

Original article



Inclusive pedagogical model for students with special educational needs in Information Technology Engineering

Modelo pedagógico inclusivo para estudiantes con necesidades educativas especiales en Ingeniería en Tecnología de la Información

Modelo pedagógico inclusivo para estudantes com necessidades educacionais especiais em Engenharia de Tecnologia da Informação

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ABSTRACT

The inclusion of students with special educational needs in engineering programs constitutes a current challenge for higher education, especially complex in STEM disciplines due to technical rigor and limited curricular flexibility. The aim of this research was to develop an inclusive pedagogical model and a strategy for its implementation in the Information Technology Engineering program of the Faculty of Mathematical and Physical Sciences at the University of Guayaquil, Ecuador. A mixed approach was used that combined the analytic-synthetic, inductive-deductive, historical-logical,

systemic-structural, modeling and Delphi expert criterion methods, complemented by surveys, interviews and observation of teachers, managers and students. The results express a pedagogical model structured around ten scientific ideas that articulate inputs, personal and non-personal components, principles, dimensions (pedagogical, technological and inclusive), cyclical stages, environments and outputs, together with the Inclúyete strategy, comprising six practical products: an awareness program, an inclusive learning tasks manual, a competency-based assessment system, accessible technology hackathons, a teacher training program, and a methodological guide. Expert validation with fifteen specialists through the Delphi method classified eleven of twelve indicators as Highly Suitable. It is concluded that the model and the strategy constitute a relevant, coherent and novel proposal, redefining inclusion as a driver of technical and cultural innovation in engineering education.

Keywords: design; education; engineering; inclusion; learning; pedagogy; strategy.

RESUMEN

La inclusión de estudiantes con necesidades educativas especiales en carreras de ingeniería constituye un desafío contemporáneo en la educación superior, particularmente compleja en disciplinas STEM, por la rigurosidad técnica y la baja flexibilidad curricular. La investigación tuvo como objetivo elaborar un modelo pedagógico inclusivo y una estrategia para su implementación en la carrera de Ingeniería en Tecnología de la Información de la Facultad de Ciencias Matemáticas y Físicas de la Universidad de Guayaquil, Ecuador. Se empleó un enfoque mixto que articuló los métodos análisis-síntesis, inducción-deducción, histórico-lógico, sistémico-estructural, modelación y Delphi de criterio de expertos, complementados con encuestas, entrevistas y observación a docentes, directivos y estudiantes. Los resultados expresan un modelo pedagógico estructurado en diez ideas científicas que articulan entradas, componentes personales y no personales, principios, dimensiones (pedagógica, tecnológica e inclusiva), etapas cíclicas, entornos y salidas, junto con la estrategia Inclúyete, integrada por seis productos prácticos: programa de sensibilización, manual de tareas de aprendizaje, sistema de evaluación competencial, hackathons de tecnologías accesibles, programa de capacitación docente y guía metodológica. La validación con quince expertos mediante Delphi otorgó la categoría de Muy Adecuado a once de doce indicadores. Se concluye que el modelo y la

estrategia constituyen una propuesta pertinente, coherente y novedosa, al redefinir la inclusión como motor de innovación técnica y cultural en la formación de ingenieros.

Palabras clave: aprendizaje; diseño; educación; estrategia; inclusión; ingeniería; pedagogía.

RESUMO

A inclusão de estudantes com necessidades educacionais especiais nos cursos de engenharia constitui um desafio atual para o ensino superior, especialmente complexo nas disciplinas STEM devido ao rigor técnico e à limitada flexibilidade curricular. O objetivo desta pesquisa foi desenvolver um modelo pedagógico inclusivo e uma estratégia para sua implementação no curso de Engenharia em Tecnologias da Informação da Faculdade de Ciências Matemáticas e Físicas da Universidade de Guayaquil, Equador. Foi utilizado um enfoque misto que combinou os métodos analítico-sintético, indutivo-dedutivo, histórico-lógico, sistêmico-estrutural, de modelagem e critério de especialistas Delphi, complementados por questionários, entrevistas e observação de professores, gestores e estudantes. Os resultados expressam um modelo pedagógico estruturado em torno de dez ideias científicas que articulam insumos, componentes pessoais e não pessoais, princípios, dimensões (pedagógica, tecnológica e inclusiva), etapas cíclicas, ambientes e produtos, juntamente com a estratégia Inclúyete, composta por seis produtos práticos: um programa de sensibilização, um manual de tarefas de aprendizagem inclusivas, um sistema de avaliação baseado em competências, hackathons de tecnologia acessível, um programa de formação de professores e um guia metodológico. A validação por especialistas com quinze especialistas, por meio do método Delphi, classificou onze dos doze indicadores como Altamente Adequados. Conclui-se que o modelo e a estratégia constituem uma proposta relevante, coerente e inovadora, redefinindo a inclusão como um motor de inovação técnica e cultural no ensino de engenharia.

