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Original article

Impact of web tools on the motivation of students in Introduction to Telecommunications

Impacto de las herramientas web en la motivación de los estudiantes de Introducción a las Telecomunicaciones

Impacto das ferramentas web na motivação dos estudantes de Introdução às Telecomunicações

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ABSTRACT

The article presents a research on the design of web tools with the objective of presenting its design for the teaching-learning process in the Telecommunications and Electronics Engineering career, specifically in the Electronics and Radiocommunications Systems discipline, in order to improve the quality of training through the implementation of innovative educational resources. It was carried out at the University of Pinar del Río "Hermanos Saíz Montes de Oca", and the universe was constituted by students and professors of the Telecommunications and Electronics Engineering career. Several methods were used: analysis-synthesis, to identify trends in the use of technological tools in learning; hypothetical-deductive, to guide the research; and historical-logical, to

contextualize the development and evolution of these tools in the educational field. During the diagnostic process, surveys were applied to teachers and students to specify the contents to be included. Using descriptive statistical methods, such as frequencies and percentages, the information was summarized. Two web tools were designed and implemented with Xara Web Designer and WordPress, serving as guides for students and familiarizing them with essential concepts. The acceptance of these tools underscores the importance of including innovative educational resources in the training of graduates in Telecommunications and Electronic Engineering. The acceptance of these tools highlights the importance of including innovative educational resources in the training of graduates in Telecommunications and Electronics Engineering. The web tools improved the motivation and learning of the students, boosting their academic and professional development.

Keywords: telecommunications; teaching-learning process; tools.

RESUMEN

El artículo presenta una investigación sobre el diseño de herramientas web con el objetivo de presentar su diseño para el proceso de enseñanza-aprendizaje en la carrera de Ingeniería en Telecomunicaciones y Electrónica, específicamente en la disciplina Electrónica y Sistemas de Radiocomunicaciones, con el fin de mejorar la calidad en la formación mediante la implementación de recursos educativos innovadores. Se llevó a cabo en la Universidad de Pinar del Río "Hermanos Saíz Montes de Oca", y el universo estuvo constituido por estudiantes y profesores de la carrera de Ingeniería en Telecomunicaciones y Electrónica. Se emplearon varios métodos: el análisis-síntesis, para identificar tendencias en el uso de herramientas tecnológicas en el aprendizaje; el hipotético-deductivo, para orientar la investigación; y el histórico-lógico, para contextualizar el desarrollo y evolución de estas herramientas en el ámbito educativo. Durante el proceso de diagnóstico, se aplicaron encuestas a profesores y estudiantes, para precisar los contenidos a incluir. Usando métodos estadísticos descriptivos, como frecuencias y porcentajes, se resumió la información. Con Xara Web Designer y WordPress se diseñaron e implementaron dos herramientas web, sirviendo de guías para los estudiantes y familiarizándolos con conceptos esenciales. La aceptación de estas herramientas subraya la importancia de incluir recursos educativos innovadores en la formación de egresados en Ingeniería en Telecomunicaciones y Electrónica. Las herramientas web mejoraron la motivación y el aprendizaje de los estudiantes, impulsando su desarrollo académico y profesional.

Palabras clave: telecomunicaciones; proceso de enseñanza-aprendizaje; herramientas.

RESUMO

O artigo apresenta uma pesquisa sobre o design de ferramentas web com o objetivo de apoiar o processo de ensino-aprendizagem no curso de Engenharia de Telecomunicações e Eletrônica, especificamente na Disciplina Eletrônica e Sistemas de Radiocomunicações, a fim de melhorar a qualidade da formação através da implementação de recursos educacionais inovadores. Foi realizado na Universidade de Pinar del Río Hermanos Saíz Montes de Oca, e o universo foi constituído por estudantes e professores do curso de Engenharia de Telecomunicações e Eletrônica. Diversos métodos foram empregados, incluindo análise-síntese para identificar tendências no uso de ferramentas tecnológicas na aprendizagem, o método hipotético-dedutivo para orientar a pesquisa, e o método histórico-lógico para contextualizar o desenvolvimento e a evolução dessas ferramentas no campo educacional. Durante o processo de diagnóstico, foram aplicados questionários a professores e estudantes para determinar os conteúdos a serem incluídos. Usando métodos estatísticos descritivos como frequências e porcentagens, as informações foram resumidas. Com Xara Web Designer e WordPress, foram projetadas e implementadas duas ferramentas web, servindo como guias para os estudantes e familiarizando-os com conceitos essenciais. A aceitação dessas ferramentas ressalta a importância de incluir recursos educacionais inovadores na formação de graduados em Engenharia de Telecomunicações e Eletrônica. As ferramentas web melhoraram a motivação e a aprendizagem dos estudantes, impulsionando seu desenvolvimento acadêmico e profissional.

