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EXPERIENCES IN THE DISTANCE

LEARNING TEACHING PROCESS IN ENGINEERING THROUGH VIRTUAL CLASSROOMS DURING THE COVID-19

EXPERIENCIAS EN EL PROCESO DE ENSEÑANZA APRENDIZAJE A DISTANCIA EN INGENIERÍAS MEDIANTE AULAS VIRTUALES DURANTE LA COVID-19

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ABSTRACT

The effects of the COVID 19 pandemic led Cuban Higher Education to take emerging measures to continue the teaching-learning process. Consequently, the undergraduate courses had to rethink the curricular designs according to the existing possibilities. The change to the distance learning modality constituted an enormous challenge for university education, with an emphasis on engineering education where students must acquire a set of skills, abilities and attitudes that allow them to fulfill their social responsibilities in the exercise of the profession. The Faculty of Electrical Engineering of the Universidad Central "Marta Abreu" de Las Villas takes on the challenge and begins to design courses on the Moodle platform and redesign the existing ones according to the new study modality, which led to the need to seek a common structure for those designs so that students would quickly become familiar with them. In this paper, the experiences in the design of virtual classrooms for engineering education are presented and the teaching results obtained by the students and their satisfaction with the contents received in two distance-taught course are discussed.

Keywords: engineering education, distance modality, interactive platforms.

RESUMEN

Los efectos de la pandemia provocada por la covid 19 llevó a la Educación Superior cubana a tomar medidas emergentes para dar continuidad al proceso de enseñanza-aprendizaje. En consecuencia, los colectivos de carreras tuvieron que replantear los diseños curriculares de acuerdo a las posibilidades existentes. El cambio a la modalidad de enseñanza a distancia constituyó un enorme reto para la formación universitaria, con énfasis en la enseñanza de las ingenierías donde los estudiantes deben adquirir un conjunto de capacidades, habilidades y actitudes que les permita cumplir con sus responsabilidades sociales en el ejercicio de la profesión. La Facultad de Ingeniería Eléctrica de la Universidad Central "Marta Abreu" de Las Villas asume el desafío y se comienzan a diseñar cursos sobre la plataforma Moodle y a rediseñar los ya existentes, acorde a la nueva modalidad de estudio, lo que propició la necesidad de buscar una estructura común para esos diseños de forma que los estudiantes se familiarizaran rápidamente con ellos. En este trabajo se presentan las experiencias en el diseño de aulas virtuales para la enseñanza de ingenierías y se discuten los resultados docentes obtenidos por los estudiantes y su satisfacción con los contenidos recibidos en dos asignaturas impartidas a distancia.

Palabras clave: enseñanza de ingeniería, modalidad a distancia, plataformas interactivas.

INTRODUCTION

The appearance of the pandemic caused by covid 19 in the world has led to the need for a radical change in teaching-learning methods and strategies in higher education centers since society, even in these circumstances, requires that continue to train professionals for the social and economic development of the country and, furthermore, are highly trained so that they can respond effectively to the dissimilar problems they must face in the exercise of their profession.

Currently, Cuban universities establish within their policies programs that refer to the integration of ICT in the activities of the institution, both for the generation of knowledge and for research and university management.

In an educational scenario from virtuality, not only should ICTs be incorporated as mediating tools in the teaching-learning process, learning should also be facilitated and equal access guaranteed to educational resources that exist in higher education institutions. (Estrada-Perea & Pinto-Blanco, 2021)

The technological availability of most students and teachers does not allow the development of synchronous distance activities, using for example videoconference platforms, so virtual classrooms become the main space to conduct student learning.

