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Virtual communications laboratory as a tool for the subject of selected telecommunications topics

Laboratorio virtual de comunicaciones como herramienta para la asignatura de temas seleccionados de telecomunicaciones

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Abstract

The pandemic has forced to abandon classrooms, replacing them with virtual learning spaces, generating various problems due to not being able to interact physically. These problems increase even more in subjects with laboratory hours. This article addresses the proposal to create a virtual laboratory for subjects related to the telecommunications area, particularly those that include the topic of microwave network links. Radio Mobile software was used for the creation of the laboratory, which is freely accessible. The objective of this research is to obtain information that allows visualizing if the use of this web tool contributes to the learningof the students, allowing to simulate the main practices that can be carried out in a laboratory or in physical form. The software was used during the teaching of a course in the subject Selected Topics in Telecommunications, through the action-research method, obtaining favorable results, achieving a better academic performance in the matter.

Educational software, Virtual lab, Telecommunications

Resumen

La actual pandemia ha obligado al abandono de las aulas, sustituyéndolas por espacios virtuales de aprendizaje, generando diversas problemáticas al no poder tener interacción de manera física. Estas problemáticas se acrecientan aún más en asignaturas con horas de laboratorio. En el presente artículo se aborda la propuesta de creación de un laboratorio virtual para asignaturas relacionadas con el área de telecomunicaciones, particularmente, con aquellas que incluyen el tema de enlaces de redes de microondas. Para la creación del laboratorio se utilizó el software Radio Mobile, el cual es de acceso libre. El objetivo de la investigación es obtener información que permita visualizar si el empleo de esta herramienta web contribuye al aprendizaje de los alumnos, permitiendo simular las principales prácticas que comúnmente se realizan en el laboratorio o en forma física. El software se utilizó durante la impartición de un curso de la asignatura Tópicos Selectos de Telecomunicaciones, a través del método investigación-acción, obteniendo resultados favorables, logrando observar un mejor rendimiento académico en la materia.

Software educativo, Laboratorio virtual, Telecomunicaciones

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Introduction

Faced with the pandemic, there has been a change in the way of teaching-learning, from one day to the next; classrooms had to be abandoned, changing them for virtual classrooms, which brought with it several problems.

For example, (Rincón, 2008) mentions that the incorporation of Virtual Learning Environments (EVA) implies reversing the process of acquisition and transformation of knowledge; therefore, educational relevance, quality, and usefulness consists in knowing how to integrate meaningful learning activities and take advantage of the tools offered by these virtual environments. Therefore, it is relevant to redesign, adapt didactic planning to technological changes, through the construction of a pedagogical and methodological structure, which must be based on content, evaluation, and experiences.

On the other side, (Sánchez, 2003) mentions that Information and Communication Technologies (TIC), depending on their use, can be a source of innovation for teaching, contributing to the learning process, offering methodologies and resources for the 21st-century student.

In (Chaupart, 2002) is stated that "what is sought is not to create a technological dependence, since ICTs are a means to apply the new, more effective pedagogies for the student". Both the teacher and the student must incorporate the use of ICT as a didactic resource in the teaching-learning process, specifically in online classes.

Derived from the above, the need arises to pay special attention to those subjects related to laboratory work, since students do not have access to the facilities, equipment, and instruments that are essential tools for the correct development of skills and abilities. And it is here where TIC can be a solution for the creation of virtual laboratories that allow students to experiment, to build their learning. All of the above is not strange to one of the subjects of the Educational Program of Engineering in Electronics and Telecommunications: Selected Topics of Telecommunications, where one of the thematic units addresses the topic of link calculations in microwave networks.

The objective of this research is to obtain information that allows visualizing if the use of a web tool (online program) helps to generate learning when link calculations of microwave networks are carried out.

Based on the objective, the following research questions were proposed:

- What elements should be integrated into the planning of virtual laboratory activities for student learning?