Palavras-chave: telecomunicações; proceso de ensino-aprendizagem; ferramentas.

INTRODUCTION

In the current era, considered to be plenty of information, technology and significant changes, society advances in line with scientific and communication development and is constantly reinventing itself. The rapid step at which technology and humanity evolve is so fast that it even exceeds understanding. This understanding leads us to recognize that change is the only constant and resisting it would be an obstacle to human progress and the creation of new knowledge.

The authors Aras *et al.* (2017) and Fernández Cruz *et al.* (2018) emphasize the continuous improvement of university curricula as a fundamental basis of Higher Education, contributing to the comprehensive development of graduates, and in accordance with the guidelines of the country's economic and social policy, which support the need to update university training and research programs in alignment with Cuba's economic and social development and new technologies.

In the Cuban context, over the course of a decade, the dynamics of a society marked by the need for professional replacement in various branches due to population ageing, the possibilities allowed by the rise of technologies and the growing demands for training professionals for the state and non-state sectors of the economy, became scenarios that conditioned the urgency of creating a new model of Cuban professional. In the document presented by the MES in 2018, these dynamics became more evident, underlining the need to renew and adapt professional training to the new times.

Cuban Higher Education, according to Tejada Fernández and Pozos Pérez (2018), must continuously align itself with the needs of society and improve its curricula to contribute to its evolution and development. The objective is to train competent professionals who can transform the organizations in which they work and offer effective solutions to the problems they face. The "E" Curricula represents this continuous improvement.

To achieve this goal, the importance of the continuous training process of Cuban professionals is emphasized, increasing the quality of training and facing the challenges of continuing education in three scenarios: undergraduate training in broad-profile careers, preparation for employment and postgraduate training. The proposal by Tejada Fernández and Pozos Pérez (2018) underlines the need to create modern incentives that support and motivate first-year students of Telecommunications and Electronics Engineering, considering the challenges and deterioration of the career, the lack of resources and the impact of the pandemic.

In short, Cuban Higher Education is focused on adapting and continuously improving to train professionals capable of responding to the current and future demands of society, despite current challenges.

From the undergraduate level, students are provided with the necessary knowledge and tools that will allow them to perform in the basic link of their profession and in other related spheres. Likewise,

the acquired skills allow them to specialize in their workplace, through a system of advanced courses, master's degrees and doctorates.

Echeverría Samanes and Martínez Clares (2018) state that it is not about overloading the student with another library of books, materials and content, since the undergraduate degree cannot cover the entire culture of a profession in a few years; mainly because knowledge is aging very quickly. Instead, there is a search for a new method of self-management of knowledge that allows the student to advance on their own in solving problems and that constitutes a guide when it comes to developing in work environments, seeking solutions to problems that arise from engineering.

In this sense, engineering education requires needs and requirements to ensure that the training process responds to the demands of the context, an aspect that demands an organization of the educational teaching process centered on the student, developed in an interactive and collaborative manner and that allows the student to acquire lifelong learning.

A future telecommunications engineer, when pursuing a degree, expects to move through the following fields of action: design, execution, resolution of practical problems with scientific methods, teaching based on the theory-practice relationship with deep relationships with industry and technical innovation. However, in 2018, it was observed that these fields were barely visible during their university education.

The authors De Brito Salazar *et al.* (2022); Tejada Fernández and Pozos Pérez (2018); Haleem *et al.* (2022); Putnik and Alves (2022); Echeverría Samanes and Martínez Clares (2018) emphasize the importance of students applying their theoretical knowledge in practice. The university must foster a closer connection with productive companies, assigning students to professionals during their internship period, to guide them and make them feel part of the collective. In addition, it is essential that the subjects are relevant and practical, and not taught in too short a time. Research on first-year students and the obstacles they face in their learning is a developing field that seeks to consolidate itself on a theoretical-methodological scale, applying both in-person and virtual resources. Among the essential points highlighted is the importance of applying theoretical knowledge in practice, achieving a close connection between the university and productive companies, the assignment of professionals to students during internships, providing the corresponding relevance and practicality of the subjects, research on obstacles in the learning of first-year students and the use of in-person and virtual resources in education.