Palavras-chave: aprendizagem; design; educação; engenharia; estratégia; inclusão; pedagogia.

INTRODUCTION

Contemporary higher education faces the ethical and social imperative of becoming a genuinely inclusive space, in response to legal mandates such as the Convention on the Rights of Persons with Disabilities (Naciones Unidas, 2006) and the Sustainable Development Goals, particularly SDG 4 on quality, equitable and inclusive education. The paradigm has shifted from the mere physical integration of students with special educational needs (SEN) toward a model of deep inclusion that requires restructuring the training process to guarantee access, participation and academic success for the full diversity of the student body (Ainscow, 2020; Booth & Ainscow, 2015).

This conceptual shift converges with the consolidation of the social model of disability, which locates barriers in the conditions of the environment (Palacios, 2008), and with the spread of Universal Design for Learning (UDL), a curricular framework that proposes multiple means of representation, action, expression and engagement. The integration of both approaches provides a solid basis for building training processes that are accessible by design, without resorting to reactive adaptations.

However, translating these principles to STEM programs presents particular challenges. The highly specialized, technical and abstract nature of Information Technology Engineering creates multifaceted barriers that limit the participation of students with SEN, expressed in non-adapted laboratories and platforms, the conceptual complexity of subjects such as algorithms and computer architecture, highly visual or auditory content, incompatibility between specialized software and assistive technologies, and standardized assessments that do not take diverse paces or styles into account (Moriña & Orozco, 2020; Sánchez Díaz & Morgado, 2022). In addition, there is insufficient teacher training in inclusive pedagogical strategies specific to the technical field, which inadvertently perpetuates exclusionary practices.

In Ecuador, regulatory progress coexists with a considerable gap between the legal framework and its practical implementation. Although several universities have set up support units, attention to diversity in the classroom is often incipient and disconnected from a deep transformation of teaching and academic management. In the Information Technology Engineering program at the University of Guayaquil, the preliminary diagnosis confirmed that the training process does not consider the learning of students with SEN from its design, that teaching activities and assessment systems follow

a single model, and that educational resources are not designed according to principles of universal accessibility.

The specialized literature on university inclusion is abundant in its axiological and normative dimensions, but there are few comprehensive proposals that systemically articulate pedagogical, technological and cultural components in the specific context of computer engineering programs (Moriña, 2017). This article addresses that gap by presenting two central contributions of a doctoral research project: an inclusive pedagogical model and the Inclúyete strategy for its implementation. The objective is to present the theoretical conception, the systemic structure and the practical products that combine equity and technical excellence in the training of Information Technology engineers, as well as the results of their scientific validation by expert judgment.

MATERIALS AND METHODS

The research adopted a mixed, explanatory and propositional approach, grounded in the dialectical-materialist paradigm, and integrated theoretical and empirical methods. The study was carried out between 2023 and 2025 in the Information Technology Engineering program of the Faculty of Mathematical and Physical Sciences at the University of Guayaquil, Ecuador. The population consisted of teachers, managers and students linked to the academic program, with an emphasis on those with institutionally identified special educational needs.

The analysis-synthesis method was used to break down conceptual, theoretical and historical information on educational inclusion and the diagnostic results, and to integrate the essential elements into a holistic understanding of the problem and the proposed model. The induction-deduction method made it possible to infer regularities from contextual observations and, conversely, to apply general principles of inclusive education to the field of Information Technology Engineering. The historical-logical method was used to reconstruct the evolution of the inclusion process in higher education, identifying trends and stages that made it possible to place the proposal on a coherent timeline.

The systemic-structural method was key to analyzing the object of research as a system of interrelated components, which facilitated the determination of the theoretical bases and the articulated conception of the implementation strategy. The modeling method enabled the abstract

representation of the inclusive pedagogical model through ten scientific ideas that organize its components, relationships and internal dynamics.

