

Integrating Educational Technologies into Business and Management Programs: A Model for Vocational and Technological Education

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Abstract

Digital transformations and advances in educational technologies have directly impacted teaching and learning processes, particularly within the context of Vocational and Technological Education (VTE). This educational modality, predominantly offered by the Federal Institutes, aims to train professionals capable of working in strategic sectors of the economy by integrating technical knowledge and innovation. Despite the potential of digital technologies, their pedagogical application remains limited, partly due to the lack of structured models to guide their curricular integration. This study aimed to develop a replicable technological integration model for Business Administration, Accounting, and Logistics programs, grounded in the identification of educational technologies with potential for pedagogical application. A quali-quantitative approach was adopted in four stages: systematic literature review, patent and software prospecting, analysis of curricular matrices, and model development. The study identified 160 patents and 560 software solutions with potential educational use, organized by thematic area and correlated with 263 courses offered within the Brazilian Federal Network of Professional, Scientific, and Technological Education. The results indicate technologies applicable to digital management, accounting automation, smart logistics, and active learning methodologies, with emphasis on tools related to strategic planning, goods tracking, and financial education. The analysis also identified structural and institutional limitations, including the need for faculty training and resistance to the adoption of new digital tools. Based on these findings, the proposed model is structured around five integrated pillars: identification of technologies, development of a teaching resource repository, continuing professional development, institutional partnerships, and outcome evaluation, providing operational guidelines for the planned integration of educational technologies in VTE. It is concluded that the planned adoption of the model can enhance professional training, align education with productive sector demands, and strengthen the role of educational institutions as promoters of innovation.

Keywords: Educational innovation; Vocational and technological education; Business education; Technology foresight; Curricular integration.

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1 Introduction

The advancement of digital technologies and the transformation of access to information have profoundly impacted education, particularly by fostering innovation in teaching and learning practices (Akour & Alenezi, 2022). The digitalization of knowledge and the growing adoption of Information and Communication Technologies (ICT) have extended learning beyond the physical boundaries of the classroom, promoting more interactive, personalized, and efficient educational models (Raja & Nagasubramani, 2018). However, this shift has also revealed structural asymmetries in infrastructure, access, and pedagogical preparedness, especially within public education systems, hindering the broader and more effective adoption of digital tools (Boeskens & Meyer, 2025).

In this context, Vocational and Technological Education (VTE) represents a strategic environment for the integration of educational technologies. In Brazil, VTE is primarily offered by the Federal Institutes of Education, Science, and Technology (IFs), institutions with vertically integrated curricula and curricular flexibility designed to meet regional and productive needs. This modality aims to prepare professionals for strategic sectors of the economy by combining theoretical and practical knowledge (Ramos, 2022). In addition to workforce preparation, VTE also seeks to equip students to address the demands of digital transformation and innovation in business and society, fostering scientific-technological literacy and contributing to national development (Castaman & Rodrigues, 2021).

According to the Nilo Peçanha Platform (Brasil, 2024), a virtual environment for collecting and disseminating official data from the Brazilian Federal Network of Professional, Scientific and Technological Education, the Business and Management axis, which includes programs in Administration, Accounting, and Logistics, is one of the most prominent in terms of program offerings and student enrollment.

Despite this institutional potential, the integration of educational technologies into VTE programs still faces significant challenges. Faculty training remains limited, particularly in Business and Management, where pedagogical practices focused on innovation are uncommon and experience with active methodologies is scarce (Boaventura et al., 2018; Favacho, 2023). In the early stages of this study, the absence of systematic mapping of educational technologies applicable to these fields was observed, which motivated the research.

In addition, institutional strategies for identifying and integrating such technologies remain fragmented or incipient, resulting in a gap between the availability of digital tools and their pedagogical use (Fontoura et al., 2023). These challenges highlight the need for structured models to support the integration of educational technologies aligned with curricular demands and labor market trends. Currently, no consolidated framework exists to guide the systematic incorporation of patents, software, and digital innovations into VTE pedagogical practices.

Given this scenario, this study seeks to answer the following research question: Which educational technologies can be integrated into the teaching of Business and Management programs in VTE? To address this question, the study conducted a technological prospecting of patents and software relevant to the teaching of Administration, Accounting, and Logistics, aiming to identify pedagogically applicable solutions.

The general objective is to develop a model for integrating educational technologies into Business and Management programs in VTE. The specific objectives are to: (i) conduct a systematic review of the literature on educational innovation in these programs; (ii) identify and classify patents and software applicable to teaching in these fields; (iii) analyze curricular matrices

and faculty profiles to assess implementation feasibility; and (iv) propose a replicable model for technological integration that can be adopted by different institutions.

This article is structured as follows: Section 2 presents the theoretical framework on technological innovation in VTE and its application in Business and Management education. Section 3 details the methodological procedures, including the systematic literature review, technological prospecting of patents and software, curriculum analysis, and development of the integration model. Section 4 presents the main findings, discusses pedagogical applications, curricular implications, and faculty training challenges, and proposes the integration model. Section 5 concludes the study and offers suggestions for future research.

2 Theoretical framework

2.1 Technological innovation in vocational and technological education (VTE)

VTE has established itself as a fundamental pillar for economic and social development, preparing professionals for a dynamic and highly competitive labor market (Dornelles et al., 2021). Unlike traditional education, which often focuses on the accumulation of theoretical knowledge, VTE emphasizes the integration of theory and practice, allowing students to acquire technical skills applicable to their future professional activities (Duarte Filho & Rodrigues, 2023). In the context of programs within the Business and Management technological axis, this approach becomes even more relevant, considering the need to train administrators, accountants, and logistics professionals capable of facing contemporary challenges.

The Federal Institutes of Education, Science, and Technology (IFs) play an essential role in offering technical and higher education programs focused on VTE. In addition to promoting quality education, these institutions aim to act directly in regional development by aligning with the needs of the productive sector (Aquino et al., 2021). This connection ensures that academic programs remain aligned with market demands while also fostering innovation and the generation of new knowledge (Coradini & Vidor, 2021).

From a methodological standpoint, VTE has incorporated innovations that go beyond conventional teaching. The use of active learning methodologies, for example, has been widely discussed as an effective strategy to improve the teaching and learning process. According to Oliveira et al. (2020), methodologies such as problem-based learning, blended learning, and gamification can make learning more dynamic and meaningful. These approaches not only stimulate critical thinking and student autonomy but also encourage more active participation in the knowledge-building process itself (Soliani et al., 2024).

The advancement of digital technologies has also led to a transformative scenario in vocational and technological education. Tools such as virtual learning environments, artificial intelligence, and augmented reality are already being used to make education more interactive and aligned with contemporary business practices (Bezerra et al., 2024). This movement reflects an increasing need to prepare students for a highly digitalized market, in which technological proficiency has become a key competitive advantage (Sobrinho & Rivera, 2021).

In this context, the Federal Institutes have stood out in adopting educational technologies, promoting the transversality of knowledge and curricular verticalization. Transversality refers to the integration of multiple areas of knowledge within professional education, allowing students to develop a broader and more interdisciplinary view of labor market challenges (Favacho, 2023). Verticalization, in turn, enables a structured academic progression, from technical courses to postgraduate programs, promoting continuous education aligned with the needs of the productive sector (Bonfante & Schenckel, 2020).

The combination of pedagogical innovation and the use of technologies in VTE strengthens student training, preparing them not only to work in the market but also to contribute with new solutions and innovative practices in their respective fields (Fontoura et al., 2023). However, for this process to be effective, a continuous effort is needed in researching and implementing educational technologies that can enhance the learning experience.

In this regard, the present study aims to contribute to this discussion by investigating the impact of technological innovation on teaching in Business and Management programs, with an emphasis on identifying and applying concrete technologies, such as patents and software, to improve pedagogical practices. Technological prospecting represents an effective approach to mapping existing innovations and assessing their potential for integration into education. This process helps identify technological trends in the sector and select tools capable of optimizing learning, making it more aligned with market demands and narrowing the gap between theory and practice.

2.2 Educational applications of patents and software in business and management programs

Technological innovation has been central to the transformation of higher and technical education, promoting new forms of teaching and learning. In this context, technological prospecting constitutes a strategy for identifying and analyzing emerging technologies with the potential to be integrated into educational environments, enabling the selection of innovative solutions and aligning education with market demands and digital transformations (Bozkurt, 2020).

In programs within the Business and Management technological axis, the adoption of patents and specialized software has proven effective in modernizing educational practices and bridging academic training with professional reality (Carmo et al., 2025; Mohammadi et al., 2025). Studies indicate that incorporating these technologies into teaching allows students to explore concepts and processes even before entering the job market, as they simulate real scenarios and foster the development of practical skills in a controlled environment (Soliani et al., 2025; Velez & Alonso, 2025).

In the field of Business Administration, business management software, artificial intelligence applied to decision-making, and strategic planning systems are widely used by companies and can be adapted as educational tools (Molina, 2017). The simulation of administrative scenarios within the academic setting enables students to understand business dynamics and develop essential skills for their professional performance (Sivarajah et al., 2019).