For all these reasons, the objective of this article is to present the design of a web tool to support the teaching-learning process in the Telecommunications and Electronics Engineering degree, specifically in the Electronics and Radiocommunication Systems disciplines, in order to improve the quality of training through the implementation of innovative educational resources.

MATERIALS AND METHODS

Historical-logical: This method allowed contextualizing the development and evolution of web tools in the educational field. Previous studies were analyzed and previous experiences in the implementation of similar technologies were evaluated, providing a solid basis for the design of the current research.

Analysis-synthesis: This was used to identify trends associated with the application of Information and Communications Technologies in the learning of subjects that make up the disciplines of Electronics and Radiocommunication Systems. Relevant data was collected and analyzed to determine how these technological tools can be effectively integrated into the educational process.

Hypothetic-deductive: This approach guided the research process. Based on specific hypotheses about the use of web tools in electronics teaching, logical deductions were made to predict possible outcomes and experiments were designed to validate or refute these hypotheses.

Design and implementation: Using the software Xara Web Designer and Word Press, two specific web tools were designed and implemented for the disciplines Electronics and Radiocommunication Systems. These tools were integrated into the curriculum and used as guides for students, facilitating their familiarization with the essential concepts and improving the quality of training.

Through these methods, we sought not only to evaluate the effectiveness of web tools in education, but also to provide a solid foundation for future research and development in this field.

The diagnosis was carried out through a survey instrument, with a universe made up of students and professors of the Telecommunications and Electronics Engineering degree; the sample was selected at random, where 10 professors and 25 students from the 1st to 5th year of the degree were chosen. The results of these allowed obtaining a comprehensive view of the needs and preferences of students and professors.

RESULTS

The results of the survey of teachers and students from 1st to 5th year of the Telecommunications and Electronics Engineering degree at the University of Pinar del Río are presented in tables 1 to 6. Table 1 shows how they rated their overall experience in the Introduction to Telecommunications course.

Table 1. Rating of overall experience in the subject Introduction to Telecommunications

Indicator	Measurement criteria	Teachers		Students	
		N. 10	%	N. 25	%
General experience in the subject Introduction to Telecommunications	Very good	3	30	5	20
	Good	5	50	10	40
	Regular	2	20	8	32
	Bad	0	0	2	8
	Very bad	0	0	0	0

Table 2 identifies the main difficulties that teachers found when teaching the subject.

Table 2. Difficulties found by teachers when teaching the subject

Indicator	Measurement criteria	Teachers	
		N. 10	%
Main difficulties found by teachers when teaching the subject	Lack of resources didactic	7	70
	Difficulty in understanding concepts by students	5	50
	Lack of laboratories practical	4	40
	Other (specify): lack of time to prepare additional material	2	20

Table 3 shows the main difficulties that students found in the subject.

Table 3. Difficulties found by students when receiving the subject

Indicator	Measurement criteria	Students	
		N. 25	%
Main difficulties found by students when receiving the subject	Lack of didactic resources	18	72
	Difficulty in understanding concepts	15	60
	Lack of practical laboratories	14	56
	Others (specify): lack of tutoring	6	24

Table 4 shows the opinion of both teachers and students on the implementation of a web tool for the subject.

Table 4. Opinion of teachers and students on the implementation of a web tool for the subject

Indicator	Measurement criteria	Teachers		Students	
		N. 10	%	N. 25	%
Considerations on the proposal for the implementation of a tool to support the subject Introduction to Telecommunications	Yes	10	100	23	92
	No	0	0	2	8

Table 5 shows the suggestions made by teachers and students about the resources they suggested including in the web tool.

Table 5. Suggested resources to include in the web tool

Indicator	Measurement criteria	Teachers		Students	
		N. 10	%	N. 25	%
Resources of interest that are suggested to be included in the web tool	Educational videos	9	90	22	88
	Articles of interest	8	80	20	80
	practical classes	7	70	23	92
	Extra materials	6	60	18	72

	Documentaries	5	50	16	64
	Interactive experiments	8	80	21	84
	Discussion forum	4	40	15	60
	Others (specify): online tutorials	3	30	10	40

Table 6 shows the opinion of teachers and students on whether the implementation of a web tool would improve motivation and academic and professional performance.

