developed with a cluster of two computers with good benefits and the PROMOX system that allowed to establish weekly copy, saving all contents of MOODLE and to work with complementary different virtual services: CEBIO WEB and repository (ftp site) of thesis, digital books, patents and articles of journals and congress related with the profession, avoiding the loss of information during the development of subjects.

In the preparation of different materials the basic tools of Office (WORD, EXCEL and Power Point) and a video editor (Camtasia Studio) were used, it allowed the elaboration of dynamic expositions (multimedia) in a format for their easy reproduction in the available means of the students (Table 3), such as: portable computers or of desk (personal or prepared in the calculations centers of the department and university), Tablets and the intelligent telephones of wide use in the university population. The participants were connected from any network point with national or international access to the MOODLE platform.

Table 3. Characteristic of the student sample in the group of Biomedical Engineering.

Total	Men	%	Women	%	Comments
63	33	52.3	30	47.6	The participants belong to 4 and 5 years of Biomedical Engineering (Course 2019-2020).

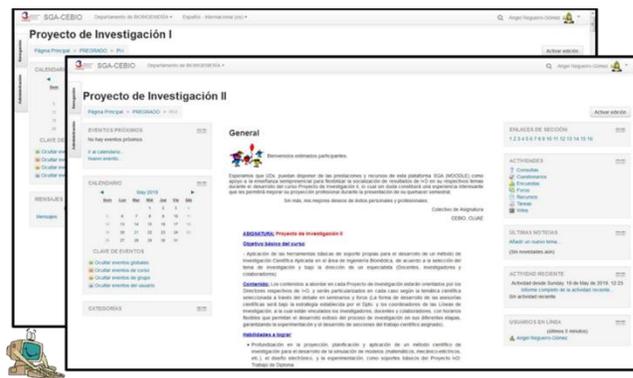
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3. Implementation, results and discussion

The figure 1 shows the presentation of different courses in LMS: MOODLE-CEBIO, where the objectives

and the content are declared; also, it shows the basic and complementary bibliography, and a group of methodological orientations for the students.

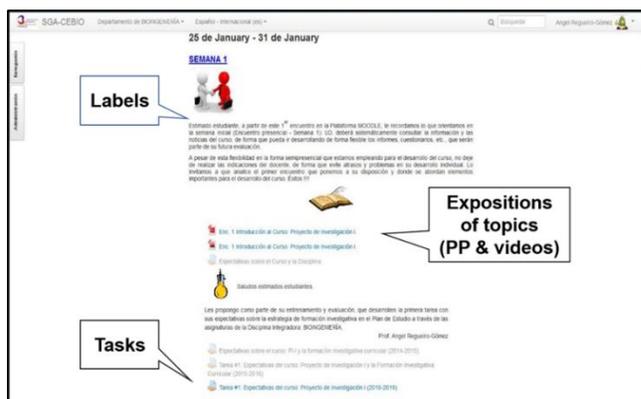
Figure 1. Windows of initial presentation of courses related with the research formation of the students in Biomedical engineering (Cujae).



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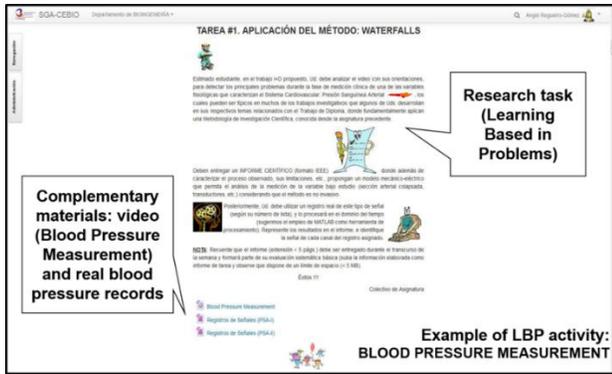
The following figures show the integrated employment of diverse resources and activities of LMS for the development of the courses, where it combine labels (Figure 2), presentations of contents in diverse formats (Power Point and videos) and research tasks (Figures 3 and 4), that increase their complexity when the learning is based on problems related with the profession. In the work is included a database (Figure 5) and another information for use of teachers and the students (Ex.: Partial reports of evaluation, announcements with the bank of scientific problems of external institutions, and others).

Figure 2. Example of resources integration for the development of the topics of the course: Research Project I in Biomedical engineering (Cujae).



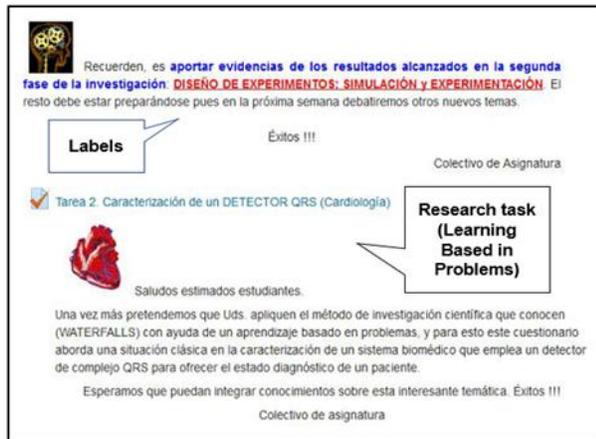
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Figure 3. Orientation of research task (Measurement of Arterial Blood Pressure) in the course: Investigation Project II (Biomedical engineering, Cujae).