In Accounting education, the use of specialized software has been fundamental in bridging theory and practice. Tools that automate accounting entries, generate financial reports, and perform digital audits not only streamline processes but also help train professionals who are better prepared to handle the sector's challenges (Sidorova et al., 2024). The analysis of patents focused on accounting innovations allows for the identification of technological trends that can be incorporated into teaching, promoting more up-to-date learning aligned with market transformations.

In the field of Logistics, technologies such as goods tracking systems, artificial intelligence for demand forecasting, and inventory management software have revolutionized the sector by optimizing operations and reducing costs (Mathieson, 2019). The adoption of these tools in educational settings enables students to develop technical skills more aligned with market needs, making them more qualified professionals capable of responding to the evolving demands of the logistics sector (Castaman & Rodrigues, 2021).

Although educational technologies bring clear benefits, their implementation in VTE still faces challenges. The lack of teacher training, resistance to adopting new tools, and limitations in

educational infrastructure hinder their integration into teaching (Duque et al., 2024). Teachers' resistance largely stems from the absence of continuing education and a lack of technical support, which creates insecurity in using new methodologies. The fear of pedagogical changes and the perception that technology might compromise traditional practices also reinforce this resistance.

The incorporation of patents and software into Business and Management programs is not merely a methodological innovation but a necessity to align professional training with transformations in the labor market. Akram et al. (2022) emphasize that the effective adoption of educational technologies requires the development of digital competencies by educators and institutional policies that encourage this transition. The absence of adequate infrastructure and the lack of institutional incentives make this process difficult, highlighting the need for structured planning to make their application in pedagogical practice feasible.

The success of this transition depends on overcoming these barriers and implementing strategies that enable the effective use of these technologies in education. The following section presents the methodological procedures adopted to map these innovations and assess their applicability in the context of VTE.

3 Methodology

This study was designed to answer the following research question: Which educational technologies can be integrated into the teaching of Business and Management programs in VTE? To this end, we adopted an applied research approach, as the study seeks to offer a solution with practical applicability to teaching in VTE, according to the definition by Ma et al. (2023). Methodologically, it is characterized as a qualitative-quantitative study that combines both approaches to provide a broader understanding of the investigated phenomenon (Machado, 2023). This approach allows for the combination of numerical data interpretation with in-depth exploration of subjective and contextual aspects, which is essential for identifying and categorizing technological innovations applicable to the teaching of Business Administration, Accounting, and Logistics.

The research was developed in four main stages, organized to ensure scientific rigor and alignment with the study's objectives: (i) systematic literature review (SLR) to theoretically support the relationship between technological innovation and teaching in VTE; (ii) technological prospecting to map patents and software that can be used in teaching these areas; (iii) curriculum analysis to identify common content in Business and Management courses; and (iv) proposal of a replicable model designed to facilitate the adoption of these technologies by other institutions. Figure 1 illustrates the methodological roadmap followed.

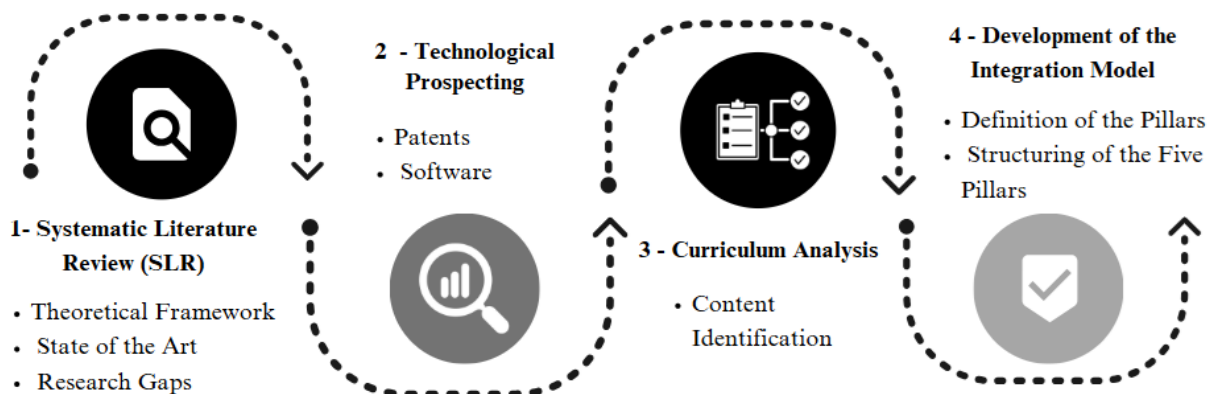


Figure 1: Methodological roadmap of the research. Source: Prepared by the authors (2025).

Figure 1 summarizes the methodological flow adopted in the study, which combines qualitative and quantitative stages to ensure rigor and practical applicability of the results. Based on this roadmap, the research was organized into four main fronts: systematic literature review, technological prospecting, curriculum analysis, and the development of the model.

3.1 Systematic literature review (SLR)

The SLR review was conducted based on the methodological guidelines proposed by Shaffril et al. (2021), ensuring coherence and rigor in the selection and analysis of sources. Its objective was to provide a theoretical foundation for the study by contextualizing the relationship between technological innovation and teaching in VTE, with a specific focus on Business and Management programs. It also sought to identify gaps in the scientific literature regarding educational practices and technologies, guiding the criteria for technological prospecting and model formulation.

Searches were conducted in the CAPES Journals Portal, SciELO, and Web of Science databases. The CAPES Portal was selected for its extensive national and international collection with institutional access; SciELO for its qualified journals with an emphasis on Latin American contexts; and Web of Science for its global coverage and rigorous indexing criteria. Boolean descriptors were used to refine results and ensure the relevance of the publications analyzed.

The search terms included combinations such as: ("educational innovation" OR "technological innovation") AND ("vocational education" OR "professional education" OR "technological education"); ("educational patents" OR "patents AND teaching") AND ("business management" OR "administration" OR "accounting" OR "logistics"); ("educational software" OR "educational technologies") AND ("business and management" OR "administration" OR "accounting" OR "logistics"); ("Vocational and Technological Education" OR "VTE") AND ("technological innovation" OR "active methodologies"); ("problem-based learning" OR "gamification" OR "blended learning") AND ("technical courses" OR "technological higher education"); and ("emerging technologies" OR "digital tools") AND ("business and management education").

The search considered articles published between 2015 and 2025, a period selected to reflect the most recent trends in teaching and technological innovation. Studies available in Portuguese and English were included. Portuguese was prioritized for its alignment with the institutional context and research audience, while English publications broadened the scope of analysis, incorporating relevant contributions from international literature. Only peer-reviewed publications addressing the application of technological innovations in the teaching of Business and Management, VTE, and the use of patents and educational software were selected. Non-peer-reviewed papers, conference proceedings without full texts, and studies that addressed innovation in education without a specific focus on Business and Management were excluded.

The review also included analysis of institutional websites from VTE institutions to gather curricular matrices of Business and Management programs. Additionally, the Nilo Peçanha platform was consulted, which compiles statistics from the Federal Network of Professional, Scientific and Technological Education, providing data on course offerings and student profiles (Brazil, 2024).

3.2 Technological prospecting

The aim of technological prospecting was to identify patents and software with potential applications in the teaching of Business and Management courses. The patent search was carried out on Google Patents, using Boolean operators to refine results. This database was chosen for its free access, usability, and broad international coverage, and it is widely used in studies on

technological innovation (Lee & Hsiang, 2020). To ensure the relevance of the patents analyzed, inclusion and exclusion criteria were applied, considering only records related to the field of Business and Management with direct or adaptable educational application. Duplicate documents, records with unclear applicability, and patents unrelated to educational contexts were excluded.

The software search followed the same methodological logic and was conducted in the database of the National Institute of Industrial Property (INPI, 2024). Specific terms related to business management, accounting, logistics, and finance were used, focusing on identifying technological solutions compatible with educational environments.

Table 1 presents the patents and software selected, considering their relevance to the course content in Administration, Accounting, and Logistics and their academic application potential.

Table 1: Distribution of selected patents and software

Business management area	Patents	Software
Accounting and Finance	29	125
Administration and Education	63	387
Logistics	68	48
Total	160	560

Source: Prepared by the authors (2025).

Some records focused on education were allocated to the Administration area, while technologies related to finance were grouped under Accounting, considering their thematic proximity. The identification of patents and software applicable to the teaching of Business Management was accompanied by an analysis of their correspondence with the courses offered, a necessary step to assess their applicability within the context of VTE. This correlation made it possible to examine the potential of these technologies in developing the intended competencies, aligning curricular content with the demands of the productive sector.

Based on this approach, the data extracted from patents and software were compared to the courses identified in the curricula of programs offered by the Federal Institute of Acre (IFAC) and other institutions in the Federal Network. This survey allowed for the identification of recurring content, serving as a reference for the analysis of the mapped technologies.

In the next step, the patents underwent a screening process to assess their applicability to education and were organized into four main areas. The content of the records was then analyzed in relation to the most frequent courses, identifying both direct applications and possibilities for adaptation to the educational context. The same procedure was applied to the software, considering their functionality and academic feasibility.