The use of virtual platforms allows distances to be shortened and favors autonomous learning,

It allows sharing learning experiences through forums and discussions, which makes it easy to get to know other people's points of view. In addition, technological tools enrich learning thanks to the comprehensiveness of the resources, making it flexible, meaningful and dynamic for the student. (Gil Vera, et al. 2019)

Consequently, to maintain communication and the work of teachers, without teaching, agreements were made at the country level to free access from the fixed platforms of ETECSA (Nauta Hogar and Wifi Zones), email, the institutional website and tele-learning platforms for undergraduate and postgraduate courses. In this way, better access for students and teachers to these resources was achieved, the main objective was to improve the content posted on the platforms. (Avello Martínez, Fernández Álvarez, & Cortés Iglesias, 2021)

On the other hand, in the administrative field, decisions were made related to the working hours of teachers and auxiliary teaching and support workers, with the application of the teleworking and distance work modality, due to its feasibility for this type of organization, with the guarantee of the assurance of essential university processes, limiting the mobility and concentration of people. (Alpízar Santana & Velázquez Zaldivar, 2021)

Derived from the policies of Higher Education in Cuba, at the Central University "Marta Abreu" of Las Villas (UCLV) the interactive platform Moodle is made available to the learning processes and the creation of virtual classrooms is oriented in all careers.

In the Faculty of Electrical Engineering (FIE) of the UCLV three majors are studied: Electrical Engineering, Automatic Engineering and Telecommunications and Electronic Engineering. In all of them there is experience in the design of virtual classrooms in the different disciplines, but as support for the modality of the Regular Daytime Course (CRD), characterized according to Horruitiner Silva (2006) "by a wide attendance and designed for students who can dedicate all their time to study." The continuity of the teaching-learning process in the midst of the existing complex epidemiological situation makes it inevitable to move to the distance education modality with some adaptations, since this modality is very flexible in its conception: for example, students can freely select the subjects that must be taken and can be examined as many times as necessary, according to the referred author, which is not exactly what will characterize the process that must be developed. Now it is intended to continue the CRD without the presence of teachers, from virtuality. Rather, according to Almaguer López, O., and L. (2022), they are remote delivery schemes that allow regular programs to be carried out in a similar way to the practices that have been designed for classroom instruction. of an educational institution.

The teaching of engineering must also respond to the active role that the engineer is required to have due to the complexity, abundance and constant change of technology, the impact of automation and information technology and the new forms of management organization that It forces them to anticipate changes and market needs, creating solutions for requirements that have not yet appeared. According to Rodríguez Serrano, Maya Restrepo, and Jaén Posada (2012) "A good education in engineering is perhaps one of the most strategic needs for the development of a society, and the way in which students acquire and apply this education will be what will determine if higher education is a true factor of transformation".

In the disciplines of engineering careers, you not only learn how things are (declarative knowledge), but also how they are done (procedural knowledge), which is why teaching activities such as laboratories and practical classes have a high presence in their programs. . To carry out

these classes, teachers use active teaching methods and are assisted by technologies applied to education.

This situation determines the need to conceive the teaching-learning process in a completely remote scenario, which implies adapting the contents and the way of imparting them to these conditions.

Teaching in engineering careers under these conditions is unprecedented in the recent history of Cuban higher education. In this paper, experiences in the use of virtual classrooms for the teaching-learning process in the distance modality are shared, a virtual classroom structure for these environments is defined, and the results obtained from the application of the proposed structure are evaluated. in two of the subjects taught at the FIE.

Design of the general structure of the course in Moodle for engineering careers

According to Juca Maldonado (2016), the integration of the fields of computing, audiovisual media and telecommunications has caused an impact on distance education in the context of globalization, so the description, speculation and reflection on the innovative phenomenon They are sources to systematize how to do technology in distance education and what to do, in order to re-elaborate the principles, laws and norms that make possible a non-contact form of teaching with positive effects.

In del Prado (2021) several expressions on distance education are exposed, motivated by an opinion article published on virtual teaching, such as: "distance learning is here to stay or rather to develop", "teach for approve or teach to learn?", "mechanically transferring the pedagogical methods of face-to-face teaching to the distance modality, is a serious mistake", "the teacher incapable of motivating his students will not be a good teacher", "the student who, hidden in cyberspace, copies and pastes, copies from another without being able to prove that he has learned, does not deceive his teachers, deceives himself", "the continuous formation of ethical and moral values are an essential part of education at a distance", "the evaluation of knowledge in distance learning calls for organizational, process and product innovation".

