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ICT-mediated Pedagogical Model Integrating ADDIE and Gamification: A Proposal to Improve Educational Research

Modelo pedagógico mediado por TIC integrando ADDIE y gamificación: Una propuesta para mejorar la investigación educativa

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Abstract

This article presents a pedagogical model mediated by Information and Communication Technologies (ICT), which integrates the ADDIE model and gamification to optimize educational research. The design is conceptualized using the metaphor of an airplane, where each part represents a crucial component of the teaching-learning process: the fuselage symbolizes the central structure of instructional design; the wings represent the didactic and gamification strategies that drive learning; engines are associated with the technological tools that provide the necessary boost; the cockpit embodies teaching management and coordination; and the body of the plane contains the educational activities carried out by the students. The methodology is structured in five key phases of the ADDIE model applied in a virtual learning environment. The results indicate that the combination of ADDIE and gamification, supported by ICT, significantly improves student motivation, engagement, and academic performance. In addition, this approach facilitates the personalization of learning and continuous progress monitoring. The conclusions highlight the effectiveness of the proposed model in modernizing education, offering an adaptable structure that responds to the demands of an increasingly digitized and demanding academic and professional environment.

Keywords: ADDIE, gamification, ICT, Education

Resumen

Este artículo propuso un modelo pedagógico mediado por Tecnologías de la Información y la Comunicación (TIC) que integra el modelo ADDIE y la gamificación para optimizar la investigación educativa. La estructura del modelo se conceptualizó utilizando la metáfora de un avión, donde cada parte representa un componente esencial del proceso de enseñanza-aprendizaje: el fuselaje simboliza la estructura central del diseño instruccional; las alas representan las estrategias didácticas y de gamificación que potencian el aprendizaje; los motores se asocian con las herramientas tecnológicas que proporcionan el impulso necesario; la cabina del piloto encarna la gestión y coordinación docente; y el cuerpo del avión contiene las actividades educativas realizadas por los estudiantes. La metodología se estructuró en cinco fases clave del modelo ADDIE aplicadas en un entorno de aprendizaje virtual. Los resultados indicaron que la combinación de ADDIE y gamificación, apoyada por TIC, mejoró significativamente la motivación, el compromiso y el rendimiento académico de los estudiantes. Además, este enfoque facilitó la personalización del aprendizaje y la supervisión continua del progreso. Las conclusiones destacaron la efectividad del modelo propuesto para modernizar la educación, ofreciendo una estructura adaptable que responde a las demandas de un entorno académico y profesional cada vez más digitalizado.

Palabras clave: ADDIE, gamificación, TIC, Educación

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Introduction

The integration of Information and Communication Technologies (ICT) into education has radically transformed conventional pedagogical practices, enabling the adoption of teaching and learning methods that foster interactivity, personalization, and inclusion (Sangrà et al., 2012). In this context, educational research faced the challenge of adapting these technological advances to optimize teaching and learning processes. The ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) has established itself as a systematic approach to instructional design, offering an organized structure that facilitates the creation of effective educational experiences (Molenda, 2015). However, despite its effectiveness, the ADDIE model can be enriched by integrating innovative methodologies that respond to the demands of 21st-century students.

One of these methodologies is gamification, which incorporates game elements into non-game contexts to increase student motivation and engagement (Deterding et al., 2011). Recent research has shown that gamification not only improves motivation but can also have a positive impact on academic performance and learning retention (Buckley and Doyle, 2014). Virtual Learning Environments (VLEs) such as Moodle and Sakai have established themselves as fundamental platforms for the implementation of innovative pedagogical strategies, allowing the adaptation of educational content to the individual needs of students (García and Tejedor, 2016). These platforms not only facilitate access to educational resources but also allow for the application of continuous and personalized assessments essential for inclusive and effective learning (Valverde et al., 2020). This study proposed a pedagogical model that combines the ADDIE approach with gamification, mediated by ICT, to enhance educational research. It also explored how Virtual Learning Environments can be used to promote inclusive learning and how ICT can transform assessment processes and the implementation of pedagogical strategies in secondary education. Finally, it considered neuroeducation as a comprehensive approach to designing learning experiences that consider cognition and brain function (Tokuhama-Espinosa, 2014).