3.3 Curriculum analysis

The objective of the curriculum analysis was to identify the most common courses in Administration, Accounting, and Logistics programs, establishing connections with the mapped technological innovations. Understanding the relationship between the content addressed in academic training and the available technological solutions enabled the development of a replicable model for integrating patents and software into VTE teaching.

Curricula from technical and higher education programs in the Business Management axis offered by the Federal Network of Vocational, Scientific and Technological Education (EPCT) were examined. Document collection was conducted through institutional websites and the Nilo Peçanha Platform, ensuring a representative snapshot of the national context. Courses were

classified and organized by thematic area, which allowed the identification of common content across different programs and modalities. This organization enabled the correlation of the analyzed courses with the technologies identified in the patent and software prospecting, creating an overview of innovations applicable to teaching.

To establish this correlation, three main criteria were considered. The first was thematic relevance, which assessed the compatibility between the mapped technologies and the content covered in each course. Next, the feasibility of use was evaluated, taking into account the possibility of adopting these technologies in the academic context, considering aspects such as accessibility, available infrastructure, and compatibility with existing pedagogical methodologies. Finally, the innovation potential was examined, analyzing the expected impact on student qualification and alignment with labor market demands.

This process deepened the relationship between teaching and technological innovation, enabling the construction of a replicable model for adopting educational technologies in VTE. The analysis highlighted the potential of patents and software to enhance pedagogical practices, promoting more interactive methodologies aligned with the demands of the digital economy. The results provided the foundation for a model that facilitates the integration of these innovations into teaching, making professional training more dynamic and attuned to current market requirements.

3.4 Development of the technological integration model

Based on the analysis of the curricula of the Administration, Accounting, and Logistics programs and the results of the technological prospecting, we developed a replicable model for the incorporation of technological innovations into the teaching of Business Management. The proposal is aligned with the regulatory structure of the Federal Institutes, which already have innovation policies and institutional mechanisms aimed at transferring technologies to the educational context (Munaretti et al., 2025; Silva et al., 2025). The objective of the model is to establish guidelines that support the systematic integration of technologies into pedagogical practices, promoting stronger links between education, innovation, and the labor market.

The definition of the model's pillars was based, following Fernández-Sánchez et al. (2022), on a cross-analysis of two data sets: (i) the content and competencies described in the curricula, organized by field of study; and (ii) the educational technologies identified through the prospecting process, classified according to their applicability to technical and higher technological education. This analysis sought to identify recurring integration patterns between content and technological tools, as well as the institutional conditions required for implementation.

As a result, five structural pillars were defined to guide the model: identification of applicable technologies, repository of teaching resources, faculty training, partnerships with companies and startups, and continuous evaluation of results. These pillars represent the essential dimensions for the planned and effective integration of technological innovations into Business Management education. A detailed presentation of each pillar, along with its practical application, will be discussed in the following section, together with an illustration of the proposed model.

4 Results and discussion

The results presented below reflect the mapping and analysis of technologies with potential application in VTE teaching, focusing on programs in the Business Management field. The investigation included the identification of educational patents and software, characterization of institutional course offerings in the Federal Network, identification of the most common subjects,

and their correlation with the mapped technologies. The faculty profile was also analyzed, highlighting the training challenges related to the incorporation of innovations into the educational context. Based on these findings, a replicable model of technological integration is proposed to support curriculum modernization and strengthen the link between education, professional practice, and innovation.

4.1 Patents

Patents play a fundamental role in protecting intellectual property and promoting innovation by guaranteeing exclusivity over an invention for a specified period. In Brazil, patents are classified as Invention Patents (PI), which protect new technical solutions to a problem, and Utility Models (MU), which refer to improvements in existing products or processes (INPI, 2024).

The analysis identified a total of 160 patent applications related to the Business Management field. For analytical purposes, these records were organized into three thematic categories, as shown in Table 1: Logistics (42%), Administration and Education (39%), which includes patents related to didactic methods and administrative solutions, and Accounting and Finance (18%).

The predominance of the Logistics area reflects increased demand for technological solutions focused on goods tracking, supply chain optimization, and automation of transportation processes. The Administration and Education category includes patents related to both administrative processes and pedagogical innovations, such as educational games, digital platforms, and interactive methodologies applied to the teaching of Business Management. This combination reinforces the role of technology in both the modernization of management and the enhancement of teaching practices.

Figure 2 illustrates the percentage distribution of patent applications across the three areas, highlighting the sectors that most drive the development of innovations applicable to vocational and technological education.

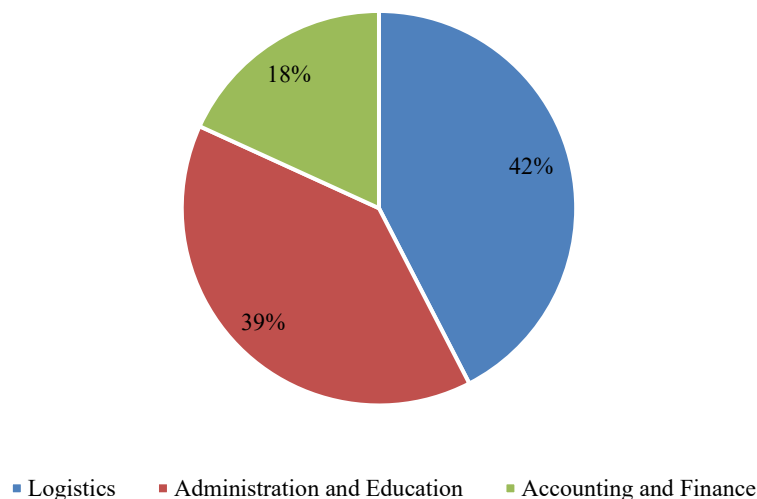


Figure 2: Percentage distribution of patents by thematic area in Business Management. Source: Prepared by the authors (2025).

In the Administration and Education category, patents were identified that integrate advanced technologies with administrative practices and pedagogical strategies. The Humanized Technology System Applied to Business Management (BR-PI1102328-A2) proposes the integration of people, processes, and technology to create more efficient and human-centered

management environments, with potential for simulating organizational scenarios in the classroom. The Business Processing Method (BR-112019007128-A2) offers a systemic approach for optimizing business processes, with potential applications in teaching activities focused on analyzing and redesigning organizational workflows. Another highlight is the Internet-Based System Using Artificial Intelligence for Commercial Analysis (BR-102019004966-A2), which uses invoice data to generate automated analyses and can be used as a teaching tool in entrepreneurship, market analysis, and business intelligence courses.

In the Logistics category, patents were identified that simulate complex processes and offer practical application potential in educational environments. The Computational Platform for Simulating the Logistics Planning of Thermoelectric Plants (BR-102021005749A2) enables real-time testing of logistical decisions through virtual reality, promoting the development of skills such as scenario analysis, planning, and decision-making. The System for Managing Spare Parts Inventory (BR-PI0619359-A2) uses historical demand analysis to optimize inventory control and can be used in educational activities focused on inventory management and demand forecasting. Complementing this set is the System for Logistics of Items and Mobile Container of Boxes (PT3551561T), which can be applied in teaching handling and storage processes, allowing the simulation of logistical flows focused on physical organization, operational efficiency, and safety. These patents support the creation of practical activities that bring students closer to real-world supply chain situations.

In the Accounting and Finance category, patents stand out for their focus on automation, digitalization, and modernization of accounting processes, with potential for educational use at different levels. The Financial Education Method and Systematization (BR-102018071873-A2) proposes a structured approach to teaching personal finance, addressing topics such as budget control, investments, and the time value of money, and is particularly useful for simulations and practical exercises in technical and undergraduate programs. The System and Method for Controlling Digital Assets (BR-112020008454-A2) allows secure management of financial assets in digital environments and can be used in activities involving emerging technologies and understanding digital transactions in accounting. The Accounting Database for Integrated Management (BR-102012033836-A2) provides a platform for unified control of patrimonial and financial information, making it suitable for courses dealing with bookkeeping, cash flow analysis, and the preparation of financial statements.

Of the total patents analyzed, 95% were filed in Brazil, while 5% originated from Portugal. Portuguese patents are mainly concentrated in logistics management systems and educational technologies applied to finance and business management teaching, reinforcing their association with the Logistics and Accounting and Finance areas. Regarding the type of patent, there is a predominance of Invention Patents (PI), which account for 93% of the records, indicating proposals with a higher degree of originality and disruptive character. Only 7% were classified as Utility Models (MU), which focus on functional improvements to existing solutions. This distribution suggests a favorable environment for innovation in the Business Management sector, with an emphasis on original technological solutions for educational and operational challenges.

The historical analysis of the records revealed a consistent growth trend starting in 2011, which accounts for 71% of the applications analyzed. This increase is particularly notable in the Logistics and Administration and Education areas, which together accounted for 77% of the filings from 2011 to 2017 and 79% from 2018 to 2024. This concentration may be associated with the advancement of digital technologies, which have driven the development of solutions aimed at modernizing logistical processes and transforming pedagogical practices in Vocational and Technological Education.