- Will the use of the proposed virtual laboratory, through the use of the Radio Mobile tool, increase student motivation?

- What action process should be used to successfully include the use of a virtual Telecommunications laboratory in the teaching of content in the Communications area?

This work is pertinent given that the use of technology seeks to improve the performance of students when carrying out work inherent to the career they are studying and relying on their learning, having as a result that their learning has a better understanding of the topics reviewed in the courses they take and, consequently, an improvement in the knowledge and skills acquired during the subjects taken. This technology is also expected to improve the organization of tasks to be carried out during the development of a solution in the field of telecommunications.

This project was developed at the Universidad Politécnica del Estado de Morelos (UPEMOR), with a group of the ninth semester of Electronics and Telecommunications Engineering. The main contribution of this study is to providea strategy that allows seeing improvements in the teaching-learning process.

This research work contains a methodology, where the selection of the tool is explained, the description of the construction of the process to validate the online software as an option to generate learning, as well as the process of execution, of the instrument to evaluate through a survey and finally present the analysis carried out, as well as the results and conclusions.

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Before developing the methodology, it is briefly explained what needs to be done to carry out a link calculation in microwave networks:

a) Location of the site (latitude and longitude) and altitude of the sites.

b) Investigation of the type of soil.

c) Verify availability of power, according to the standards of the ITU (International Telecommunications Union), for transmission in the areas to be linked.

d) Investigate propagation conditions.

- Line of sight: Refers to an unobstructed path between the transmitting and receiving antennas. So that there is the best propagation of Radio Frequency signals.

- Feasibility of a link: Refers to the line of sight calculation whose probability of linking two sites is 99.65% (ITU Standards).

Methodology

According to (Álvarez & Álvarez, 2014) the action research method begins with a collective or group idea that some type of improvement or change in the process that is being participated is desirable, such is the case of the process of teaching-learning. According to (Pérez, 1989), action research requires the participation of groups, integrating both participants and observers in the process of inquiry and dialogue. Consisting of the following steps:

1. Delimitation of the problem to be investigated in action.

2. Planning the action process.

3. Execution of the action.

4. Evaluation of what is generated in the action.

This set of four steps can be repeated in successive spirals. It is this research method that is taken as a basis, to propose the project work methodology, which is shown in Figure 1.

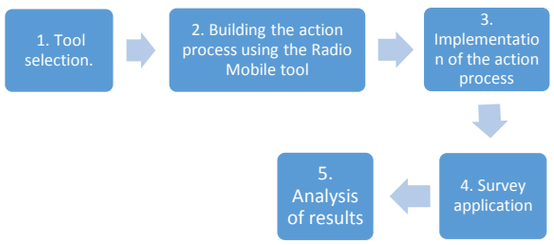

Figure 1 Work methodology
Source: Own elaboration

The methodology is made up of five stages:

1. *Selection of the tool*. In this stage, the problem to be investigated is delimited, in our particular case: deciding which platform could be the one that would promote greater learning in the student.

From information from previous courses, in which the cartography provided by INEGI was used, the students had to enter the position data and investigate the propagation conditions, indicating this in the cartography (see Figure 2). What involved doingpartial-time work, because of the lack of information for the link calculation process. To find out more in detail, they must go to the place where the microwave base is placed, something thatis not desirable in this pandemic.