1.1. ADDIE Model in Education

The ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model is widely recognized for its flexibility and effectiveness in instructional design in diverse educational contexts, ranging from formal education to corporate training and distance education (Branch and Dousay, 2015). This approach is based on a sequential structure that allows educators to create educational programs tailored to specific student needs and pedagogical objectives (Morrison et al., 2011). A notable aspect of the ADDIE model is its ability to integrate diverse learning theories and pedagogical approaches. For example, it has been effectively used in constructivist contexts, where active learning and student construction of knowledge are emphasized (Molenda, 2015). This model is especially relevant in digital educational environments, where students can interact with multimedia content, participate in online discussions, and collaborate on group projects, all facilitated by rigorous instructional design. The Assessment phase of the ADDIE model focuses not only on measuring student performance but also on continuously evaluating

and improving the teaching process itself. This aspect is crucial to ensuring that educational programs remain relevant and effective in changing contexts (Reigeluth, 1999). The integration of emerging technologies such as Information and Communication Management Technologies (ICM) has expanded the capabilities of the ADDIE model, providing advanced tools for learning personalization and real-time monitoring of student progress (García and Tejedor, 2016).

1.2. Gamification in Education

Gamification has established itself as a powerful methodology for engaging students in the learning process by including game elements in educational environments (Deterding et al., 2011). This technique has been shown to be especially effective in increasing both intrinsic and extrinsic student motivation, improving their academic performance and satisfaction with learning (Buckley and Doyle, 2014). Self-determination theory, proposed by Ryan and Deci (2000), supports the idea that students' intrinsic motivation is strengthened when they experience competence, autonomy, and social connection. Gamification, by offering challenges tailored to students' skill level, personalized options, and an environment that fosters collaboration and friendly competition, fits perfectly with these principles (Kapp, 2012).

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1.3. Virtual Learning Environments (EVA & AVA)

Virtual Learning Platforms (VLPs), such as Moodle, Blackboard, and Sakai, have transformed education by offering environments that facilitate flexible, personalized, and adaptive learning (Bower et al., 2015). These tools allow educators to design educational experiences that fit students' needs and learning styles, promoting inclusion and improving accessibility (Sangrà et al., 2012). The incorporation of Information and Communication Technologies (ICTs) into VLPs has strengthened these platforms, facilitating advanced management of educational information and effective communication between participants in the educational process (Valverde et al., 2020). In these environments, ICTs not only simplify content delivery but also enable learning personalization, adjusting educational paths to individual students' needs and providing immediate feedback (Bower et al., 2015). Furthermore, TGISC-supported AVPs enable continuous and personalized assessment, which is essential for adaptive learning and improved academic performance (García & Tejedor, 2016). These environments' ability to collect and analyze real-time data on student performance has opened up new possibilities for evidence-based education, where pedagogical decisions are based on detailed and accurate analyses (Siemens, 2013).

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1.4. 1.4.Neuroeducation and Methodological Design

Neuroeducation, which combines cognitive neuroscience with education, offers valuable insights into how the brain functions during learning and how to design more effective, student-centered educational experiences (Tokuhama, 2014). This field emphasizes the importance of aligning pedagogical strategies with natural brain processes such as attention, memory, and motivation to optimize learning (Sousa, 2017). Neuroeducation highlights that learning is a highly individualized process, influenced by cognitive and emotional differences among students. Information and Communication Technologies (ICTs), by enabling the collection of data on students' cognitive and emotional responses, facilitate the personalization of learning and the adaptation of pedagogical strategies to maximize their effectiveness (Tokuhama, 2014).

Furthermore, neuroeducational research has shown that emotions play a crucial role in the learning process. Experiences that generate positive emotions, such as curiosity and joy, can significantly improve information retention and knowledge transfer (Immordino and Damasio, 2007). Gamification, which emotionally engages students through challenges and rewards, aligns with these neuroeducational principles, creating learning environments that are both cognitively stimulating and emotionally enriching (Kapp, 2012).