Next, he proposes some key vectors of the addressed subsystem, which must be analysed. Among them are:

- Pedagogical design of distance teaching.
- Basic components of effective distance teaching.
- Organizational and material conditions for teachers and students.
- The teachers with the most accumulated experience, their tele computer empowerment.
- The correspondence between the contents and their distance learning.
- Good practices in distance teaching

Consequently, it is appropriate to rethink the teaching-learning processes both methodologically and structurally in order to achieve the comprehensive training of students even without the presence of teachers. Hence the relevance of this work.

The FIE courses hosted on the Moodle platform have different structures, some of them have become information repositories, others respond to particular interests in a subject or the creativity of the teacher and, in general, the resources provided by the platform are wasted. . Therefore, a structure is needed that in a general way "resembles" the teaching-learning processes that are normally carried out in person, with the support of the teachers in charge of directing them and who use the resources available in an efficient way. the platform. On the other hand, without being inflexible, it is beneficial that most of the courses are similar in terms of form, to facilitate the student's familiarization with the platform, logically considering the characteristics of the subjects.

Horruitiner Silva (2006) defines the different aspects that must be located and updated on a certain platform when subjects are created on the university's INTRANET.

On the other hand, in López Fernández (2010) the components for the didactic structure of a Distance Education course were identified using the management platforms as a tool, which were grouped depending on the similarities of their functions. The forms in which the components are manifested were called elements, and the grouping, according to the similarity of functions, was designated as design. Due to the above, the didactic structure of the course was made up of: Formative Design, Technological Design and Teacher Design, and the elements of each of these designs are formalized.

Taking both sources as a reference, the structure of the courses on the Moodle interactive platform is determined in the context of the FIE, considering the particularities of the subjects.

As a result, it is established that the components of the course should be those listed below:

1. Presentation of the subject: Explains what the subject is about briefly. It must contain the following elements:

a) Welcome: It must be written courteously and respectfully, indicate the usefulness of the course in the

professional's training, transmit confidence in success, explain the help that the faculty is willing to offer them. A brief explanation of the theory that they will receive is offered, how the discipline is organized, the year in which it is taught, the structure of the course in general and the professors who will participate.

b) Analytical program: The foundation of the discipline, the general instructional and educational objectives, the methodological and organizational indications of the subject, the subjects of the subject with their system of knowledge and skills, the evaluation system, the tasks they complete are exposed. curricular strategies and bibliography.

c) Organization of the subject in the period according to the scheduled time.

d) General Bibliography: The basic and complementary texts of the subject are presented.

e) Didactic materials: Repository of information to deepen the contents of the subject and enable a closer approach to it, such as the materials prepared by the teachers.

f) Simulation programs: The installation of the program that will be used for the simulation and a tutorial for its management are provided.

g) Control record and evaluations: Useful for students to know their evaluation status and that of their classmates, helping them to compare their performance with the rest of their classmates. It is recommended to use an Excel document.

h) Notice forum: For interaction between teachers and students.

2. Didactic guide: It is the instrument to guide and facilitate learning, help to understand and apply the different knowledge, as well as to integrate all the means and resources that are presented to the student as support for their learning. To do this, you must take into account:

a) Learning strategy: it is necessary to implement didactic strategies, with a practical approach that reflects a set of procedures aimed at facilitating the evolution of thinking in students (Roque Herrera, Valdivia Moral, Alonso García, & Zagalaz Sánchez, 2018). It refers to the procedures or skills that each student must develop to learn. Its functionality, from the didactic point of view, is to provide the student, through an interactive process, with the tools that help them appropriate the knowledge that they want to transmit in the teaching-learning process. The strategies must be integrated with digital technologies to strengthen the teaching-learning process of teachers and students. (Vargas-Murillo, 2020)

b) Method: It is the way of developing the process, it is the structure of the process, both of the activities to be carried out by the students and the teacher, as well as of the different types of communications that are developed in it.

c) Teaching task: It is the set of orientations and actions (problems, exercises, situations) that respond to the demands of each one of the moments of the cognitive cycle, or of the stages of the assimilation process, in correspondence with the objectives and contents.

d) Didactic materials: The teaching material or medium is the one that links and keeps alive the interactivity that is wanted in this educational modality. The teacher uses a series of aids that facilitate his task of cultural mediation: these aids are the didactic material, which is any artificial or natural object that produces significant learning in the student. (Morales Munoz, 2019)

3. Content: It is the selection of the elements of the subject and its structure that the student must appropriate in order to operate with knowledge in professional know-how.