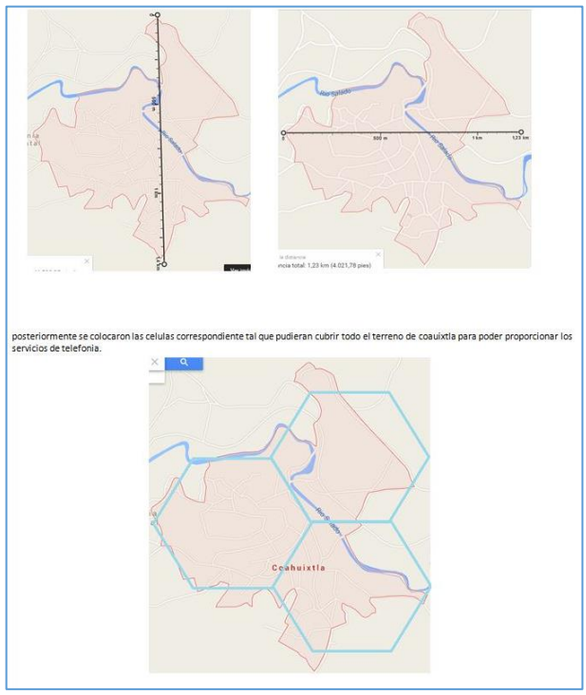

Figure 2 INEGI work on cartography
Source: Own elaboration

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Facing this situation, it was decided to look for an online program, preferably free, that had greater versatility displaying the maps and being able to put the elements for the calculation of the link. Finding Air Link software online, Figure 3.

The use of this software implied that the students did not have to travel to the site and spent less time as they no longer had to insert icons or images, but some problems were detected, the first of which is that it only uses the equipment of whom made the website, preventing the placement of other brands or models, the second problem is that it performed the calculation without the student interacting with the values to be considered and this generates a bias in learning. One last problem is that the values indicated by the ITU standards could not be counted on, since it does not consider the type of area (desert, forest, etc.), power level restrictions, etc. (Standards P.525, P.527, K.69, among others).

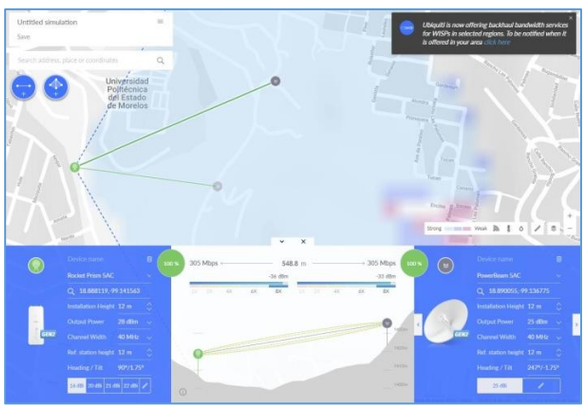

Figure 3 Software AirLink
Source: Own elaboration.

We continued looking for another alternative technological tool, finding the Radio Mobile software (also free), which would allow placing the maps and locations, to form the microwave networks (Figure 4), to generate the sites individually and based on values that the student had to calculate, link them and finally create the network that can contain up to 150 sites.

Figure 4 Menu to generate specifications of microwave sites
Source: *Own elaboration*

When creating the sites, the students are based on preliminary calculations of the selected link (Figure 5), so they must know the characteristics of the transmitter, the receiver, the ITU standards, etc. In other words, the student must know the behavior of the network that he is implementing, which leads him to achieve his learning, unlike support software.

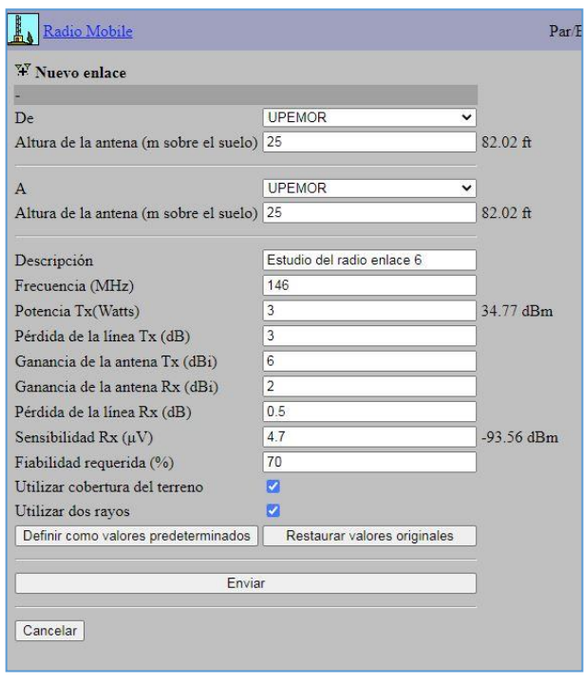

Figure 5 Data that must be entered after calculation by the student
Source: Own elaboration