1.5. Innovative Techno-Pedagogical Structure Focused on ICMTs.

Information and Communication Management Technologies (ICMTs) represent an advanced approach to digital education, combining data management, effective communication, and real-time analytics to optimize teaching and learning processes (García and Tejedor, 2016). These technologies enable the creation of dynamic and adaptive learning environments that adapt to students' changing needs, facilitating deep learning personalization and efficient management of educational resources (Siemens, 2013). Within an innovative techno-pedagogical structure, ICMTs integrate multiple functions, from the organization and distribution of educational content to the monitoring and analysis of student progress. This integration not only improves the efficiency of the educational process but also enables more effective and timely feedback, real-time problem identification, and the implementation of personalized educational interventions (Valverde et al., 2020). In the context of gamification, SGITs facilitate the personalization of learning experiences, adapting educational challenges to students' individual abilities and needs. This data-driven approach ensures that the learning experience is not only motivating but also aligned with specific educational objectives, optimizing the pedagogical impact (Kapp, 2012). In short, SGITs are fundamental to creating educational environments that are efficient, inclusive, and student-centered, promoting adaptive and evidence-based learning (Siemens, 2013).

Methodology

The methodology presented was based on a solid theoretical framework derived from the integration of key bibliographic references in the fields of pedagogy, ICT, and gamification,

combined under the ADDIE model. This methodological approach acted as the "learning vehicle" that guided the design and implementation of the educational proposal. The methodology is described below, structured in five main phases according to the ADDIE model, each enriched with evidence from the academic literature.

Analysis Phase (A)

The analysis phase focused on identifying educational and technological needs based on a thorough literature review. According to Gagné et al. (1992), needs analysis is essential to the success of any instructional design. This phase includes:

- Literature review: Relevant studies addressing the integration of ICT in education (Molenda, 2015), the effectiveness of gamification in educational environments (Kapp, 2012) and the application of the ADDIE model in various contexts (Branch and Dousay, 2015) were examined.
- Definition of objectives: Based on the review of previous studies, clear learning objectives are established, aligned with the competencies necessary for educational research, as suggested by Morrison et al. (2011).
- Identifying challenges: Reviewing works such as those by Hamari et al. (2014) allows us to anticipate common challenges in the implementation of ICT and gamification, such as resistance to change and lack of adequate infrastructure.

Design Phase (D)

In this phase, a detailed instructional plan was developed, guided by theory and best practices identified in the literature. According to Merrill (2002), effective design should be based on sound instructional principles that facilitate deep learning.

- Content structuring: Educational content is organized into sequential modules, integrating recommendations from studies on the effectiveness of modular instruction and interactive multimedia (Reigeluth, 1999).
- Gamification strategies: Gamification strategies are designed based on work such as that of Deterding et al. (2011), which highlights the importance of narrative, progression, and feedback to increase student motivation.
- Technological adaptation: Appropriate ICT tools, such as LMS platforms and gamification applications, are selected based on previous research on their effectiveness in educational environments (Bower et al., 2015).

Development Phase (D)

The development phase focused on the creation and adaptation of educational materials, guided by guidelines identified in the literature.

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- Production of materials: Digital educational resources (videos, simulators, interactive questionnaires) are developed using tools such as Adobe Captivate and Articulate Storyline, according to recommendations from instructional design experts (Morrison et al., 2011).
- Testing and validation: Pilot testing of the developed materials is proposed to ensure their quality and effectiveness, following the procedures described by Branch and Dousay (2015).

Implementation Phase (I)

The implementation of the pedagogical model was designed to take place in a virtual learning environment, supported by ICT.

- Program implementation: The steps for implementation on platforms such as Moodle are detailed, based on studies that demonstrate its effectiveness in distance education (García and Tejedor, 2016).
- Gamified activities: The proposed activities are designed based on the literature on effective gamification, ensuring that the game elements maintain motivation and engagement (Kapp, 2012).