The empirical methods included surveys of 86 students and 32 teachers; semi-structured interviews with six academic managers and administrators; and structured observation of 18 class sessions in laboratories and classrooms. The instruments were subjected to content validation by specialists and to pilot testing before being applied. The information was processed through methodological triangulation and thematic analysis supported by emerging categories.

The scientific validation of the model and the strategy was carried out using the Delphi method of expert judgment, following the canonical procedure described by Landeta (1999). The self-assessment questionnaire was applied to determine the Competence Coefficient ($K = \frac{1}{2}K_c + K_a$) in an initial sample of 22 candidates. Fifteen experts with $K \geq 0.80$ were selected, from Ecuador, Cuba, Mexico and Colombia, with experience in university pedagogy, educational inclusion, computer engineering and instructional design. Two successive questionnaires with twelve indicators were applied: six for the model (T1-T6) and six for the strategy (P1-P6), rated on a five-category scale: Very Adequate, Quite Adequate, Adequate, Somewhat Adequate and Inadequate. The ratings were processed using the cumulative relative frequency technique and comparison with cut-off points, complemented by a qualitative analysis of the comments.

The ethical principles of research with human beings were respected through informed consent, confidentiality, voluntary participation and the right to withdraw from the study. The protocol was approved by the unit's academic management, and the anonymity of the participants was guaranteed in the presentation of results.

RESULTS

The model is organized into ten scientific ideas that form a coherent system. The first idea establishes the inputs of the model, based on the personalized diagnosis of physical, cognitive and socio-emotional barriers; flexible curricula grounded in UDL; specialized teacher training in inclusive strategies and assistive technologies; and an academic culture that values diversity as a driver of innovation. The second idea conceptualizes the inclusion process for students with SEN in the program as a dynamic and multidimensional system which, grounded in principles of equity and social justice, seeks to guarantee access, participation, academic success and socio-emotional

integration through the articulated transformation of institutional, pedagogical and technological structures.

The third idea sets out the non-personal components: technical content diversified through multiple representations; active methods such as project-based and challenge-based learning; means supported by assistive technologies and accessible platforms; flexible organizational forms; and inclusive competency-based assessment with multidimensional rubrics. The fourth idea identifies the personal components and their interacting roles, with students with SEN as active subjects and co-authors, teachers as facilitators of inclusive learning, educational support staff, classmates, families and university authorities, forming a co-responsible ecosystem.

The fifth idea formulates four guiding principles: equity with technical excellence and universal accessibility; active participation and innovation from diversity; specialized teacher training and systemic collaboration; and flexible assessment with an inclusive competency-based approach. These principles sustain the internal coherence of the model and guide decision-making at each stage of its implementation. The sixth idea structures three complementary and interdependent dimensions: the pedagogical dimension, which guides how to teach, active methods and teacher training; the technological dimension, which represents the with what, expressed in accessible environments, assistive technologies and inclusive platforms; and the inclusive dimension, which provides the what for, embodied in policies, values and relational dynamics.

The seventh idea organizes the process into four cyclical stages, starting from the institutional and personalized diagnosis; the design and implementation of systemic adaptations; the participatory execution of inclusive practices; and continuous improvement based on feedback. The eighth idea defines the educational environment on three articulated planes: physical, virtual and socio-emotional. The ninth idea establishes the outputs of the model, expressed in technically competent and socially sensitive professionals, teachers trained in inclusive pedagogies, institutions with sustainable policies and resources, and accessible technological solutions generated from diversity. The tenth idea integrates the whole into a systemic conceptualization that redefines inclusion as a driver of technical and cultural innovation.

The Inclúyete strategy is the practical contribution that operationalizes the model. It starts from a situational diagnosis synthesized in a SWOT matrix, from which four strategic lines are derived: offensive, defensive, adaptive and survival. Its general objective is to support the practical

implementation of the inclusive pedagogical model in the Information Technology Engineering program, and it is specified in five specific objectives linked to six products.

The first product is the Student Awareness Program "Connected through Inclusion", aimed at transforming student culture through four axes: communication, dialogue, experience and recognition. The second product is the Inclusive Learning Tasks Manual, which offers multisensory guides for breaking down algorithms, data structures and network protocols using haptic, auditory and visual resources, with differentiated role protocols and links to accessible platforms such as GitHub or H5P.