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2. *Construction of the action process of the Radio Mobile software*. We proceeded to propose a methodology to be followed to make much more efficient the use of the software and that would imply a prior research process. This led to propose the construction of the process as a case study, which when requesting to generate a network of services of microwaves, leads the students to show a competence, from an integrative approach, that represents a dynamic combination of attributes that according to Heywood (1993), cited by Villa and Villa (2007), provides: a description of the action to the extent that the person seeks to perform it as a particular type of solution; performance in specific situations, incorporating the idea of judgment, to provide a service, for example, connectivity; interpretive capacity and consequent decision-making; integration and relationship in specific contexts and fundamental tasks that, as "intentional actions", are a central part of professional practice. Determine that the link is completed based on the calculations made and is operational in situations, such as adverse weather conditions. As well as any other type of disturbance when transmitting the signal.

Table 1 describes the steps of the action process used.

In Figure 6, the result that is obtained is observed, when carrying out the work as a development of the work environment to provide a solution, for example: to a connectivity problem between various points and that the very process of framing the idea of a case study, make it feasible.

#	Activity	Supervision	Duration
1	In a virtual environment, the learner was introduced to online educational software, explaining its function and main components. Demonstrative examples are shown in order to understand its use and scope.	The student is allowed to interact with the application freely, without proposing any exercises, with the aim of familiarising him/her, experimenting and asking questions to resolve doubts about the functions of the online programme. Information is collected through observation: student behaviour, interest in the software, questions and doubts raised.	1 hour
2	A series of sessions is scheduled where the learner is asked to solve a set (previously prepared) of exercises using the online software. Students are allowed to interact with each other and can work in teams if they wish.	Information is collected through observation: behaviour, interest, doubts. The exercises solved by the students are collected.	Several sessions of 3 hours each
3	An evaluation session is scheduled. Evidence of knowledge is designed, where the learner must use the tool to solve a series of exercises. The student is asked to work individually.	The results of the knowledge evidence are collected.	2 hours
4	A survey is applied to the students, using an ad hoc questionnaire. This was done in order to gather the students' impressions after participating in the experience.	The results of the survey are collected.	30 minutes

Table 1 Action process
Source: Own elaboration

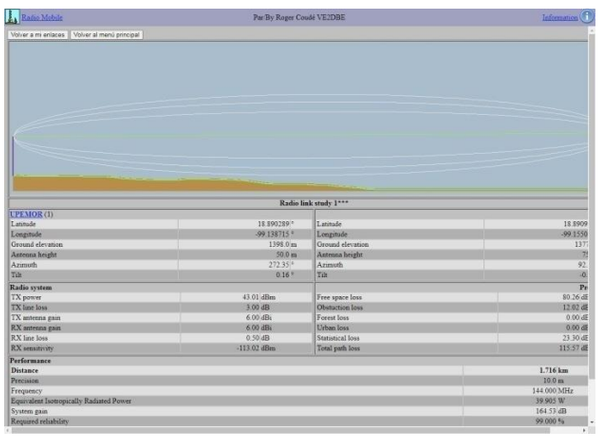

Figure 6 Line of sight and link feasibility calculations
Source: Own elaboration

3. *Execution of the action process.* At this stage of the research, the study group was defined, determining that the experimentation would be carried out with the group of the ninth semester of the Engineering in Electronics and Telecommunications career of the UPEMOR. The study group has the following characteristics:

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Success in completing university studies in the area of electronics and telecommunications engineering depends a lot on personality characteristics, study habits, development of learning skills, and time management to fulfill the tasks assigned in each one of the subjects studied during a semester, semester, or school year. In this sense, the group of students from the third cycle of training of the electronics and telecommunications engineering study program (2018-2021 generation) will reach this point in the study plan.