4.2 Computer programs (software)

In addition to patents, 560 computer software records related to the Business Management field were analyzed. Software plays a significant role in the digitalization of business processes and the improvement of educational practices, enabling the integration of digital tools into technical and higher education.

For analytical purposes, the records were organized into three thematic categories aligned with VTE courses: Accounting and Finance (46%), Administration and Education (33%), and Logistics (21%). Figure 3 shows the percentage distribution of these records by area.

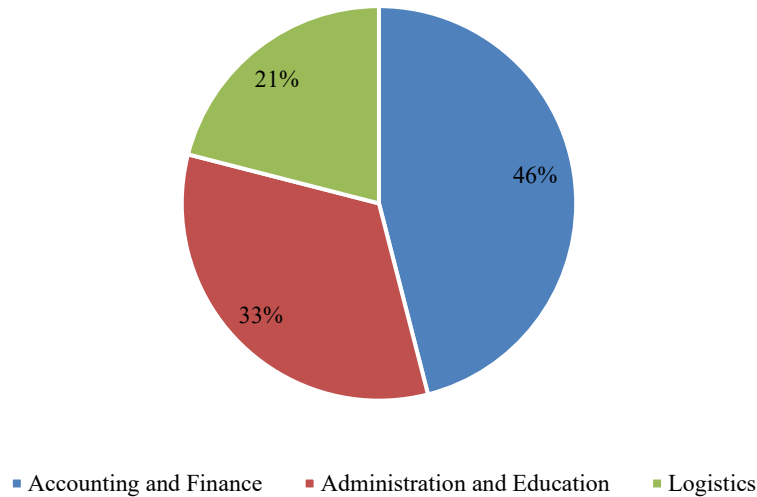


Figure 3: Percentage distribution of software by thematic area in Business Management. Source: Prepared by the authors (2025).

The analysis of the registered software shows substantial progress in the digitalization of financial, logistical, and administrative processes. The Accounting and Finance category holds the majority of the records, reflecting the growing demand for accounting automation, budget control, and the use of artificial intelligence in financial data analysis. In the Logistics category, the dominant systems are those for goods tracking, transport planning, fleet management, and reverse logistics, indicating a continuous interest in technological solutions for operational optimization. The Administration and Education category includes software for human resource management, strategic planning, administrative process automation, and tax organization, as well as technologies focused on pedagogical modernization. Despite the large number of entries in this category, a decline in new tools has been observed in recent years, possibly indicating a trend toward stabilization or saturation in this segment.

Among the software analyzed, some stand out for their educational application potential. In the Logistics area, the Commercial and Logistics Routing System (BR-5120240010955) offers tools for optimizing delivery routes and goods distribution. Its use in the classroom allows the simulation of logistics scenarios, fostering skills related to transport planning and management. The Reverse Logistics Company Management System (BR-5120210001150) is also relevant for educational purposes, as it introduces sustainable practices such as waste management and material reintegration into the production cycle, topics aligned with current industry demands.

In the Accounting and Finance area, WebMoney – Personal Finance Management (BR-5120240002545) provides a digital environment for managing income, expenses, and financial goals, useful for activities related to financial education, personal budgeting, and financial planning. This approach is complemented by the RPG Personal Finance Spreadsheet – Instituto

#AJOGADA (BR-5120230037826), which uses role-playing game (RPG) logic to simulate everyday financial situations, increasing student engagement and supporting learning through gamification.

In the Administration and Education category, SGMaster – Marketplace Management System (BR-510049088-2024) allows the simulation of e-commerce platform operations, giving students the opportunity to understand processes such as product registration, order management, and performance analysis in digital environments. SMK Sales Administration (BR-510000788-5) provides tools for commercial management, with potential application in teaching activities on sales strategies, goal setting, customer service, and commercial decision-making.

The qualitative analysis of the records revealed a recurring challenge: the use of generic titles for software, such as “Financial Management System,” “Business Control,” and “Strategic Planning.” This practice makes it difficult to distinguish between systems and hinders the understanding of each tool’s functional scope, limiting their applicability in educational contexts. This limitation stems from the lack of more descriptive standards in the INPI’s software registration process, which negatively affects the traceability and critical evaluation of these technologies for pedagogical use.

From an educational standpoint, the identified records have strong potential to enhance teaching in VTE. The incorporation of these tools into pedagogical practices promotes the creation of more dynamic and production-aligned learning experiences, enabling students to simulate real business scenarios and develop technical skills in an applied manner.

4.3 Institutions and programs

The Vocational, Scientific, and Technological Education (EPCT) system in Brazil comprises 64 institutions and 656 campuses distributed across the country. In the Business Management technological axis, 46 institutions and 410 campuses offering programs were identified, representing 72% of the institutions and 62% of the campuses in the federal network. This scenario highlights the strong presence of the area within EPCT and the strategic importance of Administration, Logistics, and Accounting programs. Table 2 shows this distribution by institution and number of campuses.

The analysis identified 716 program offerings in the Business Management axis, with a predominance of the Technical Program in Administration, which accounts for 70% of the total. Next are the Bachelor's in Administration (15%) and the Technical Program in Logistics (11%). Undergraduate Technology Programs (CSTs), such as the Undergraduate Technology Program in Logistics, make up 2% of the offerings—the same proportion as the Technical Program in Accounting. The Bachelor's in Accounting Sciences is residual, with only 0.4%. Table 3 details this data.

Table 2: Institutions and campuses offering programs in the Business Management axis

Acronym	Campuses	Acronym	Campuses
IFSP	27	IFAL	8
IFMA	23	IFC	7
IFAM	17	IFF	7
IFCE	17	IFG	7
IFPI	17	IFPA	7
IFPR	17	IFPE	7
IFRS	16	IF GOIANO	6
IFSC	16	IFRJ	6
IF BAIANO	14	IF SERTÃO-PE	5
IFSUL	14	CPII	5
IFMT	13	IFAP	5
IFNMG	12	IFTO	5
IFMG	12	IFB	5
IF FARROUPILHA	11	CEFET-RJ	4
IFES	11	IFAC	3
IFPB	11	IFRR	3
IFMS	10	IFS	2
IFBA	10	CEFET-MG	1
IFRO	10	UFMA - COLUN	1
IF SUDESTE MG	9	UFPB - CAVN	1
IFRN	9	UFRPE - CODAI	1
IF SUL DE MINAS	8	UFMS POLITÉCNICO	1
IFTM	8	UFV - CEDAF	1
Total		410	

Source: Prepared by the authors (2025).

Table 3: Number of programs offered in EPCT (2024)

Program name	Number offered	Percentage
Technical Program in Administration	498	70%
Bachelor's in Administration	105	15%
Technical Program in Logistics	79	11%
Undergraduate Technology Program in Logistics	16	2%
Technical Program in Accounting	16	2%
Bachelor's in Accounting Sciences	2	0,40%
Total	716	100%

Source: Prepared by the authors (2025).

The diversity of educational programs in EPCT reflects the system's mission to provide flexible and comprehensive vocational training. These programs vary in structure, duration, and target audience, aligning with Brazil's national strategy for workforce development.

The predominance of technical programs (83%) confirms EPCT's focus on mid-level professional training aimed at rapid and qualified entry into the job market. Meanwhile, the bachelor's programs (15%) and CSTs (2%) reflect an expansion of offerings directed at the development of specific higher-level competencies, particularly in strategic areas such as process

management, logistics, and finance. Figure 4 presents the percentage distribution by type of program, facilitating the visualization of the different modalities.

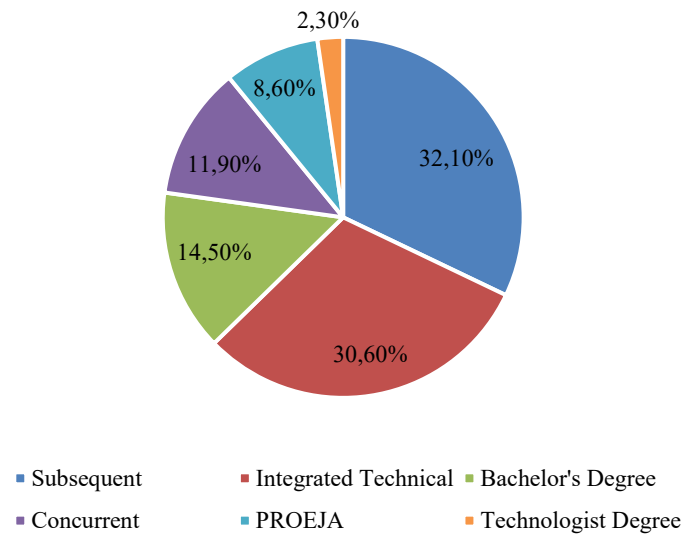


Figure 4: Distribution of programs by type of offering. Source: Prepared by the authors (2025).