Table 6. Opinion on the impact of the web tool on motivation and performance

Indicator	**Measurement criteria**	**Teachers**		**Students**	
		N. 10	**%**	**N. 25**	**%**
Opinion on the impact of implementing a web tool.	Yes	9	90	22	88
	No	0	0	1	4
	Maybe	1	10	2	8

In the qualitative analysis carried out on the data, most teachers and students positively assessed their experience in the Introduction to Telecommunications course in the disciplines of Electronics and Radiocommunication Systems. However, they identified several difficulties, such as the lack of teaching resources and practical laboratories. The respondents highlighted the importance of implementing a web tool with resources such as educational videos, articles of interest, practical classes, extra materials, documentaries and interactive experiments. Both teachers and students considered that the web tool would contribute to improve motivation, academic and professional performance.

Therefore, the implementation of a web tool was seen as a positive and necessary measurement by teachers and students. The proposed tool was to include a variety of educational resources that addressed the identified difficulties and supported the teaching-learning process, improving the quality of training in the Telecommunications and Electronics Engineering degree. Finally, the final design of two web tools was reached, as can be seen in figure 1, the proposal for the initial covers for the Electronics and Radiocommunication Systems disciplines, which included the necessary and required elements for each of them, essential in the training of graduates.

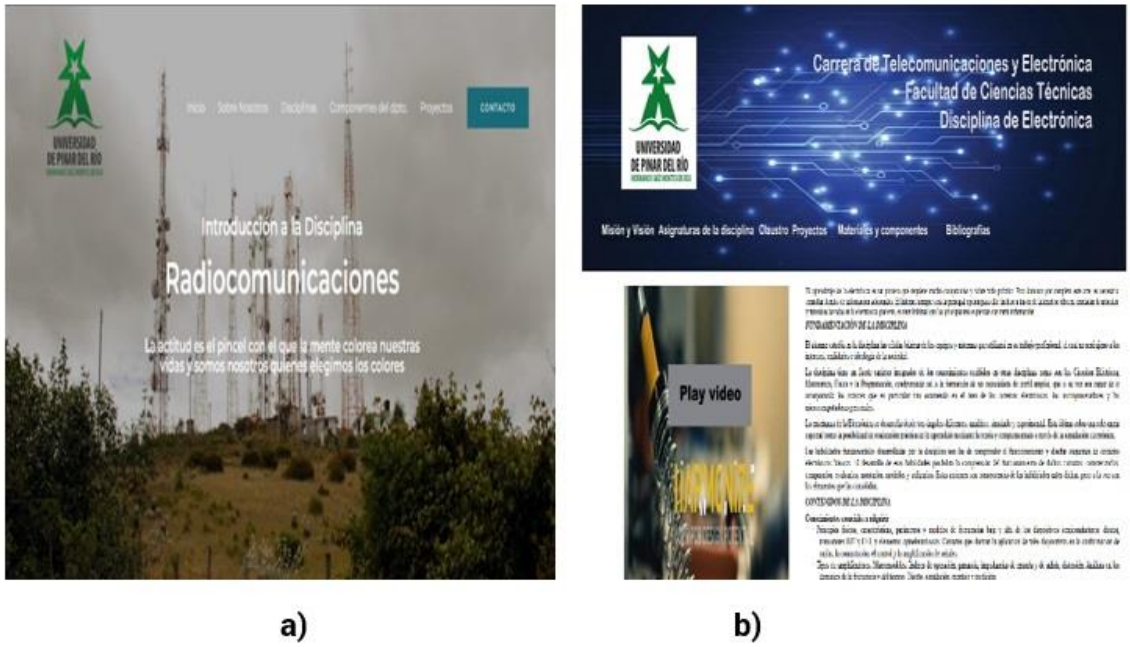

Figure 1. General view of the websites designed for the disciplines: a) Radiocommunications and b) Electronics

Two software programs were used to create these websites: Xara Web Designer and WordPress. As can be seen in figures 2 and 3, the design and the final proposal were shown, as well as the dashboard associated with the software used, which constituted the work environment.