The third product is the Inclusive Competency-Based Assessment System, which combines multidimensional rubrics, digital portfolios, practical assessments in real contexts and multi-format feedback, weighing both the algorithmic efficiency and the accessibility of the solutions developed. The fourth product, the Accessible Technology Hackathons, are collaborative innovation events in which students with and without SEN develop solutions to real digital accessibility problems, which gives concrete form to the inclusive dimension by positioning students with SEN as co-authors of technology.

The fifth product is the Teacher Training Program in Inclusive STEM Pedagogy, structured in modules on theoretical foundations, UDL applied to technical content, assistive technologies, inclusive competency-based assessment and the design of inclusive projects. The sixth product, the Methodological Guide for Systemic Implementation, links the previous products with stages, indicators and monitoring mechanisms, ensuring coherence between the dimensions of the model and the institutional actors.

The proposed model and the strategy for its implementation were theoretically validated using the Delphi method of expert judgment. The validation process was applied to 15 experts with a Competence Coefficient $K \geq 0.80$ (10 with $K \geq 0.90$, considered highly competent; 5 with K between 0.80 and 0.89, of medium-high competence). Six indicators of the model were evaluated (conceptual relevance; systematicity; coherence between dimensions; UDL-social model integration; feasibility in other STEM programs; cross-cutting scientific novelty) and six of the strategy (relevance to the diagnosis; coherence with the model; clarity of stages; relationship between practical products and barriers; contextual feasibility; cross-cutting scientific novelty).

Eleven of the twelve indicators were rated Very Adequate and only two, feasibility in other STEM programs and contextual feasibility, were rated Quite Adequate, with no indicator falling into the lower categories. The qualitative analysis of the comments converged with the quantitative results. The experts highlighted as the central contribution the redefinition of inclusion as a driver of technical and cultural innovation; recognized the solid integration between the social model of disability and UDL; and valued the link between the Accessible Technology Hackathons and curricular training. The more cautious observations focused on the transferability of the model to different institutional contexts and on making explicit the minimum conditions for its implementation. A second Delphi round was not required, in accordance with the canonical procedure.

DISCUSSION

The model was grounded in the interdisciplinary articulation of five theories. Álvarez de Zayas's (1999) Theory of Conscious Processes provides the conception of learning as a conscious, reflective and participatory act, in which students move from dependence to cognitive autonomy through a dialectical process of planning, execution and evaluation.

Booth and Ainscow's (2015) Theory of Educational Inclusion guides the proactive removal of barriers and the systemic transformation of cultures, policies and practices. Leontiev's (1993) Activity Theory emphasizes the social and technological mediation of learning, which is particularly relevant given the central role of assistive technologies.

Ausubel *et al.*'s (1983) Theory of Meaningful Learning ensures the connection between technical content and students' prior experience. Finally, Deci and Ryan's (2000) Self-Determination Theory contributes the motivational dimensions of autonomy, competence and relatedness, which are essential for sustaining the engagement of students with SEN in demanding academic environments.

The results confirm the relevance of systemically articulating UDL and the social model of disability as an epistemological foundation for designing inclusive training processes in STEM programs, a finding consistent with the most recent literature, which warns of the inadequacy of isolated adaptations and calls for systemic transformations (Moriña, 2017; Sánchez Díaz & Morgado, 2022). The originality of the proposal lies in overcoming the dilemma, frequently raised in engineering education, between technical rigor and educational equity. By integrating accessibility and functional

diversity as criteria of technical quality, the model defuses the tension between the two extremes and presents them as complementary dimensions of contemporary professional education.

The structure of the model engages productively with previous proposals. The conceptualization of the inclusion process as a dynamic and multidimensional system draws on elements of Booth and Ainscow (2015), but enriches them by translating them into the didactic language of personal and non-personal components and by specifying principles and stages according to the particular features of learning information technology. The central role given to technological mediation, grounded in Leontiev (1993) and operationalized in assistive technologies and accessible platforms, coincides with contemporary trends in the design of virtual environments.

The diagnostic findings, namely insufficient teacher training, inaccessible infrastructure, informal adaptations and non-explicit policies, are consistent with those reported by Moriña and Orozco (2020) in Ibero-American universities, which suggests that the barriers detected in Guayaquil are not an isolated phenomenon but a regional manifestation with structural causes. By combining cultural awareness, inclusive learning tasks, competency-based assessment, *hackathons*, teacher training and a methodological guide, the Inclúyete strategy responds to these barriers in an articulated way and goes beyond the fragmented interventions documented in the literature.

