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Teaching and learning process of the subject Fundamentals of Television: didactic strategy

Proceso de enseñanza aprendizaje de la asignatura Fundamentos de Televisión: estrategia didáctica

Processo de ensino e aprendizagem da disciplina de Fundamentos da Televisão: estratégia didáctica

Abstract

Introduction: the training of engineers in Cuba requires a broad profile that integrates theoretical knowledge and practical skills, particularly in the dynamic field of emerging technologies. **Objective:** to provide a pedagogical strategy for the course Fundamentals of Television within the Telecommunications and Electronics Engineering program at the University of Pinar del Río. **Method:** a descriptive study with a qualitative-quantitative approach was conducted. Theoretical methods included historical-logical analysis, modeling, and systemic-structural analysis. Empirical methods comprised documentary analysis, interviews, surveys, and analysis and synthesis, applied to the entire population of administrators, faculty, and students for the 2024-2025 academic year. **Results:** curriculum updating aligned with international standards and active methodologies improved the teaching-learning process. General and specific technologies were integrated, 87% of students achieved key competencies, and assessment using rubrics enabled more objective evaluation. **Conclusion:** scientifically grounding the instructional design is essential for quality training, emphasizing linkage to real problems, the use of adapted tools, and continuous faculty development.

Keywords: didactics, television, engineering, pedagogy, university

Resumen

Introducción: la formación de ingenieros en Cuba demanda un perfil amplio que integre conocimientos teóricos y habilidades prácticas, especialmente en el dinámico campo de las nuevas tecnologías.

Objetivo: fundamentar una estrategia didáctica para la asignatura Fundamentos de Televisión en la carrera de Ingeniería en Telecomunicaciones y Electrónica de la Universidad de Pinar del Río. **Método:** se empleó una investigación descriptiva con enfoque cuali-cuantitativo. Los métodos teóricos incluyeron el histórico-lógico, la modelación y el sistémico-estructural. Los métodos empíricos comprendieron análisis documental, entrevistas, encuestas y análisis y síntesis, aplicados a la población completa de directivos, profesores y estudiantes del curso 2024-2025. **Resultados:** la actualización curricular con estándares internacionales y metodologías activas mejoró el proceso. Se integraron tecnologías generales y específicas, el 87% de los estudiantes alcanzó competencias clave y la evaluación con rúbricas permitió una valoración más objetiva. **Conclusión:** fundamentar científicamente el diseño didáctico es esencial para una formación de calidad, destacando la vinculación con problemas reales, el uso de herramientas adaptadas y la actualización docente permanente.

Palabras clave: didáctica, televisión, ingeniería, pedagogía, universidad

Resumo

Introdução: a formação de engenheiros em Cuba exige um perfil amplo que integre conhecimentos teóricos e habilidades práticas, especialmente no dinâmico campo das novas tecnologias. **Objetivo:** fundamentar uma estratégia didática para a disciplina Fundamentos de Televisão no curso de Engenharia em Telecomunicações e Eletrônica da Universidade de Pinar del Río. **Método:** empregou-se uma pesquisa descritiva com abordagem quali-quantitativa. Os métodos teóricos incluíram o histórico-lógico, a modelagem e o sistêmico-estrutural. Os métodos empíricos compreenderam análise documental, entrevistas, questionários e análise e síntese, aplicados à população completa de dirigentes, docentes e estudantes do ano letivo 2024-2025. **Resultados:** a atualização curricular com padrões internacionais e metodologias ativas melhorou o processo. Integraram-se tecnologias gerais e específicas, 87% dos estudantes alcançaram competências-chave e a avaliação por meio de rubricas permitiu uma valoração mais objetiva. **Conclusão:** fundamentar cientificamente o desenho didático é essencial para uma formação de qualidade, destacando a vinculação com problemas reais, o uso de ferramentas adaptadas e a atualização permanente do corpo docente.

Palavras-chave: didática, televisão, engenharia, pedagogía, universidade

Introduction

In the context of higher education in Cuba, the Ministry of Higher Education (MES) promotes the training of engineers with a broad profile, capable of responding to the demands posed by technological development and the management of telecommunications and electronic systems. This approach necessitates not only solid theoretical knowledge but also practical and innovative skills that enable future professionals to adapt to the disruptive changes within the sector, particularly in fields such as Information and Communication Technologies (ICT), where technological convergence is a constant factor (Mishra & Koehler, 2006).