This diversity of modalities (technical, bachelor's, and technological) reflects the vertical structure of the federal network, which allows academic progression within the same institution. This arrangement meets the needs of different student profiles, from those seeking rapid entry into the workforce to those aiming to deepen technical and managerial competencies at more advanced educational levels. Based on this overview, the next section analyzes how the curricula of these programs relate to the mapped technologies, highlighting opportunities for integrating patents, software, and the most common subjects in the field.

4.4 Courses, content, and correlations with patents and software

The analysis of the curricula of Business Administration, Accounting, and Logistics programs within EPCT made it possible to identify the most common courses in these programs and their potential connections with educational patents and software. This review covered 105 Bachelor's in Business Administration programs, 16 undergraduate technology programs in Logistics, 2 Bachelor's in Accounting Sciences programs, 498 offerings of the Technical Program in Administration, 79 in Technical Logistics, and 16 in Technical Accounting.

In total, 263 courses were analyzed across the various programs, with particular emphasis on 58 distinct courses in the Bachelor's in Business Administration, 60 in Technical Accounting, and 50 in Technical Logistics. Despite the variation in naming conventions across institutions, many course contents were found to be equivalent, enabling the integration of common technologies across different programs and educational levels.

Based on this mapping, a correlation was established between the most recurrent courses and the technologies identified in the technological prospecting, allowing an association between curricular content and innovative solutions that can enhance teaching in these areas. Table 4 summarizes the main findings of this study, presenting examples of courses in each program and their respective connections to patents and educational software.

Table 4: Relationship between courses, patents, and software in Business Administration, Accounting, and Logistics programs

Area	Program	Example courses	Related patents	Related software
Administration	Bachelor's and Technical	General Management Theory	BR-102012027125-A2: Business management system and method	2024BR510049088: SGMaster – Marketplace Admin
		Human Resource Management	BR-102013024840-A2: Electronic timekeeping system	00693-1: SARHA – HR Management
		Financial Management	BR-102020022339-A2: Decentralized financial management system with AI	2024BR510037110: Digital Bookkeeping System (SPED)
		Digital Marketing and Corporate Communication	BR-112019007128-A2: Business processing method and device	BR-102018011750-A2: Online scheduling and marketing system
		Strategic Management	BR-102012016050-A2: Corporate governance excellence system	2020BR5120200020291: NOGAPS – Business Management
Accounting	Bachelor's and Technical	General Accounting	BR-102013030762-A2: Didactic set for accounting problem-solving	BR5120210023137: Confere Contábil System
		Tax Accounting	BR-102012022732-A2: Virtual system for tax and accounting consultants	BR5120240033815: SIAT WEB – Integrated Tax Admin
		Financial Mathematics	BR-102020022339-A2: Decentralized financial management using cognitive computing	BR5120250002220: Financial Market Simulator
		Accounting Auditing	BR-112020008454-A2: System and method for digital asset control	2024BR510049509: Pharmacy Control and Admin System
		Financial Education	BR-102018071873-A2: Financial education systematization method	09057-4: Ganância – Personal Finance
Logistics	CST and Technical	Business Logistics	BR112017025338A2: Smart logistics blocking system	BR5120240034617: IGL – Logistics Management Interface
		Inventory and Materials Handling	BR-112019011827-A2: Goods tracking and control method	BR5020130012388: DIM Logistics – Distribution Management
		Transport and Distribution Planning	BR102014029011A2: Product monitoring and tracking system	06484-1: E-Cargas – Virtual Logistics Operator
		Reverse Logistics and Sustainability	BR102020009327A2: Smart reverse logistics bin with internet connection	BR5120210001150: Reverse Logistics Company System
		IT Applied to Logistics	BR112017025338A2: Smart logistics blocking system	BR5120180521657: Logistics Management System

Source: Prepared by the authors (2025).

The correlation observed between the most common courses in the Business Management axis and the mapped technologies reveals a consistent alignment between curricular content and available technological innovations. The analysis of course syllabi from different institutions in the Federal Network made it possible to identify a core set of courses, such as Financial Planning, Business Logistics, General Accounting, Human Resource Management, and Entrepreneurship, that are directly related to the patents and software identified in the technological prospecting. This convergence points to favorable conditions for incorporating active methodologies and digital tools into teaching, enabling curricular modernization without compromising the core

structure. The presence of technologies applicable to existing course content creates opportunities to enhance practical learning, foster real-world problem-solving, and develop competencies aligned with labor market demands.

In the area of Administration and Education, programs such as the Technical Program in Administration, the Bachelor's in Business Administration, and Undergraduate Technology Programs (CSTs) in Managerial Processes show strong connections to technologies related to integrated business management (ERP), administrative process automation, digital marketing, and artificial intelligence for decision-making. These solutions reflect organizational transformations driven by digitalization and respond to the growing demand for professionals with analytical and strategic skills. Tools like SGMaster – Marketplace Management System allow students to simulate e-commerce platform operations and can be applied in courses like Digital Entrepreneurship and E-commerce. SPED – Public Digital Bookkeeping System supports teaching in Fiscal Management and Organizational Processes by enabling simulation of tax routines in a digital environment.

In the area of Accounting and Finance, programs such as the Technical Program in Accounting, the Bachelor's in Accounting Sciences, and CSTs in Financial and Tax Management demonstrate alignment with technologies for digital bookkeeping, electronic auditing, tax planning, and automated financial analysis. The increasing digitization of accounting processes and stricter compliance requirements call for professionals equipped to operate complex systems. Software like SIAT WEB – Integrated Tax Management System can be used in Tax Accounting courses to simulate tax calculation and collection. The Financial Market Simulator supports investment analysis and cash flow management exercises. Confere Contábil stands out as a tool for teaching digital auditing and compliance.

In the area of Logistics, programs such as the Technical Program in Logistics and the CST in Logistics show strong alignment with solutions for goods tracking, transport planning, reverse logistics, and supply chain integration. Digitalization in this sector has promoted the use of technologies based on artificial intelligence and the Internet of Things (IoT), with a focus on operational efficiency. Courses like Inventory and Materials Handling can benefit from tools like DIM Logistics – Distribution Management, which simulates operations in distribution centers. IGL – Logistics Management Interface supports teaching in Business Logistics, enabling simulations of routes, delivery control, and operational decisions. The Reverse Logistics Company Management System contributes to teaching sustainable practices such as reuse and recycling of products within the supply chain.

Overall, the articulation between courses, technologies, and professional competencies reinforces the importance of updating EPCT curricula by integrating technological solutions capable of fostering more applied and contextualized educational experiences. The incorporation of simulators, management systems, and digital platforms into the learning environment supports the development of both technical and behavioral skills from the outset. This integration strengthens the adoption of active methodologies and aligns the teaching process with real-world industry demands. The convergence between emerging technologies and curricular content also highlights the need for continuous revision of syllabi and pedagogical projects to ensure that programs keep pace with technological, regulatory, and operational changes in the fields of Administration, Accounting, Finance, and Logistics.

To ensure effective integration of technologies into the curriculum, the role of educators is essential. The next section analyzes the profile of these professionals and the challenges of technological training.

4.5 Faculty profile and challenges in technological training

The modernization of teaching in EPCT depends on the qualification of faculty members responsible for mediating the use of innovative technologies in the teaching-learning process. The profile survey of professionals working in Business Administration, Accounting, and Logistics programs revealed a large and highly qualified faculty, but also highlighted specific challenges regarding the adoption of new technological tools.

The study identified a total of 1,524 faculty members distributed across six areas of expertise: Information Technology, Accounting, Production and Logistics, Economics, Law, and Occupational Health and Safety. The areas with the highest concentration of professionals were Information Technology, Accounting, and Production and Logistics, indicating a strong presence of specialists in fields directly related to business management. Furthermore, institutions with the highest number of faculty members, such as IFMA, IFSP, and IFAM, also offer the most programs in the area.

In terms of academic qualifications, most professors hold a master's degree, followed by those with doctoral degrees and postgraduate diplomas. Figure 6 shows the percentage distribution of faculty by academic qualification.

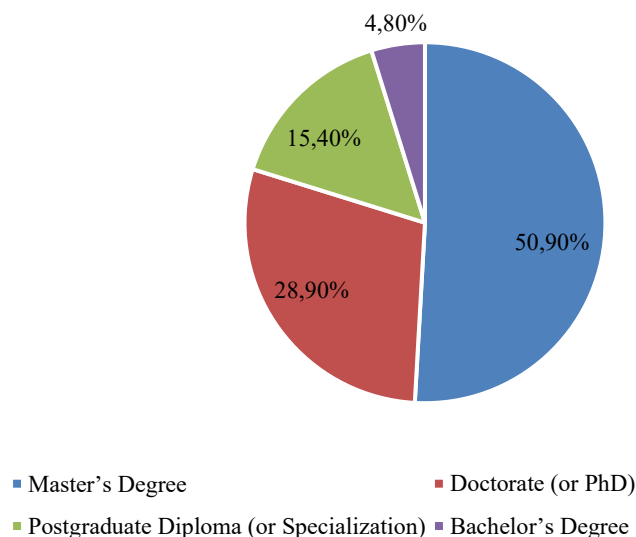


Figure 6: Distribution of faculty by academic qualification

Source: Prepared by the authors (2025).