A specific contribution of the practical proposal is the incorporation of Accessible Technology Hackathons as a learning space, where students with SEN stop being the object of adaptations and become co-authors of technology. This reversal of roles operationalizes the principle of Active Participation and Innovation from Diversity and aligns with the perspective of disability studies, which recognizes persons with disabilities as producers of situated knowledge (Palacios, 2008).

The experts' reservations regarding the transferability of the model to other STEM programs and its contextual feasibility are not a substantive weakness, but rather a prudent consensus on the limits inherent in any situated pedagogical proposal. These observations coincide with the methodological principle of pedagogical contextualization and open lines of future work toward adapting the model to related engineering programs such as mechatronics, biomedical and industrial engineering; making explicit the minimum institutional conditions for its implementation; and developing specific rubrics that recognize functional diversity without returning to a deficit-based approach.

Among the limitations of the study, it should be noted that validation was carried out through expert judgment and did not include an experimental implementation process measuring the impact on learning. Although the Delphi method provides theoretical consistency and recognized feasibility, future studies should complete the cycle with pilot tests and longitudinal case studies that evaluate the effects of the model on academic, socio-emotional and employment indicators.

The contextual scope of the proposal calls for caution in generalization and opens opportunities for comparative research in other regions and educational modalities.

REFERENCES

- Ainscow, M. (2020). Promoting inclusion and equity in education: Lessons from international experiences. *Nordic Journal of Studies in Educational Policy*, 6(1), 7-16.
<https://doi.org/10.1080/20020317.2020.1729587>
- Álvarez de Zayas, C. M. (1999). *La escuela en la vida: Didáctica*. Editorial Pueblo y Educación.
https://books.google.com/cu/books/about/La_escuela_en_la_vida.html?id=cU6JAAAACAAJ&redir_esc=y
- Ausubel, D. P., Novak, J. D., & Hanesian, H. (1983). *Psicología educativa: Un punto de vista cognoscitivo*. Trillas. <https://books.google.com/cu/books?id=2sQmPAAACAAJ>
- Booth, T., & Ainscow, M. (2015). *Guía para la educación inclusiva: Desarrollando el aprendizaje y la participación en los centros escolares* (G. Echeita Sarrionandia, C. Simón Rueda, & M. Sandoval Mena, Trans.). FUHEM Ecosocial.
https://www.fuhem.es/media/educacion/File/Guia_Educacion_Inclusiva_FUHEM.pdf?srsId=AfmBOopGFufrrgKv-QiHPC-nFzReLEYObOZ7G5aqNk0FGXPobyVYadJG
- Deci, E. L., & Ryan, R. M. (2000). The «what» and «why» of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, 11(4), 227-268.
https://doi.org/10.1207/S15327965PLI1104_01
- Landeta, J. (1999). *El método Delphi: Una técnica de previsión del futuro*. Ariel.
<https://books.google.com/books?id=yJWBPwAACAAJ>

Leontiev, A. N. (1993). *Actividad, conciencia y personalidad*. El sudamericano.

<https://www.marxists.org/espanol/leontiev/180.leontiev-web2.pdf>

Moriña, A. (2017). Inclusive education in higher education: Challenges and opportunities. *European Journal of Special Needs Education*, 32(1), 3-17.

<https://doi.org/10.1080/08856257.2016.1254964>

Moriña, A., & Orozco, I. (2020). Facilitating the retention and success of students with disabilities in health sciences: Experiences and recommendations by nursing faculty members. *Nurse Education in Practice*, 49, 102902. <https://doi.org/10.1016/j.nepr.2020.102902>

Naciones Unidas. (2006). *Convención sobre los derechos de las personas con discapacidad*.

OHCHR. <https://www.ohchr.org/es/instruments-mechanisms/instruments/convention-rights-persons-disabilities>

Palacios, A. (2008). *El modelo social de discapacidad: Orígenes, caracterización y plasmación en la Convención Internacional sobre los Derechos de las Personas con Discapacidad*. CERMI.

<https://www.uv.mx/cendhiu/files/2021/11/Elmodelosocialdediscapacidad.pdf>

Sánchez Díaz, M. N., & Morgado, B. (2022). Moving toward the Inclusion of University Students with Disabilities: Barriers, Facilitators, and Recommendations Identified by Inclusive Faculty. *The Journal of Continuing Higher Education*, 70(3), 175-191.

<https://doi.org/10.1080/07377363.2021.1946635>

Conflict of interest

The authors declare no conflicts of interest.

Author contributions

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



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