Evaluation Phase (E)

Finally, the evaluation phase proposes a formative and summative approach, aligned with the principles described in the literature.

- Formative assessment: The implementation of continuous assessments is proposed to monitor progress, using techniques suggested by authors such as Gagné et al. (1992).
- Summative evaluation: The effectiveness of the model will be evaluated through final projects and exams, complemented by satisfaction surveys, as recommended by the literature on educational evaluation (Reigeluth, 1999).
- Analysis and feedback: A detailed analysis of the evaluation results will be carried out, supported by the literature to make adjustments and improvements to the proposed pedagogical model (Merrill, 2002).

Results

The proposal to use the structure of an airplane as a metaphor for the pedagogical components of MPmTIC (ICT-mediated pedagogical model) and gamification has been enriched with specific details about how each component of the airplane correlates with key aspects of the educational process. Detailed results are presented below in *Table 1*, including how the different parts of the airplane are integrated into the pedagogical model, supported by the ADDIE model.

Table 1

Relationship between the Parts of the Aircraft and Pedagogical Components of the MPmTIC Model.

Parts of the Airplane	Pedagogical Components	Description
Fuselage	Main Structure of Instructional Design	It represents the planning and organization of the content and learning objectives.
Wings	Teaching Strategies and Gamification	They symbolize strategies used to motivate and engage students, such as gamification.
Engines	Technological and Techno Pedagogical Tools	They promote the necessary drive for learning through LMS and gamification applications.
Cockpit	Teaching Management and Coordination	Space where the teacher monitors and directs the educational process.
Body of the Aircraft	Educational activities	Contains the individual and collaborative activities that students carry out.
Wheels	Technical and pedagogical support	They promote the infrastructure and support necessary for the digital learning environment

Nota. Detailed parts of the aircraft and its structure.

3.1. Fuselage: Main Structure of the Instructional Design

The airplane fuselage represented in *Figure 1* represents the central structure of the ICT-mediated pedagogical model (ICTmPM). This component was essential for the model's analysis and design, ensuring that the learning objectives were clearly defined and aligned with the identified needs of the students. The information gathered during the analysis phase allowed for the development of a content plan and effective pedagogical strategies.

- Analysis (A): Clear competencies and goals are defined, an initial diagnosis is made to identify students' needs and prior levels through surveys and data analysis, and appropriate ICT tools are selected, such as LMS platforms (Moodle or Canvas) and Google Forms surveys.
- Design (D): Content is planned through teaching modules, interactive teaching resources such as animated presentations and e-books are created, and gamification strategies are designed that include levels, badges, challenges, and rewards.
- Development (D): Educational materials (videos, podcasts, interactive simulators, and quizzes) are produced, and assistive technologies are implemented using authoring tools such as Adobe Captivate or Articulate Storyline. Gamification platforms such as Classcraft or Kahoot are also integrated..
- Implementation (I): Synchronous and asynchronous activities are carried out in the virtual environment, learning is facilitated through tutorials and discussion forums, and quizzes are used for formative assessment.
- Assessment (E): Summative assessments are conducted through exams and final projects, student performance and satisfaction are reviewed, and adjustments are implemented to improve the educational process.

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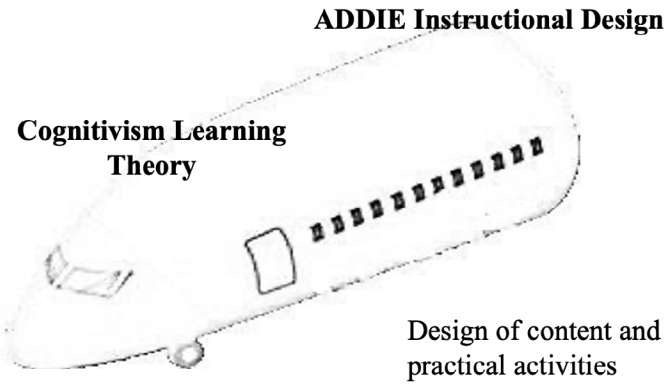
Figure 1

Fuselage Components: MPmTIC Design.