Although academic qualifications are high overall, a significant number of faculty members hold only an undergraduate degree, particularly in the field of Information Technology. The Administration area stood out for having the highest concentration of faculty with master's and doctoral degrees, which may indicate a favorable environment for incorporating innovations into teaching.

However, as Akour and Alenezi (2022) point out, formal academic qualifications alone do not guarantee familiarity with active methodologies or proficiency in digital teaching tools. Although many professors have relevant professional experience, integrating technological innovations into the classroom may present a challenge, especially given the rapid evolution of educational software, platforms, and interactive tools. The curricular analysis revealed the need for targeted training to enable faculty to incorporate these tools into pedagogical planning and use them in alignment with labor market demands and innovative teaching methods.

In this context, it is essential to implement structured actions for faculty development, such as continuing education programs, partnerships with educational technology companies, development of interactive teaching materials, and stronger integration between educational institutions and virtual learning environments. Preparing faculty to use these innovations not only increases the potential for applying the mapped technologies, but also contributes to more dynamic teaching practices that are aligned with the demands of the digital economy (Abildinova et al., 2024).

The following section presents a replicable model for the integration of these technologies into EPCT teaching, ensuring that curricular modernization is accompanied by effective strategies for faculty training and professional development.

4.6 Technological integration model for business management education in VTE

The digitalization of administrative, accounting, and logistics processes has demanded new educational approaches to train professionals capable of meeting labor market demands. In this context, VTE must integrate technological innovations into Business Management education to keep pace with changes in the sector.

Based on the findings of this study, we propose a technological integration model designed for Business Administration, Accounting, and Logistics programs. This model outlines a structured path for adopting educational patents and software, aligning them with the courses identified through technological prospecting in order to modernize technical and higher technological education.

The proposed model is based on five pillars that guide the implementation of technology in Business Management programs: identification of applicable technologies, which involves selecting relevant patents and software for teaching; development of a teaching resource repository, which organizes support materials for the use of these innovations; faculty training, aimed at the continuous professional development of teachers in applying new tools; partnerships with companies and startups, which enable access to educational software; and continuous evaluation of outcomes, allowing the monitoring of the impact of technologies on learning.

Figure 7 illustrates the proposed model, highlighting the relationship between its pillars and their application in the educational context of VTE.

Implementation of the model begins with identifying technologies applicable to Business Management courses. To this end, each institution should conduct technological prospecting based on three criteria: market needs, to ensure that selected solutions align with current trends; course offerings, to enable the natural integration of tools into syllabi; and feasibility, to guarantee accessibility and compatibility with the academic environment. This survey can be conducted using platforms such as Google Patents, INPI, and software repositories, and the results should be documented to support faculty and administrators in integrating these innovations into teaching.

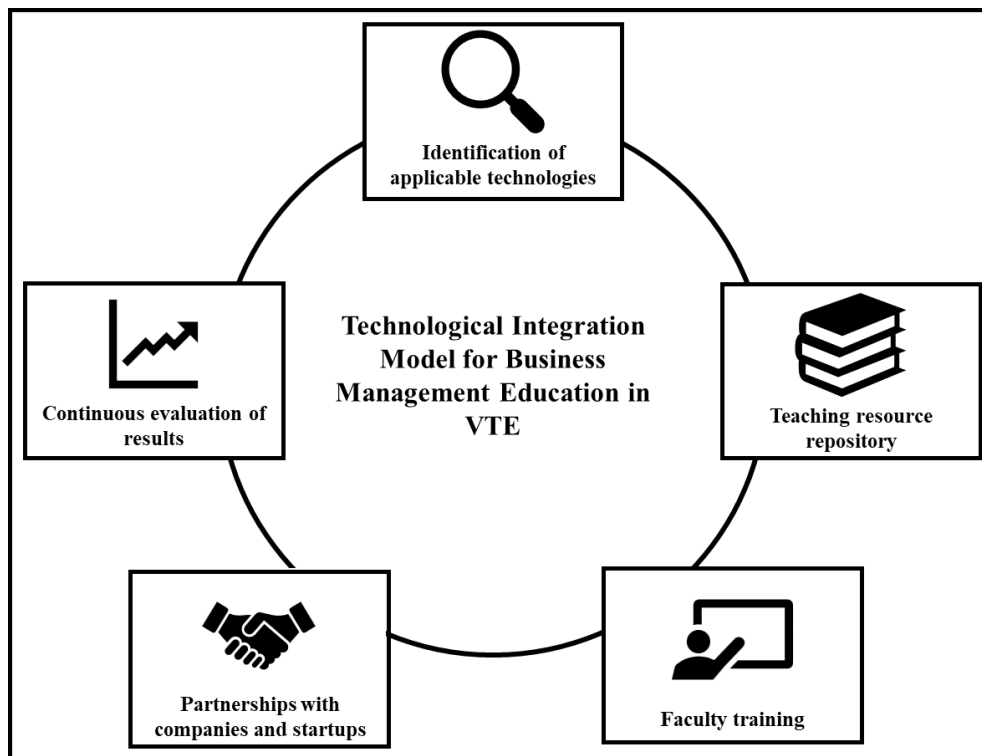


Figure 7: Technological integration model for Business Management education in VTE

Source: Prepared by the authors (2025).

For example, in a Business Management program offered within VTE, the proposed model could be applied to courses such as Financial Management, Business Logistics, or Organizational Processes. Technological prospecting would enable the selection of educational software aligned with curricular needs, such as enterprise management systems or digital simulation platforms. These technologies could then be incorporated into an institutional repository containing tutorials and simulation-based activities, supporting their use in classroom and laboratory practices. Faculty training initiatives would prepare instructors to employ these tools through active learning strategies, while partnerships with technology providers could facilitate access to updated digital environments reflecting real organizational practices. Continuous evaluation mechanisms would monitor student engagement and competency development associated with technology-supported learning activities.

Following this implementation logic, the effective use of the identified technologies requires the creation of a digital repository that gathers support materials in an accessible and dynamic format (Damasceno-Santos et al., 2023). This resource bank may include tutorials and practical guides on the use of selected tools, case studies based on real-world scenarios, simulations and educational games to encourage interactive learning, and virtual environments using artificial intelligence and data analytics to enhance the academic experience. Regular updates to the repository ensure that faculty and students maintain continuous access to pedagogical innovations, contributing to the development of competencies aligned with labor market demands.

Integrating these new technologies into VTE requires faculty training to ensure effective classroom use (Sousa & Vasconcelos, 2023). Institutions should offer regular training sessions on active methodologies, such as gamification and problem-based learning (PBL), as well as courses on software tools specific to Business Management. Forming inter-institutional study groups may also be a valuable strategy for faculty to share experiences, best practices, and challenges in

implementing new technologies, strengthening educational innovation collaboratively (Liu et al., 2024).

The adoption of these technologies can be expanded through strategic partnerships with companies and startups, providing free or subsidized access to widely used educational software. These collaborations also encourage knowledge exchange between students and professionals and support the joint development of new solutions, allowing students to participate in real-world projects and gain practical experience. Institutional agreements offer an efficient pathway to formalize these partnerships, promoting closer ties between academia and the productive sector (Esangbedo et al., 2023).

To ensure the effective implementation of technologies in teaching, it is essential to establish mechanisms for monitoring and evaluating results. This can be done through student and faculty feedback using surveys and interviews, along with analysis of academic performance to track the development of technical and practical competencies (Dusi et al., 2024). Monitoring graduate employability is also important to assess the alignment between training and job placement. Periodic reviews of the technologies in use ensure that the model remains current and relevant, allowing institutions to make strategic adjustments when needed and maintain alignment with industry demands.

The proposed model represents a structured strategy to modernize VTE, ensuring that institutions accompany the digital transformation of the productive sector. Implementing this model enables faculty and students to access innovative tools, fostering a more dynamic, interactive, and market-aligned teaching environment. Additionally, by organizing a resource repository, training faculty, and establishing strategic partnerships, institutions create favorable conditions for applying innovative methodologies and developing competencies relevant to the world of work.

As a replicable and flexible tool, the model can be adapted to the specific characteristics of each institution, making it suitable for implementation in diverse educational contexts and contributing to ongoing innovation in the teaching of Business Administration, Accounting, and Logistics.

4.7 Technological trends and curricular implications in business and management education

The qualitative analysis of patent applications highlights the diversity and evolution of technological innovations applied to the fields of Business Administration, Accounting, and Logistics. In the management context, there has been a significant increase in the development of solutions focused on the collection and analysis of business data, reflecting the growing importance of business intelligence and the automation of decision-making processes in the contemporary corporate environment (Gani et al., 2023). This scenario indicates the need for VTE programs to incorporate tools and methodologies that enable students to understand and apply these concepts in practical contexts.