4. Practice: It corresponds to the exercises that are done in each topic based on the achievement of the skills that must be taken into account for the success of the contents that are proposed based on the objectives set. Includes mock labs. It is essential to recognize the importance of laboratory practices in engineering programs, since in these spaces the student can test the concepts, laws, knowledge and ideas that arise from reading theory, explanations from teachers, thematic concerns and ideas. (Camelo-Quintero, 2019)

5. Self-assessment: Allows the student to judge, for himself, about his own learning, detecting progress and difficulties and taking actions to correct them. It also provides feedback to the teacher on student achievement.

6. Interaction spaces to clarify doubts: They constitute the physical place where those involved in the teaching-learning process meet to exchange ideas and points of view in relation to an object of study. The interaction can occur between individuals (teacher-student or student-students) or through teaching materials (student-contents). There are two communication tools on the platform (forums and internal messaging). They can be performed both synchronously and asynchronously.

7. Partial evaluations: Composed of a set of evaluations that students must carry out to verify the knowledge they have been acquiring in each one of the subjects, such as extraclass tasks and reports from the simulation laboratories.

8. Conclusions of the course: It is important to know the evaluation of the students about the different aspects of the course through a satisfaction survey or similar instrument.

It is recommended to take into account the following aspects:

• Organize the activities by week to balance the contents, making the resources available at the beginning of each topic and leaving them open throughout the course so that students who fall behind can go as fast as possible. This dosage will allow students to overcome short-term goals and objectives, preventing them from becoming saturated with the content they must overcome.

• Include simulated practices that replace the real ones regarding the interpretation of the results obtained, using simple free simulation programs available on the Internet.

• In the didactic guides, the entire procedure to be followed by the students must be oriented so that they resemble the organization of the classes in the CRDs. It is important to take into account that students are not familiar with distance education, so special attention must be paid to the guidance offered to them.

• Prepare videos by the teacher that facilitate, through the explanation of exercises, the understanding of the theoretical contents.

• Within the didactic materials, different videos must be made available to the students to help them understand the application of the theory in practical exercises, which increase in complexity. These videos can be made by the teacher or downloaded from the internet where there are a large number of them, although they must be reviewed to verify if they meet the requirements of the subject.

• The teacher must accompany students at all times and encourage them in the face of difficulties that appear.

• In each topic of the subject, a forum must be enabled to clarify doubts, both synchronously and asynchronously, according to the connection possibilities of professors and students.

With all these elements, teachers were oriented to prepare virtual classrooms, always adapting them to the singularities of each subject, for all UCLV FIE careers, both for CRD and CPE students.

Evaluation of the results achieved using the proposed structure

Based on the proposed structure, the following subjects were assembled on the Moodle platform:

• Fundamentals of Communications III that is taught in the Telecommunications and Electronics Engineering career in the 4th year located at: Faculty of Electrical Engineering/Undergraduate/Regular Daytime Course/ Telecommunications Engineering/IV Year/I Period/FC3 /

• Electrical Circuits I that is taught in the Automatic Engineering career in the 2nd year located at: Faculty of Electrical Engineering/Undergraduate/Regular Daytime Course/Automatic Engineering/II Year/I Period/CE-1A/

In both subjects, in addition to the contents to be studied and exercises to be solved, teaching materials created by the teachers or taken from the Internet were made available to the students to facilitate the study of the contents in each subject, as well as self-assessments to check the level of content assimilation. Table 1 shows the distribution of topics for both courses, as well as the distribution of available teaching materials and self-assessments in each topic.