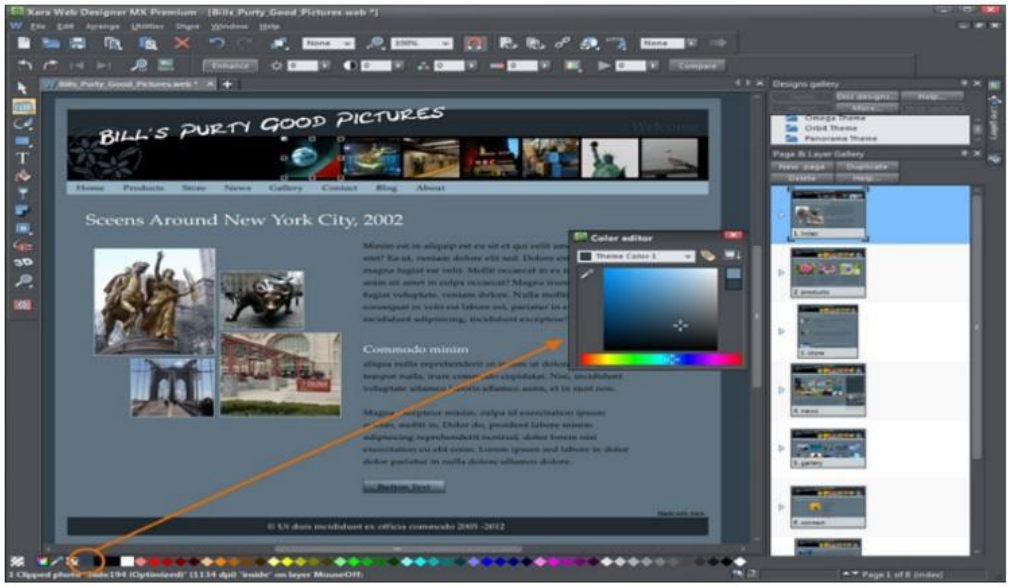

Figure 2. Screenshot of the Xara Web Designer software

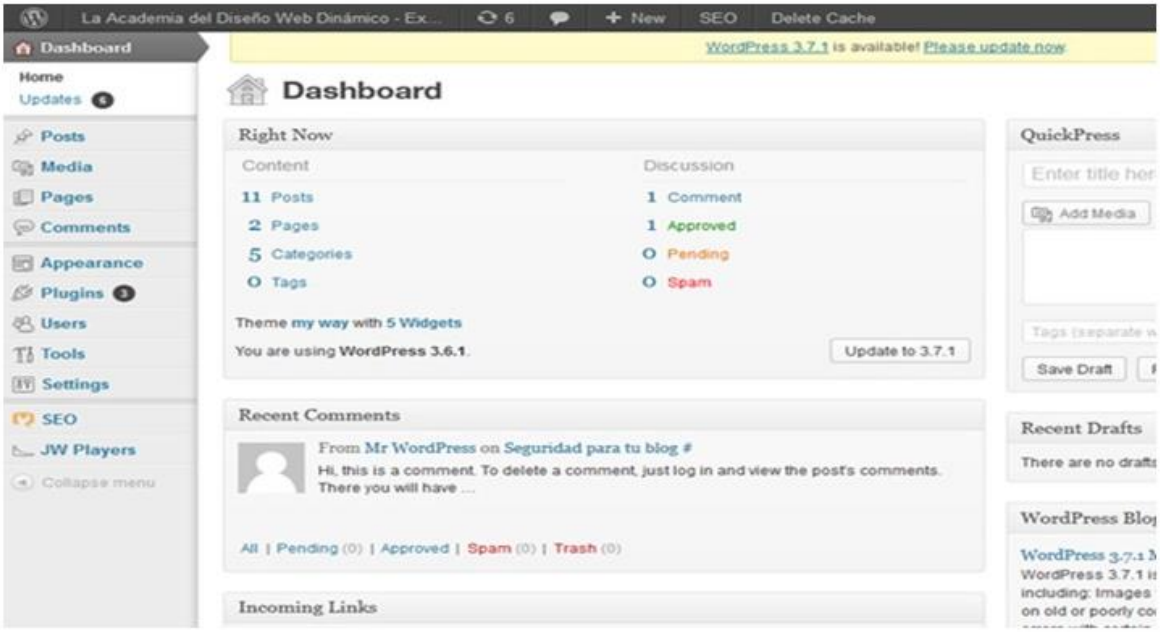

Figure 3. WordPress main interface

First proposal: Electronic discipline

Support Website Image Catalog. As can be seen in figure 4, some elements are included in the proposal with a summary of the discipline.