The course Fundamentals of Television, part of the curriculum E for the Telecommunications and Electronics Engineering program at the University of Pinar del Río (UPR), plays a crucial role in preparing competent professionals for the design, operation, and maintenance of technologies related to television systems. However, an assessment revealed limitations in its teaching-learning process (TLP), characterized by the following:

- An excessively theoretical approach with limited practical application.
- Traditional teaching methods that restrict student autonomy.
- Outdated content or insufficiently contextualized material related to the needs of the labor market.
- Inadequate utilization of technological tools and virtual learning environments (Castellanos, 2001; Bebell et al., 2023).

These weaknesses affect the holistic development of students, who graduate without mastering essential competencies necessary for innovation and adaptation to advancements in this specialty within the program.

Given this scenario, it is imperative to redesign the TLP of the course through a developmental didactic strategy that integrates:

- Active pedagogical approaches utilizing project-based learning or the study of real cases (Aparicio-Gomez & Ostos-Ortiz, 2020).
- Collaboration with the business sector to contextualize content.
- Strategic use of educational technologies such as simulators, virtual laboratories, and, currently, the opportunities provided by artificial intelligence (Baş & Baştuğ, 2020).
- Formative evaluation that measures both theoretical knowledge and practical skills (Fitzpatrick et al., 2024).

The primary objective of this article is to substantiate an innovative didactic strategy for the TLP of Fundamentals of Television, ensuring professional training aligned with the demands of digital transformation and the needs of the labor market in telecommunications.

This proposal is based on a critical analysis of theoretical frameworks concerning engineering didactics, the educational policies of the Ministry of Higher

Education (MES, 2007), and the results of diagnostics applied to students and teachers at UPR. Its implementation will help bridge the gap between academic training and the competencies required for professional practice, thereby enhancing the social impact of future engineers on the technological development of the country.

Methods and materials

The study was grounded in a qualitative approach, as the primary objective was to gain an in-depth understanding of the dynamics within the teaching-learning process (TLP) from the perspectives of the involved stakeholders in a specific educational context. It incorporated quantitative elements to quantify and generalize certain findings regarding the studied population. This integration facilitated a triangulation of data that enriched the analysis.

The research was designed as descriptive and case-based, aiming to characterize the current state of the TLP in a specific course and program, diagnosing its particularities to substantiate a proposal for didactic improvement.

The population comprised all stakeholders involved in the course "Fundamentals of Television" within the Telecommunications and Electronics Engineering program at the University of Pinar del Río during the 2024-2025 academic year. This included:

- Administrators: department head, year head, and discipline head (3 individuals).
- Instructors: 7 professors from the discipline.
- Students: 48 third- and fifth-year students from both regular and semi-attendance programs.

The entire study population was included, meaning no sampling was conducted, as the study intentionally encompassed all individuals within this specific context to achieve a comprehensive and profound diagnosis of the case in question.

The methods and techniques were applied as follows:

Theoretical methods:

- Historical-Logical: to analyze the evolution of the TLP in the course and determine its stages and regularities.
- Modeling: to create an abstract representation and graphic design of the proposed didactic strategy.
- Systemic-Structural: to logically and comprehensively design the strategy, establishing connections between didactic foundations and educational actions.

Empirical methods and techniques:

- Document analysis: the curriculum, analytical program, and course materials were reviewed to diagnose the predominant approaches in the TLP and their relation to the use of ICT.
- Interviews: conducted with students and instructors to diagnose the conditions of the current model, focusing on their opinions and practices regarding the didactic use of ICT.
- Surveys: administered to students to assess how the TLP was unfolding, identifying emphases on non-essential aspects and the lack of precise methodological guidance for integrating didactic tools.
- Analysis and synthesis: employed to process and interpret the information gathered through all the previous techniques, both qualitatively and quantitatively.

Results and discussion

The research was conducted during the 2022-2023 academic year at the Faculty of Telecommunications of the University of Pinar del Río, with the primary aim of transforming and enhancing the teaching-learning process (TLP) for the course "Fundamentals of Television" in the Telecommunications and Electronics Engineering program. This study was theoretically grounded in the principles proposed by Mishra and Koehler (2006), focusing on two dimensions: Didactic Management and Technological Management.

The research team identified significant limitations in the traditional approach to the course, including a predominance of conventional expository methods, minimal alignment with the labor market's needs in this field, and insufficient utilization of emerging digital technologies in television. These deficiencies underscored the necessity to design and implement an innovative didactic strategy that addresses the current demands of engineering education.

For the execution of the study, the specialist team established a fundamental premise that effective integration of these dimensions would facilitate meaningful learning and develop the professional competencies required in contemporary television systems.