Considering their performance in various subjects taught during different semesters of the study program, personality characteristics such as academic procrastination have been identified, which is a common problem in high school and upper secondary students (Barraza-Macías & Barraza-Navarez, 2019). This group of students has this personality trait, which leads them to undergo high levels of stress and on several occasions, they have generated inadequate results in the delivery of requested tasks and/or projects. There are multiple causes of procrastination, with the amount of work and proper management of your time being its main factors.

Likewise, these students base their learning on the use of computer information technologies (tutorials, web pages, learning forums, etc.), which today has become the most common way of the learning process (Martinez, Esmeralda, Cantu, & Patricia, 2018). However, the use of this type of learning strategies has generated that their performance is subject to the presence of a tutorial to develop the activities requested in the different subjects. This has led to their analysis capacity not being adequately developed, and they only develop the ability to reproduce what is described in tutorials.
Finally, even with inappropriate personality traits, it is noted that the group of the third cycle of electronics and telecommunications training has managed to be at this stage of their training due to their sense of responsibility, dedication, and perseverance, which are key elements for successful completion of the curriculum.

4. *Survey application*. Once the students' experience with the online software had concluded, a survey was applied, for which an ad hoc questionnaire was designed.

5. *Analysis of results*. In the last stage, a detailed analysis of the results obtained during this research process was carried out.

Results

As part of the analysis of results, a survey was applied to the students that consisted of five questions, of which three focused on the use of the tool and two on interactivity with the teacher. In Table 2, the statistics generated from the application of the instrument are presented.

From the questions asked, it is observed as a result: that the support of software has facilitated the students' learning and that it was easy and simple for them to use. The question asked about the interaction with the teacher gives an unexpected result, since they show little interaction between students and teacher.

In addition to the instrument, data was collected throughout the action process, through direct observation, highlighting the following:

1. The attitude of the group changed when Introducing the use of software in the dynamics of the class. The students showed greater participation with respect to the first sessions.

2. The use of the tool allowed to foster teamwork, interactions between group members could be observed to explain the sites that they had to link to.

3. The general average obtained in the evaluation of the first partial of the subject, improved with respect to groups that took the same subject in previous years.

4. In general, the students' comments have been very positive regarding the technique and tools used by the teacher.

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Question	N	Mean	Standard deviation	Standard error of the mean
Do you feel that the Radio Mobile programme provides the right elements for learning?	12	10	0	0
Does the interface of the Radio Mobile programme allow quick access to insert information and perform calculations?	12	8.75	2.26	0.65
Does the Radio Mobile software allow interaction with the teacher?	12	7.58	3.18	0.92
Does the Radio Mobile programme allow easy and simple access to the generated map and base station information, as well as to the line of sight?	12	8.75	2.26	0.65
Does using an online programme allow you to know and measure your progress in a course?	12	8.75	2.26	0.65

Table 2 Descriptive statistics
Source: Own elaboration

Conclusions

Motivation is a very important element in any work methodology and the educational field is no exception (Peinado & Navarro, 2014). Motivation turns out to be a condition that guarantees both effectiveness and efficiency in the use of technology in the teaching-learning process.

The use of technological tools as teaching tools has always been widely recommended, especially for digital natives, such as the case of our students today.

The improvement in the grades that are observed, taking into account the history of the first partial, of previous courses, indicate that the software tool used improved the performance and the interest of the student, since it allows them to observe the fieldwork environment, without having the problems of transfer to the different points to be linked in a real network, allowing better learning. As future work, it is necessary to implement other stages within the same subject to give training in other thematic units, since the results and comparisons only correspond to a first partial among the courses with which it has been evaluated.

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