Figure 4. Display of the start of the web page seen from the Mozilla Firefox browser

Continuing with this proposal, figure 5 presented one of the sections created from the surveys to teachers and students, dedicated to common electronic materials and components. This section was related to the basic knowledge required in the different subjects within the discipline, thus contributing to developing the necessary skills. Next, figure 6 showed the catalog of reference books that would be used by students to study and deepen the content, functioning as an alternative to a repository.

Figure 5. Page showing the most common materials and components in electronics

Figure 6. Page showing the catalogue of the bibliography used in each of the subjects of the discipline

Figure 7 shows the electronic instrumentation section, which presents some measuring equipment, general aspects of the subject and videos of an electronics laboratory; as well as a video of electrical measurements. Figure 8 presents the section dedicated to digital electronics.

Figure 7. Page corresponding to the subject Electronic Instrumentation

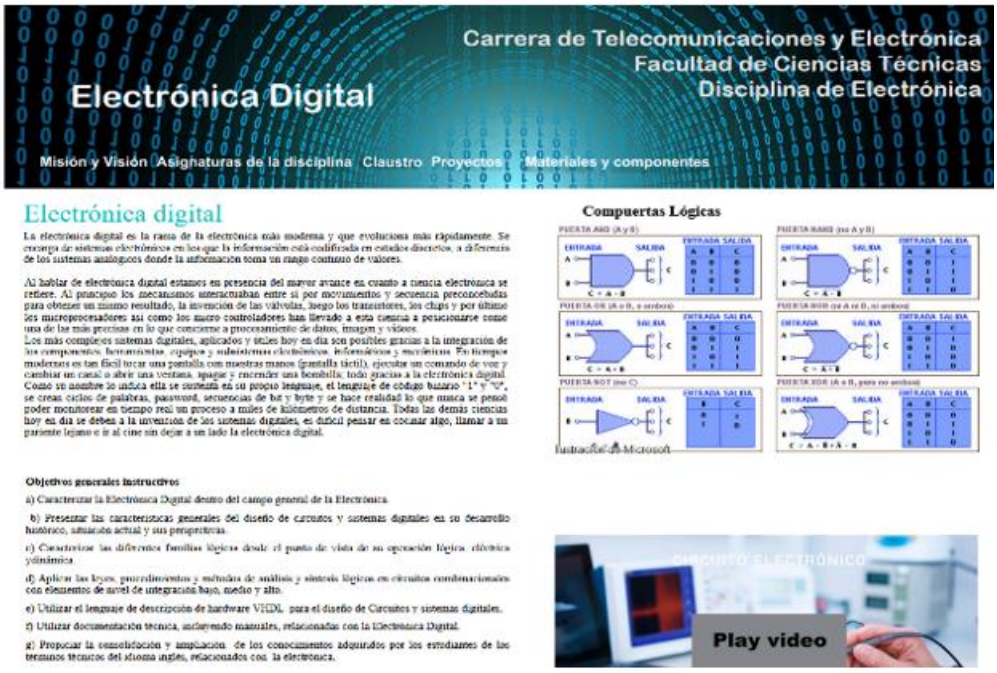

Figure 8. Page corresponding to the subject Digital Electronics

Other resources used in the educational tool

The website was provided with a selection of educational videos, which served to support much of the content included in the project.

Videos included:

- analog.mp4
- analog2.mp4
- components1.mp4
- components functions.mp4
- digital.mp4
- laboratory.mp4
- matrix.mp4
- measurements.mp4

Due to the intensive use of mobile devices by students, specifically tablets and phones with Android operating systems in its different versions, a selection of some Apps used in teaching electronics was made that can be useful in developing their skills.

Selected applications:

- basic-electrical-engineering-3-3.apk
- droid-tesla-6-21.apk
- electrodroid-5-1.apk
- electronics-toolbox.apk
- everycircuit-free-2-26.apk

In order to facilitate access to these materials, the website has download links to each of them.