The research process was structured into five crucial stages: initial diagnosis, curriculum design, practical implementation, evaluation of results, and systematization of experiences. Each stage employed specific data collection instruments and clearly defined evaluation criteria, ensuring the validity and reliability of the results obtained.

The study population comprised all stakeholders involved in the educational process: students, faculty, and academic administrators. This selection provided a comprehensive view of existing challenges and validated the effectiveness of implemented solutions from multiple perspectives.

The results indicated that the systematic application of the TPACK model in the course "Fundamentals of Television" significantly transformed the educational

process, overcoming the initially identified limitations and achieving enhanced quality levels in students' professional training.

Foundation of the didactic strategy for the TLP of "Fundamentals of Television" course in the Telecommunications and Electronics Engineering program at the University of Pinar del Río.

In support of this objective, a specific didactic proposal was developed and grounded in the systematic integration of the dimensions of Didactic Management and Technological Management to transform the teaching-learning process.

Theoretical foundation and justification:

Table 1

Dimensions, foundations, and components of the proposed didactic strategy

Dimension	Justification	Component	Specific Elements
1. Didactic Management Dimension	**Theoretical bases:** Postulates of Mathé and Mithalal (2025) on curriculum design and relationships between professional competencies (Forcael et al., 2022). **Justification for inclusion:** • Surpassing traditional approaches. • Ensuring systematic planning. • Implementing active learning strategies. • Establishing effective control and evaluation mechanisms.	**a) Curriculum Planning**	**Redesigned thematic structure (4 modules):** 1. Technical fundamentals of television (analog and digital). 2. Transmission and reception systems. 3. Emerging technologies (IP TV, streaming). 4. International norms and standards. **15 learning outcomes aligned with:** 1. Program exit profile. 2. Needs of the Cuban productive sector. 3. International UIT standards.
		b)	**Fundamental types**

Dimension	Justification	Component	Specific Elements
		Methodological Strategies	**of activities:** 1. Integrated theoretical-practical sessions (60% of time). 2. Workshops on solving real problems (25%). 3. Applied projects in collaboration with companies (15%). **Continuous formative assessment system:** 1. Competency-based evaluations. 2. Weekly self-assessments.
2. Technological Management Dimension	**Theoretical bases:** Principles of technological integration (Ramírez-Montoya et al., 2024) and TPACK framework. **Justification for inclusion:** • Updating technical content. • Developing technological competencies. • Addressing the lack of specialized equipment.	**a) Technological Infrastructure**	**Virtual digital television lab with:** • System simulator for evaluating technical parameters. • Repository of real signal data for practical exercises. • RF parameter measurement station using emulated tools. **Moodle platform with:** • 20 interactive learning objects. • Technical video library featuring 35 tutorials. • Specialized forums by topic.
		b) Technological	**Developed materials:** • 8 practical

Dimension	Justification	Component	Specific Elements
		Didactic Resources	laboratory guides grounded in theoretical concepts. • 5 case studies based on real data from Telepinar. • Procedures manual for digital television equipment aligned with available resources.

Source: Authors' own elaboration.

Applied design methodology:

1. Analysis phase:

- A content matching exercise was conducted with five international universities offering courses on specific topics related to television systems.
- Twelve key technological competencies were identified.
- The requirements of the Ministry of Communications were analyzed in relation to undergraduate training.

2. Design phase:

- Three preliminary versions of the didactic strategy were developed.
- These versions were validated by experts using the Delphi method.
- Adjustments were made to the didactic strategy proposal based on institutional feasibility criteria.

3. Validation phase:

- The strategy was implemented with a pilot group of 15 students.
- Observational data were collected and processed.
- Final adjustments were made based on the feedback received.

Results of the design process:

1. Normative documents:

- Updated analytical program (45 pages).
- Laboratory procedures manual.
- Competency-based evaluation guide

2. Created technological resources:

- Fifteen interactive simulations of various processes in television systems.
- Three virtual system prototypes, based on undergraduate thesis results.
- A digital library accessible via the Moodle platform containing 120 educational resources.

Justification of the integration of dimensions:

The interrelation among the dimensions was established through:

1. Alignment maps linking:

- Learning objectives.
- Teaching methods.
- Specific technologies.
- Evaluation criteria.

2. Teacher training system including:

- Workshops for technological updates.
- Consultations on active teaching methodologies.
- Classroom support.

3. Feedback mechanisms through:

- Satisfaction surveys.
- Analysis of academic results.
- Evaluation from employer organizations.