Note. The figure shows how the aircraft fuselage symbolizes the planning and organization of instructional design, integrating the phases of the ADDIE model.

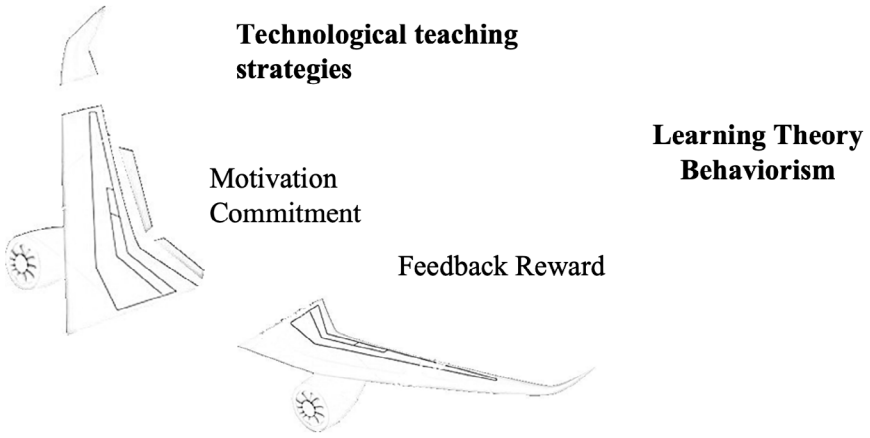
3.2. Wings of the Airplane: Teaching and Gamification Strategies

In *Figure 2*, the airplane's wings symbolized the teaching and gamification strategies that drive the educational model. These strategies allowed the model to "fly," keeping students motivated and engaged through well-designed activities..

- Motivation and Engagement: A narrative serves as a guiding thread for the activities, allowing for the creation and customization of avatars, and difficulty levels are set to maintain student interest.
- Feedback and Rewards: Point systems, digital badges, and achievements are implemented, and an honor roll is published to encourage competition and collaboration among students.
- Collaboration and Competition: Working groups are formed for collaborative projects, competitions based on educational content are organized, and the use of educational social networks like Edmodo is encouraged to share achievements and resources.

Figure 2

Interaction of Engines and Wings in the Educational Aircraft..



Nota. The figure highlights the interaction between teaching strategies (wings) and technological tools (engines), showing how they work together to drive learning.

3.3. Aircraft Engines: Technological Tools and Techno Pedagogy

In *Figure 3*, the airplane's engines provide the necessary momentum for the pedagogical model to move forward. These engines correspond to the technological and techno-pedagogical tools that facilitate content management, collaboration, and motivation in the learning environment..

- Learning Management Systems (LMS): Tools such as Moodle, Canvas, and Blackboard manage and organize educational content.
- Collaboration tools: Google Workspace, Microsoft Teams, and Slack facilitate communication and collaboration between students and teachers.
- Content creation tools: Powtoon, Canva, and Prezi are used to develop engaging and interactive educational materials.
- Gamification apps: Classcraft, Kahoot, and Quizizz integrate game elements to increase student motivation and engagement.
- Techno Pedagogy: Content is adapted to personalize learning, ensuring that resources are accessible to all students, and learning analytics are implemented to continuously adjust and improve educational processes.