In the area of Accounting and Finance, the predominance of patents related to digital assets and blockchain technology points to a structural transformation in accounting and auditing processes. These innovations have provided greater security and transparency in financial transactions, requiring professionals to adapt to new digital tools and accounting models based on decentralized technologies (Javaid et al., 2022; Kaden et al., 2021). The integration of such solutions into education can expand students' understanding of accounting digitalization, allowing them to develop practical skills aligned with industry demands.

In the logistics domain, the analysis of patent records reveals a growing focus on technologies that optimize supply chains, improve goods tracking, and integrate artificial

intelligence into transport management. The pursuit of greater operational efficiency, cost reduction, and sustainability has driven the development of advanced systems for logistics planning and real-time inventory monitoring (Salinas-Navarro et al., 2024). Applying these technologies in education can prepare students for the current challenges of the sector, allowing them to understand, in practice, the impacts of automation and digitalization in business logistics.

In addition to the specific technological trends in each area, the study also identified a shift toward the adoption of innovative pedagogical approaches, such as playful and interactive methodologies. The development of patents incorporating elements like business games and computer simulations reinforces the importance of active learning in vocational education, making learning more dynamic and aligned with market needs. This approach aligns with studies highlighting the positive impact of active methodologies on student engagement and performance, especially in programs aimed at training highly skilled professionals (Magalhães et al., 2021; Martinez & Gomez, 2025).

Despite this promising outlook, the adoption of active methodologies and digital tools in the context of Vocational and Technological Education still faces significant challenges. Formal qualifications alone do not guarantee proficiency in educational technologies or familiarity with innovative teaching approaches. Many instructors express insecurity due to the rapid pace of platform updates and the complexity of available digital resources (Duque, 2023). The lack of continuing education, limited technical support, and resistance to change hinder the effective integration of these innovations into pedagogical planning (Rezende et al., 2024). Beyond technical training, meaningful adoption of technologies requires alignment with teachers' pedagogical beliefs and practices, as they tend to incorporate tools that are compatible with their conceptions of teaching and learning. In this regard, the literature emphasizes the importance of collaborative, contextualized, and ongoing training programs (Watson & Rockinson-Szapkiw, 2021). Therefore, the proposed curricular modernization must be accompanied by institutional strategies that foster a culture of innovation and create concrete conditions for developing digital competencies within VTE.

Overall, the patent analysis shows a significant increase in filings in recent years, particularly in the subfields of digital accounting and smart logistics. This phenomenon suggests growing demand for solutions that optimize business processes and underscores the importance of digitalization in productive sectors. The ongoing development of management-oriented technologies highlights the need for VTE programs to adapt to these changes, promoting curriculum updates and integrating innovative tools into teaching.

Although the results indicate a strong concentration of technological development in areas such as digital accounting and smart logistics, the analysis also points to underexplored domains within Business Management education. Fewer technological solutions were identified addressing managerial decision-making in small and medium-sized enterprises, public and nonprofit management contexts, and interdisciplinary competencies related to organizational strategy and human-centered management. This asymmetry highlights opportunities for developing educational technologies that support complex decision-making, collaborative problem-solving, and contextualized management practices. Addressing these gaps may broaden the scope of technological innovation in VTE and promote solutions better aligned with diverse institutional and socioeconomic realities.

In this context, the correlation between the identified technological innovations and the courses offered in Business Administration, Accounting, and Logistics reinforces the relevance of curricular modernization. In Business Administration programs, using software for financial management, data analysis, and strategic planning can contribute to training professionals capable of operating in a market increasingly driven by digital information. In Accounting, adopting tools for digital bookkeeping, automated auditing, and tax planning enables more realistic learning

experiences, equipping students with essential skills to navigate the digital transformation of the field. In the logistics context, technologies for transportation optimization, inventory monitoring, and supply chain integration can prepare students to work in a highly dynamic and competitive environment.

The findings of this study demonstrate that technological innovation plays a fundamental role in training professionals for the Business and Management sector. The proposed curriculum modernization not only strengthens the connection between theory and practice but also supports teachers in adopting new teaching methodologies. By providing a conclusive technical report to Science and Technology Institutions (STIs), this study contributes to strengthening the educational ecosystem, promoting training that is more closely aligned with market needs.

Finally, incorporating emerging technologies into technical and higher VTE programs represents an opportunity for the continuous improvement of teaching practices. Adopting a structured model for integrating these innovations can ensure that programs keep pace with transformations in the productive sector, offering students more qualified and relevant training to meet the demands of the labor market. Thus, this study reinforces the need for investments in educational innovation and faculty development, ensuring that VTE continues to play its strategic role in preparing professionals for the digital economy.

5 Conclusion

This article explored the application of technological innovations in Vocational and Technological Education (VTE), focusing on the identification of patents and software applicable to the teaching of Business Administration, Accounting, and Logistics programs. The findings point to a dynamic landscape in which the incorporation of new technologies plays a key role in curriculum modernization and professional training, creating opportunities to enhance pedagogical methods and prepare students for an increasingly digitalized labor market.

The analysis included 160 patent applications and 560 registered software programs, revealing a significant volume of innovations aimed at the Business and Management field. Among the areas analyzed, Logistics accounted for the largest share of patent applications (42%), highlighting the demand for technological solutions for goods tracking, transport optimization, and integrated supply chain management. Business Administration and Teaching (39%), which includes patents focused on didactic methods and administrative solutions, and Accounting and Finance (18%) also presented relevant contributions, with innovations aimed at accounting automation, digital bookkeeping, and interactive educational platforms. The predominance of invention patents (IP) over utility models (UM) indicates a focus on more disruptive solutions, expanding their potential application in education.

Beyond technological prospecting, the analysis of course syllabi and subject content in Business Administration, Accounting, and Logistics enabled the establishment of concrete links between curricular content and the identified innovations. The Business Administration program showed a strong connection with tools focused on strategic management, financial automation, and digital marketing. In Accounting, software for digital bookkeeping, auditing, and tax planning stood out, reflecting the growing digitalization of the field. Logistics, in turn, aligned closely with intelligent systems for inventory management, goods tracking, and reverse logistics. This detailed approach not only highlighted the potential of these technologies to enhance academic training but also underscored challenges such as the need for faculty development and the adaptation of teaching practices.

The main contribution of this research was the proposal of a replicable model for technological integration in Business and Management education in VTE. Structured around five

pillars—identification of applicable technologies, creation of a didactic resource repository, teacher training, partnerships with companies and startups, and continuous outcome evaluation—the model offers guidelines for the incorporation of educational innovations, enabling VTE institutions to implement more dynamic, interactive, and market-aligned teaching methodologies.

Based on the findings, several avenues for future research emerge. One of the most relevant developments is the experimental implementation of the model in technical and technological institutions, allowing for an evaluation of its impact on learning outcomes and students' readiness for the job market. There is also room for studies that delve deeper into the use of emerging technologies, such as generative artificial intelligence, augmented reality, and blockchain, in curriculum modernization and the development of new pedagogical approaches. Another promising line of inquiry involves assessing the impact of these innovations on the employability of VTE graduates, exploring how the use of technological tools in education contributes to professional integration and performance.

The results reinforce the need to bridge innovation and education, promoting professional training that is aligned with the transformations of the digital economy. Incorporating patents and software into Business and Management education not only modernizes pedagogical practices but also strengthens the role of educational institutions as drivers of innovation and economic development. For this transformation to be effective, ongoing dialogue between academia, industry, and public policy is essential, ensuring that vocational education keeps pace with technological evolution and prepares students for the challenges and opportunities of the future.

References

- Abildinova, G., Abdykerimova, E., Assainova, A., Mukhtarkyzy, K., & Abykenova, D. (2024). Preparing educators for the digital age: teacher perceptions of active teaching methods and digital integration. *Frontiers in Education*, 9. <https://doi.org/10.3389/feduc.2024.1473766> [GS Search]
- Akour, M., & Alenezi, M. (2022). Higher Education Future in the Era of Digital Transformation. *Education Sciences*, 12(11), 784. <https://doi.org/10.3390/educsci12110784> [GS Search]
- Akram, H., Abdelrady, A. H., Al-Adwan, A. S., & Ramzan, M. (2022). Teachers' perceptions of technology integration in teaching-learning practices: A systematic review. *Frontiers in Psychology*, 13, 920317. <https://doi.org/10.3389/fpsyg.2022.920317> [GS Search]
- Aquino, C. N. P., Campinho, A. L. M. de C., & Arruda, A. P. S. N. (2021). As prerrogativas dos Institutos Federais e a oferta educacional. *Cadernos do Desenvolvimento Fluminense*, (19), 153–180. <https://doi.org/10.12957/cdf.2020.59163> [GS Search]
- Bezerra, E. T., Damacena, R., Lima, I. F. S., Lisboa, A. O. C., Ferreira, M. O., Freitas, A. Q., ... Vieira, A. J. F. (2024). O impacto das tecnologias emergentes na educação: transformações e desafios na era digital. *Revista Ibero-Americana de Humanidades, Ciências e Educação*, 10(7), 2992–3003. <https://doi.org/10.51891/rease.v10i7.14950> [GS Search]
- Boaventura, P. S. M., Souza, L. L. F., Gerhard, F., & Brito, E. P. Z. (2018). Desafios na formação de profissionais em Administração no Brasil. *Administração: Ensino e Pesquisa*, 19(1), 1–31. <https://doi.org/10.13058/raep.2018.v19n1.775> [GS Search]
- Boeskens, L., & K. Meyer (2025). *Policies for the digital transformation of school education: Evidence from the Policy Survey on School Education in the Digital Age*. OECD Education Working Papers, n. 328, OECD Publishing, Paris. <https://doi.org/10.1787/464dab4d-en> [GS Search]