From October to December 2022, a comprehensive didactic strategy was designed and substantiated for the course "Fundamentals of Television" in the Telecommunications program at the University of Pinar del Río, contextualized to meet specific needs. The proposal was structured around two complementary dimensions: Didactic Management, focusing on teaching-learning processes, and Technological Management, aimed at developing professional competencies using updated tools.

In the Didactic Management Dimension, the academic program was completely redesigned, organizing content into four integrated modules that spanned from technical fundamentals to emerging digital television technologies, thus overcoming the traditional fragmentation of content (Bani, 2024). This curricular redesign was complemented by the implementation of five didactic sequences based on active methodologies, such as Project-Based Learning (Bracho-Fuenmayor, 2025a; Tawil et al., 2023; Aparicio-Gomez & Ostos-Ortiz, 2020), where students worked on real cases from the province, including the analysis of technical failures at the local transmission plant and designing solutions for the transition to digital systems. The evaluation system underwent radical transformation,

incorporating twelve competency-specific rubrics (García-Cortés & Hernández, 2021) that allowed for a more objective assessment of students' technical-professional performance.

In the Technological Management Dimension, a virtual laboratory was created with fifteen simulations in LabVIEW for Digital Television systems. This allowed students to experiment with QAM and COFDM modulations without the need for expensive physical equipment, utilizing principles of interactive multimedia design (Behrendt & Smallfield, 2024; Cabezas, 2019). This platform was complemented by an advanced implementation of Moodle, which included 35 interactive learning objects, specialized technical forums, and a repository of real captured signals (Lee & Chang, 2024), anchored in a pedagogical approach that integrates access, beliefs, and educational uses of technology (Baş & Baştuğ, 2020; Bebell et al., 2023).

The results showed a significant improvement ($p < .05$) compared to previous experiences: 92% of students were able to apply theoretical concepts in real situations (versus 68% reported by Fernández-Villalobos et al., 2016), and 87% achieved basic competencies in digital TV system design (surpassing the 72% noted by Flores et al., 2018). Additionally, student satisfaction was reported at 4.5/5, significantly higher than the 3.8/5 from prior studies (Garduño, 2020).

These advances are attributed to the systemic integration of three key factors: the technological updating of content, supported by the development of teacher competencies in ICT and the design of interactive resources (Lyublinskaya & Du, 2022; Park et al., 2025; Sripan & Lertpongrujikorn, 2025; Bracho-Fuenmayor, 2025b); the active methodology centered on real projects (Fazilla et al., 2023; Jug Došler et al., 2023; Safia et al., 2024; Singer et al., 2024); and the availability of enhanced interactive digital resources and online environments (Dong et al., 2025; Jach et al., 2023; Lam & Siew, 2024; Mäkiniemi, 2022; Puy et al., 2025; Méndez & Jiménez, 2025; Jiménez Pérez, 2025). The research engaged critically with leading Cuban references, such as Castellanos (2001) on developmental didactics, Rueda et al. (2016) on vocational education, and Morris et al. (2021) on hybrid models, surpassing their proposals by incorporating a more advanced technological focus and more accurate and objective assessment tools (Espitia & Rojas Ramírez, 2025; Fitzpatrick et al., 2024; Krach & Corcoran, 2023).

As a limitation, it was identified the need for an additional 40% preparation time for teachers, linked to the ongoing requirement for technological and pedagogical updates. As a projection, it is recommended to extend this experience to other technical courses, establish ongoing agreements with industry companies, and develop a continuous teacher training program to ensure the sustainability of the model.

Conclusions

Based on the initial diagnosis that identified an excessively theoretical TLP characterized by traditional methods, outdated content, and low technological

utilization, an innovative didactic strategy has been established, structured around two integrated dimensions. The Didactic Management Dimension responds to the diagnosis through a modular curricular redesign and the implementation of active methodologies (such as Project-Based Learning linked to the productive sector) and a formative evaluation system employing rubrics. The Technological Management Dimension overcomes infrastructure limitations by creating a virtual environment with simulated laboratories (e.g., fifteen simulations in LabVIEW) and interactive resources on Moodle. This strategy proves effective, with 92% of students applying theoretical concepts in real situations and 87% achieving basic competencies in digital TV system design, thereby validating its relevance for developing competent professionals within the context of Cuban higher education.

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Taymí Breijo Worozs 2: Supervision, Validation/Verification, Visualization, Drafting/Original Draft, and Writing, Review and Editing.
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