Table 1: Didactic materials distribution by topic

Curse: Electrical Circuits I		
Topic	**Didactic Materials**	
	Videos	**Study guide**
I. Analysis of simple lineal resistive networks	13	1
II. General solution methods and theorems	8	1
III. Analysis of dynamic networks in time domain	4	1
Totals	25	3
Curse: Fundamentals of Comunication III		
I. Digital modulations	6	1
II. Spectrally efficient modulation	3	1
III. Synchronism	4	1
IV. Multiplexing and multiple access	9	1
V. Application of spread spectrum technique	4	1
Totals	**26**	**5**

The impact of the use of the proposed structure for the courses in Moodle was evaluated through a questionnaire designed ad-hoc and applied to the students of the courses in question, for which their voluntary participation was requested.

The questionnaire was completed by 67.5% (27 of 40) of the students enrolled in the subject Fundamentals of Communications III and 80% (20 of 25) of the students participating in the subject Electrical Circuits I. The students had to evaluate eight items using a scale from 1 to

5 (where 1 is totally disagree, 2 disagree, 3 neither agree nor disagree, 4 partially agree and 5 is totally agree) and in a last item give a rating to the course using the same scale (1-possible, 5 excellent).

The results of the survey in each of the courses are shown in Table 2, the percentage of satisfied and dissatisfied students corresponds to scores of 5 and 4 for satisfied and 2 and 1 for dissatisfied. Neutral results (rating of 3) are not shown in the table, but can be inferred from the results shown.

Table 2: Students satisfation survey

Preguntas	Electrical Circuits I		Fundamentals of communications III	
	% Pleased stud.	% Unpleased stud.	% Pleased stud.	% Unpleased stud.
The course program is accessible.	95.00	0.00	100.00	0.00
The objectives are correctly marked and precise.	100.00	0.00	100.00	0.00
The presentation of the contents is sequenced in a coherent and adequate way.	90.00	5.00	100.00	0.00
The contents and resources are developed in different formats and are easily accessible.	90.00	5.00	96.30	0.00
The sequence of the topics covered favors self-knowledge and the search for information by the student.	90.00	10.00	88.89	0.00
The activities contained in the course allow communication and interaction between students and teacher.	95.00	5.00	92.59	3.70
The resources and means used, as well as the structure of the course and the activities, are motivating and stimulate learning.	80.00	10.00	88.89	3.70
The results of my evaluation are fair and correspond to my performance.	95.00	0.00	92.59	0.00
Following a scale of 1-5 (1 lousy, 5 excellent), how would you rate the course, based on your experiences as a student.	90.00	0.00	88.89	3.70

As part of the applied survey, students were also asked to indicate favorable and unfavorable aspects of the subject received, which are summarized as:

Favourable

• The facilitation of the content and availability of the professor in the clarification of doubts.

• For me the course has been the most structured and organized of all and I consider that there has been a good interaction between students and teachers, although never the same as if it were face-to-face, in terms of knowledge I can say that I have learned more than I expected, but not everything that I would like, however, I hope to be able to better understand in September the things that I may not have understood now and raise doubts that arise along the way.

• Flexible time regarding the delivery of tasks.

• Great attention, concern, availability of the teacher in the face of doubts and suggestions from us students.

• In one way or another I think that I not only learned to study more, to not depend so much on the teacher, I think that we increase our capacity by studying in this way.

• Very good preparation of the course by the teachers, at all times they have supported us, they have always been available to clarify doubts, it has been a course in which new knowledge has been acquired.

• We are studying perhaps more than with face-to-face classes.

• The truth is that during the course I felt very comfortable, I certainly exceeded my expectations, thank the teachers for the great work they have done.

• Despite being strong, the contents were broken down in an accessible way.

• The self-assessment method is quite practical when evaluating yourself.

Unfavourable

• There may have been negative things, but in my opinion, I saw everything very well, the teachers answered our questions, all the content you needed was there.

• Lack of more tutorial videos.

• In the study guides put more explained exercises.

• Seeing only the lecture and studying through the book does not provide the same motivation for the subject as a teacher would do in front of it, explaining her way of seeing it and explaining practical examples.