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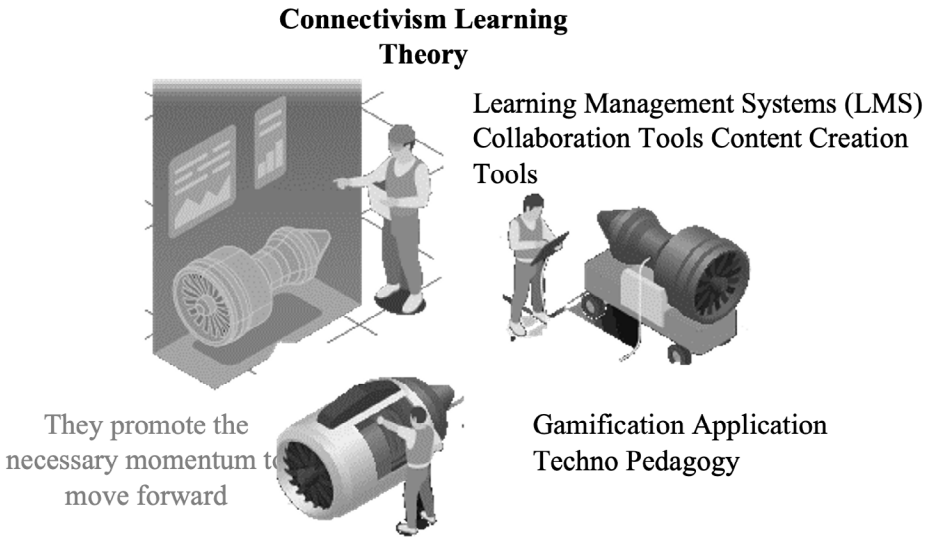
Figure 3

Schematic of the MPmTIC Model based on the Aircraft Structure.



Nota. The figure illustrates how each part of the aircraft, including the engines, relates to a specific component of the pedagogical model.

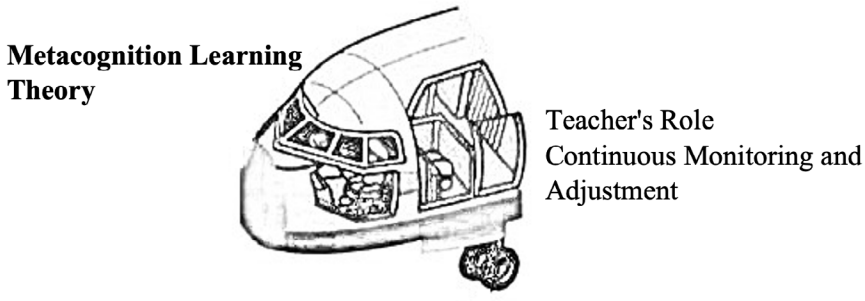
3.4. Cockpit: Teaching Management and Coordination

In *Figure 4*, the cockpit symbolizes the teacher's role in managing and coordinating the educational process. Here, the teacher acts as a facilitator, evaluator, and motivator, using analytical tools to monitor progress and make real-time adjustments.

- Role of the teacher: The teacher guides and supports students, evaluates their progress, and encourages their active participation.
- Continuous monitoring and adjustment: Analytical tools are used to monitor progress, and periodic meetings are held to adjust and improve the educational process.

Figure 4

Management and Coordination in the Cockpit.



Nota. The figure shows how the cockpit aligns with educational management, representing the space from which the teacher directs and supervises the teaching-learning process.

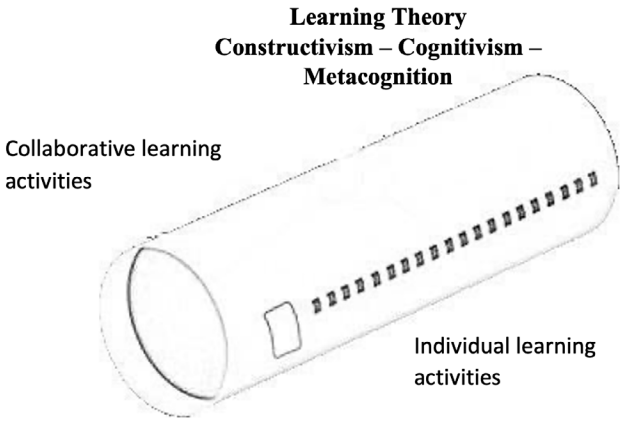
3.5. Aircraft Body: Educational Activities

In *Figure 5*, the body of the plane represents the educational activities the students carried out, both individually and collaboratively. These activities are essential for the practical application of knowledge and the development of skills.

- Actividades de aprendizaje individual: Incluyen lecturas interactivas, simulaciones, laboratorios virtuales, y autoevaluaciones con retroalimentación inmediata.
- Actividades de aprendizaje colaborativo: Se realizan proyectos grupales, foros de discusión, y juegos educativos, que permiten aplicar los conocimientos en un entorno lúdico y motivador.