Source: own.

Figure 4. Orientation of research task (Characterization of QRS Detecting) in the course: Project of Research II (Biomedical engineering, Cujae).



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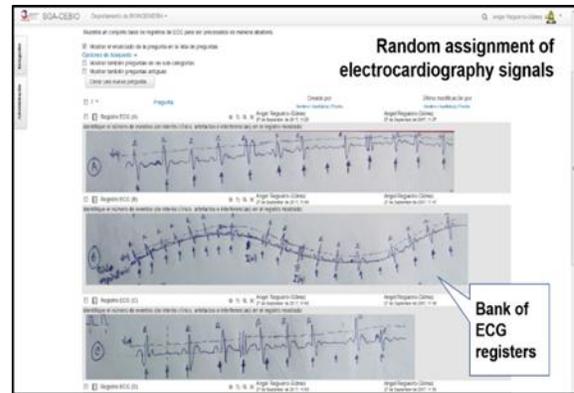


Figure 5. Employment of database for the control of the participants in the development of research topics associated to the course: Project of Research I (Cujae).



Source: own.

In the final phase of the research formation general, some topics of professional interest are proposed, such as the protection of scientific results (Ex.: patents and registrations of products) (Figure 6 Sect. Higher Left), and the development of technical records and costs of biomedical systems (Figure 6 Sect. Higher Right); besides using other resources like the socialization of previous research topics (Figure 6 Sec. Low Left) or the analysis of technical validation of biomedical technologies (Figure 6 Sec. Low. Right: topics are showed in English to reinforce the learning of that language in the biomedical program).

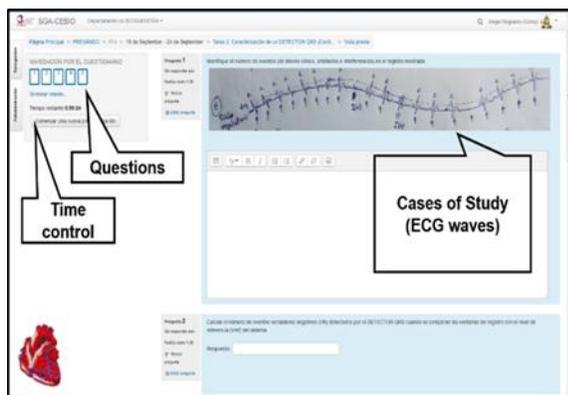


Figure 6. Examples of topics and activities developed in the courses of research formation in Biomedical engineering (Cujae).

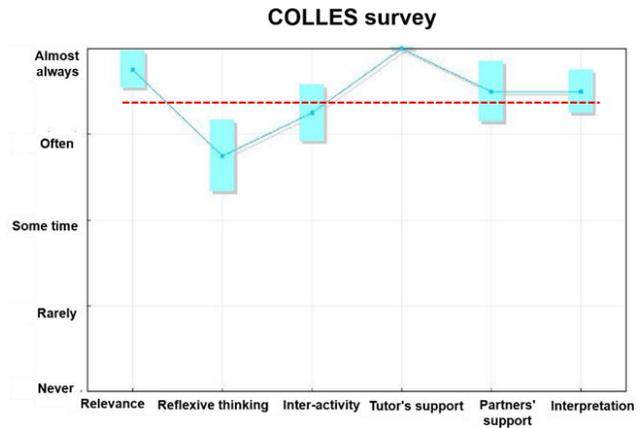
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The BLOG was the space used in the virtual teaching for the debate and socialization of advances and results achieved by the participants in their topics throughout

the courses. This space of exchange scientific-technician showed the honesty of the participants, the responsibility in the handling of scientific information, the solidarity and creativity in the development of the assigned tasks; as well as the sense toward the institution and other ethical and juridical aspects related with the activities of the course.

The figure 7 shows the approaches received in the application of a COLLES survey. This survey was used as instrument to measure the acceptance of the employment of the virtual teaching through the resources of LMS during research formation, showing very good results in the variables evaluated by the participants.

Figure 7. Results obtained of a COLLES survey applied in the LMS (MOODLE) to the participants.



Source: own.

The survey applied shows that the process of the students' reflection was the lowest indicator, due to the new form of focus of the proposed problems related with the profession. However, in general the participants showed good satisfaction (> 93 %) in the teaching shape and the general results of the courses.

4. Conclusions

The didactic strategies used for the virtual learning in the development of the research formation in the courses, with the combined employment of LMS's resources, the ICT and the techniques of Learning Based in Problems, has allowed a bigger flexibility in the educational process, with a bigger incidence personalized in the habits, abilities and methods of the participants, improving their academic and professional performance.

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