• Although the effort has been great on the part of the teachers and the students, I feel that we have gone through the subject only as one more goal to graduate, I believe that from a distance the contents can be overcome, but only that, go through the subject as one more without taking the love and teaching that an automatic engineer could feel for this

• It will always be negative to lack face-to-face classes, but given the situation it was necessary.

• Impossibility of studying together with the other students.

• Little time to develop so it can generate accumulation of content.

The results achieved in the evaluation by the students show high levels of satisfaction in all the evaluated aspects and the students recognize that the structure and dosage of the course contents facilitated the assimilation of the contents. However, some limitations in student learning are also identified. A group of these limitations can be faced from the generation of appropriate content and adjusted to the needs of each subject, this being one of the most important challenges to face in this type of teaching.

Students recognize some of the advantages of using distance learning methods, but there are limitations in the use of these methods for the development of practical skills to solve problems inherent to the profession. Developing methods that combine self-management of knowledge with practical face-to-face activities can be a successful solution that will contribute to increasing student preparation and satisfaction.

The evaluation of the results was not only limited to the satisfaction of the students with the courses received but also to the results achieved in the evaluations carried out. Table 3 shows the distribution of evaluations by topic and the average grades in each of them.

Table 3: Distribution of evaluations by topic and point average

Subject: Electrical Circuits I				
Topic	**Self-assessments**	**Laboratories**	**Homework Extracurricular**	**Point Average**
I	1	2	1	4,08
II	2	1	1	4,41
III/	2	1	1	4,23
Totals	5	4	3	4,24
Subject: Fundamentals of the Communications III				
I	1			4,45
II	1		1	4,75
III	1			4,16
IV	1		1	4,66

V	2		2	4,71
Totals	7		4	4,54

Table 4 shows the teaching results of the last three courses to compare the pass rates without taking special exams, the total pass rates, and the quality of the grades. It is necessary to clarify that in the case of the CE I subject, the final exam was carried out in person when the blended classes were authorized to begin in November 2021, which was prepared with the same characteristics as those applied in previous courses.

Tabla 4: Results of the last three curses

Indicador	Electrical Circuits I			Fundamentals of the Communications III		
	Curso			Curso		
	18-19	19-20	21	18-19	19-20	21
Initial registration	38	43	24	54	55	42
Approved without extraordinary	22 (57%)	11 (25,6%)	15 (62,5%)	44 (81,48%)	49 (89,09%)	42 (100%)
Total passes	33 (86%)	33 (76,7%)	18 (75 %)	54 (100%)	55 (100%)	42 (100%)
With final grades of 4 and 5	10 (26.3%)	19 (41.86%)	10 (45,83%)	36 (66.6%)	31 (56,36%)	38 (90,5%)
Deprecated	5 (13,15%)	10 (23.25%)	6 (25%)	0	0	0

It can be observed that, in comparison with the previous courses, in the subject CE I the highest percentage of students who received the distance course passed without having to carry out the calls for extraordinary exams, likewise the quality of the qualifications behaved. The total passes had a behavior similar to previous years, although lower than that obtained in the 18-19 academic year. In the case of the subject Fundamentals of Communications III, the percentage of passes without extraordinary was higher than that of the two previous courses. The same behavior showed the percentage of students with grades of 4 and 5.

CONCLUSIONS

Due to the characteristics of engineering profile careers, where the student must be an active subject, in the distance modality it is essential to establish the structure that a course must have on the Moodle platform, so that the student can become familiar with the less time possible with the way of presenting the activities.

The structure must have an organization that corresponds to the classification of teaching that is handled in the CRD so that the change of modality does not burden students unnecessarily.

The accompaniment of the professors who work in the subjects must be constant and must be attentive to the difficulties that the students are confronting during the development of the course.

The laboratories with simulation programs must be present in the subjects that require it and even in the distance modality it is possible to provide the students with the tools and guides for their realization.

The applied survey shows a high degree of satisfaction on the part of the students and they recognize that the structure and dosage of the course contents facilitated their assimilation.

The teaching results show that it is possible to develop courses in the distance modality with a similar quality to those taught in the face-to-face modality in engineering careers.

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