Figure 5

Educational Activities in the Air Force Corps.



Nota. The figure shows how the body of the aircraft houses the essential educational activities for learning, integrating approaches such as constructivism and connectivism.

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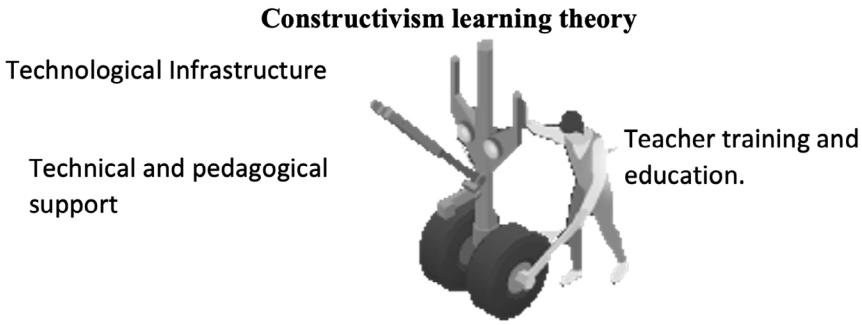
3.6. Airplane Wheels: Fundamental Supports

In *Figure 6* the airplane wheels were shown representing the fundamental supports of the pedagogical model, such as the technological infrastructure, the continuous training of teachers, and the technical and pedagogical support necessary for the effective functioning of the learning environment.

- Technological Infrastructure: Includes internet connectivity, devices, servers, and management software necessary to support the digital learning environment.
- Teacher Training and Education: Continuing education is essential for the effective implementation of the pedagogical model.
- Technical and Pedagogical Support: Provides ongoing assistance to teachers and students, optimizing the use of technology and resolving issues.

Figure 6

Fundamental Supports Represented by the Wheels of the Airplane.



Nota. The figure illustrates how the airplane's wheels represent the support elements that ensure a stable and accessible learning environment.

This MPmTIC pedagogical model, integrating ADDIE, gamification, Technopedagogy, and learning theories, provides a robust and dynamic structure to improve the teaching-learning process. Each part of the aircraft symbolizes different components and roles, ensuring interactive, collaborative, and personalized learning.

Conclusions

This article proposed an innovative pedagogical model mediated by Information and Communication Technologies (ICT), which integrates the ADDIE model and gamification as key strategies for improving educational research. Using a structural analogy with an airplane, several essential pedagogical components were identified and correlated, which can be optimized through this proposal. The main conclusions derived from this study were the following.

The use of an airplane structure as a pedagogical metaphor has proven effective in visualizing and organizing key components of the teaching-learning process. This metaphor facilitated the understanding and planning of the pedagogical model, making the integration of ICT and gamification more accessible in diverse educational contexts. Furthermore, the combination of the ADDIE model with gamification strategies has shown great potential for improving student motivation, engagement, and academic performance. By structuring the educational process into well-defined phases (Analysis, Design, Development, Implementation, and Evaluation) and adding playful elements, learning was more dynamic, engaging, and effective.

The implementation of ICT tools, such as learning management systems (LMS), gamification applications, and collaboration tools, is crucial to modernizing and optimizing the educational process. These technologies not only facilitate content management and distribution but also allow for personalized learning and real-time monitoring of student progress. Teachers play a fundamental role in the implementation of the pedagogical model, acting as facilitators, evaluators, and motivators. The use of analytical tools and the ability to adjust the educational process in real time are critical to ensuring that the model meets its objectives and adapts to students' needs.

Technological infrastructure, ongoing teacher training, and technical and pedagogical support are essential pillars for the sustainability and success of the proposed pedagogical model. Investment in these supports guarantees a robust, accessible, and efficient learning environment. This pedagogical model has the potential to significantly improve the quality and effectiveness of educational research. By providing a structured and dynamic approach, mediated by ICT and reinforced by gamification, students are expected to develop stronger research skills and be better prepared to face the challenges of the academic and professional world.

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