Second proposal: Radiocommunications discipline

Support Website Image Catalog of the Radiocommunications discipline, where the cover of the tool in WordPress was included in figure 9.

Figure 9. Initial cover of the web resource dedicated to the Radiocommunications discipline

On the home page, you can see a general menu that includes: subjects, with the contents of each subject; the department component menu, where all the equipment that students may be using is shown, including a photo of the radiocommunications laboratory of the degree; the projects menu, etc. Each of the subjects of the discipline is also found, as shown in figure 10, which includes photos of radiocommunications systems, components, equipment used in these systems, and advances in technology over the years.

Figure 10. Other links included in the web proposal of the Radiocommunications discipline

Other resources used in the educational tool

In order to achieve a greater impact of the educational resource, the website was provided with a selection of educational videos, which provided the basis for much of the content included in the project.

DISCUSSION

After consulting other materials, the main idea was directed towards the challenges posed by the integration of technological tools in university teaching, so a series of strategies were proposed that were necessary to adapt and transform, based on the needs and demands of the current context.

According to Catal and Tekinerdogan (2019), Ellahi *et al.* (2019), Garcés and Peña (2020), Goldin *et al.* (2022) and Sonntag *et al.* (2019), educational programs had to be adapted and customized to address emerging technologies and the needs of today's industry, which involved designing skills-based curricula, integrating digital technologies coherently and effectively, and promoting lifelong learning.

Secondly, De Brito Salazar *et al.* (2022); Goldin *et al.* (2022); García Meneses *et al*. (2021) and Putnik and Alves (2022) referred to the need to create successful learning environments where teachers act as facilitators, supporters, and advisors. This included adopting active, collaborative, and interdisciplinary methodologies and promoting students' autonomy, creativity, and critical thinking.

The idea of evolving and adapting to technological changes was defended, which involved keeping up to date with innovations and trends in the educational field, exploring and experimenting with new digital tools and platforms, and evaluating their impact and effectiveness in the teaching-learning process (De Brito Salazar *et al* 2022; Goldin *et al.*, 2022; Tejada Fernández & Pozos Pérez, 2018; Nieto Taborda *et al.,* 2020).

Technological tools, in this case web-based, fostered active and collaborative learning, where students were the protagonists of their own process. These resources enhanced and reinforced the learning processes and were located in key subjects, adjusting to the contexts and particular characteristics of the exchange spaces.

Digital tools have gained greater importance and relevance at global levels. However, many countries in the world had not trained teachers with digital skills nor were they prepared for technology-mediated education, as argued by the United Nations Educational, Scientific and Cultural Organization in 2020. However, these gaps were substantially narrowed due to the use of digital tools that facilitated the teaching-learning process.

In Cuba, research was carried out by authors such as García Meneses *et al.* (2021), Hernández Garcés and Avilés Rodríguez (2019) and Echeverría Samanes and Martínez Clares (2018), among others, who highlighted the need to use certain computer tools and information technologies for learning and problem solving, although they did not delve into the study of the formation and development of technological skills in students.

It is concluded that the demands for new training requirements are evident in the face of the extraordinary technological transformations that have revolutionized the dynamics of production and services, and a highly competitive and demanding labor market. The incorporation of this type of web tools fostered the training of graduates capable of learning and unlearning in a short time, with sufficient preparation to interact with technologies, enhancing their search skills and developing the necessary capabilities to solve problems in changing contexts.

Furthermore, it is critical for educational institutions to invest in the ongoing training of teachers, ensuring that they are abreast of the latest technologies and pedagogical methodologies. Collaboration between universities and industry was also highlighted as a crucial factor in ensuring that educational programs are aligned with the needs of the labor market. This collaboration can include the implementation of internships, joint projects and mentoring programs, where students can apply their knowledge in real-life situations and acquire practical skills that better prepare them for their future careers.

Finally, the use of emerging technologies such as artificial intelligence and augmented reality was identified as an opportunity to enrich the educational process, providing new forms of interaction and personalized learning that can be tailored to the individual needs of each student. The integration of these technologies into the curriculum can significantly transform the educational experience and better prepare students to face the challenges of the future.

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Conflict of interest

Authors declare no conflict of interests.

Authors' contribution

The authors participated in the design and writing of the article, in the search and analysis of the information contained in the consulted bibliography.