- Bonfante, R., & Schenckel, C. (2020). O Princípio da Verticalização nos Institutos Federais: Possibilidades e Desafios. *Metodologias e Aprendizado*, 1, 83–90. <https://doi.org/10.21166/metapre.v1i0.1112> [GS Search]
- Bozkurt, A. (2020). Educational technology research patterns in the realm of the digital knowledge age. *Journal of Interactive Media in Education*, 2020(1), 18. <https://doi.org/10.5334/jime.570> [GS Search]
- Brasil. (2024). *Plataforma Nilo Peçanha: Observatório de Dados e Informações*. Ministério da Educação, Brasília, DF.
- Carmo, J. E. S., Lacerda, D. P., Klingenberg, C. O., & Piran, F. A. S. (2025). Digital transformation in the management of higher education institutions. *Sustainable Futures*, 9(100692), 100692. <https://doi.org/10.1016/j.sftr.2025.100692> [GS Search]
- Castaman, A. S., & Rodrigues, R. A. (2021). Práticas pedagógicas: experiências inovadoras na Educação Profissional e Tecnológica. *Revista Diálogo Educacional*, 21(68). <https://doi.org/10.7213/1981-416x.21.068.ao05> [GS Search]
- Coradini, L., & Vidor, A. M. (2021). Um projeto de educação para um projeto de desenvolvimento nacional: o papel dos institutos federais de educação, ciência e tecnologia. *Juventude.Br*, (15), 15–22. [GS Search]
- Damasceno-Santos, G., Costa, W. L., Hora, A. J. F., Silva, K. B. S., Sales, G. A., Jesus, J. P. S., Rodrigues, K. D. C. F., Miranda Freitas, L. (2023). Coleção Ensino de Ciências na Escola: um repositório digital como apoio pedagógico para o ensino e a formação. *Scientia Plena*, 19(3). <https://doi.org/10.14808/sci.plena.2023.034402> [GS Search]
- Dornelles, F. R. B., Castaman, A. S., & Vieira, J. A. (2021). Educação profissional e tecnológica: desafios e perspectivas na formação docente. *Revista Exitus*, 11, e020133. <https://doi.org/10.24065/2237-9460.2021v11n1id1537> [GS Search]
- Duarte Filho, N. F., & Rodrigues, R. F. L. (2023). O uso de ferramentas tecnológicas e o estudo das bases conceituais da educação profissional e tecnológica: intersecções entre teoria e prática no Mestrado ProfEPT. *Revista Novas Tecnologias na Educação (RENTE)*, 21(2), 13–22. <https://doi.org/10.22456/1679-1916.137720> [GS Search]
- Duque, R. C. S., Placido, R. L., Loureiro, V. J. S., Jesus, J. W., Mansano, S., Sousa, T. S. R., Martins, A. D., Maçalai, G., Di Santo, M. S., & Silva, K. A. F. D. (2024). A resistência à tecnologia nas escolas: Fatores, desafios e soluções práticas. *IOSR Journal of Humanities and Social Science*, 29(8), 58-65. <https://doi.org/10.9790/0837-2908095865>
- Dusi, L. L., Pedrosa, S. M. P. A., & Santos, S. R. M. (2024). Tecnologias Digitais e Aprendizagem Docente: Histórias em função de um saber específico. *Revista da FAEBA - Educação e Contemporaneidade*, 33(74), 119–132. <https://doi.org/10.21879/faeaba2358-0194.2024.v33.n74.p119-132> [GS Search]
- Esangbedo, C. O., Zhang, J., Esangbedo, M. O., Kone, S. D., & Xu, L. (2023). The role of industry-academia collaboration in enhancing educational opportunities and outcomes under the digital driven Industry 4.0. *Journal of Infrastructure Policy and Development*, 8(1). <https://doi.org/10.24294/jipd.v8i1.2569> [GS Search]
- Favacho, M. V. O. (2023). *Formação continuada de professores na era da educação 4.0: saberes, identidade docente e as práticas pedagógicas*. Dialética. [GS Search]
- Fernández-Sánchez, M. R., Garrido-Arroyo, M. del C., & Porras-Masero, I. (2022). Curricular integration of digital technologies in teaching processes. *Frontiers in Education*, 7. <https://doi.org/10.3389/educ.2022.1005499> [GS Search]

- Fontoura, J. S. D. A., Neves, R. M. S., & Sasset, R. S. (2023). *Educação em perspectiva: Formação docente, políticas educacionais e história da educação em contexto emergente*. Pedro & João Editores.
- Gani, M. O., Yoshi, T., & Rahman, M. S. (2023). Optimizing firm's supply chain resilience in data-driven business environment. *Journal of Global Operations and Strategic Sourcing*, 16(2), 258–281. <https://doi.org/10.1108/jgoss-02-2022-0013> [GS Search]
- INPI. (2024). *Consulta base de dados do INPI*. Instituto Nacional da Propriedade Industrial, Brasília, DF.
- Javaid, M., Haleem, A., Singh, R. P., Suman, R., & Khan, S. (2022). A review of Blockchain Technology applications for financial services. *BenchCouncil Transactions on Benchmarks, Standards and Evaluations*, 2(3), 100073. <https://doi.org/10.1016/j.tbench.2022.100073> [GS Search]
- Kaden, S. R., Lingwall, J. W., & Shonhiwa, T. T. (2021). Teaching blockchain through coding: Educating the future accounting professional. *Issues in Accounting Education*, 36(4), 281–290. <https://doi.org/10.2308/issues-19-080> [GS Search]
- Lee, J.-S., & Hsiang, J. (2020). Patent claim generation by fine-tuning OpenAI GPT-2. *World Patent Information*, 62(101983), 101983. <https://doi.org/10.1016/j.wpi.2020.101983> [GS Search]
- Liu, J., Aziku, M., Qiang, F., & Zhang, B. (2024). Leveraging professional learning communities in linking digital professional development and instructional integration: evidence from 16,072 STEM teachers. *International Journal of STEM Education*, 11(1). <https://doi.org/10.1186/s40594-024-00513-3> [GS Search]
- Ma, J., Ovalle, J., & Wang, Y. (2023). Institutional factors influencing knowledge production for practice: Evidence from nonprofit studies. *PloS One*, 18(10), e0293360. <https://doi.org/10.1371/journal.pone.0293360> [GS Search]
- Machado J. R. F. (2023). Metodologias de pesquisa: um diálogo quantitativo, qualitativo e quali-quantitativo. *Devir Educação*, 7(1). <https://doi.org/10.30905/rde.v7i1.697> [GS Search]
- Magalhães, S. R., Rodrigues, L. M., & Alves Pereira, C. (2021). Metodologias ativas que empregam tecnologias digitais de informação e comunicação (TDIC) no ensino médio integrado. *Revista Prática Docente*, 6(3), e083. <https://doi.org/10.23926/rpd.2021.v6.n3.e083.id1257> [GS Search]
- Martinez, M. E., & Gomez, V. (2025). Active learning strategies: A mini review of evidence-based approaches. *Acta Pedagogica Asiana*, 4(1), 43–54. <https://doi.org/10.53623/apga.v4i1.555> [GS Search]
- Mathieson, S. (2019). Integrating research, teaching and practice in the context of new institutional policies: a social practice approach. *Higher Education*, 78(5), 799–815. <https://doi.org/10.1007/s10734-019-00371-x> [GS Search]
- Mohammadi, N., Maghsoudi, M., Sabet, M., & Soghi, M. (2025). Unveiling the evolution of educational technologies: A patent-based clustering and life cycle analysis. *IEEE access: Practical Innovations, Open Solutions*, 13, 55740–55768. <https://doi.org/10.1109/access.2025.3554741> [GS Search]
- Molina, M. C. (2017). Contribuições das licenciaturas em educação do campo para as políticas de formação de educadores. *Educação & Sociedade*, 38(140), 587–609. <https://doi.org/10.1590/es0101-73302017181170> [GS Search]

- Munaretti, G. C. O., Sá Júnior, E. M., Dantas, U. S., & Soliani, R. D. (2025). Transferência de tecnologia: um estudo nos Institutos Federais da Região Norte do Brasil. *Cadernos de Prospecção*, 18(1), 3–22. <https://doi.org/10.9771/cp.v18i1.60852> [GS Search]
- Oliveira, J. L. S., Lima, P. D. S. N., Carvalho, C. L., & Fonseca, A. V. S. (2020). Sala de aula 4.0 - Uma proposta de ensino remoto baseado em sala de aula invertida, gamification e PBL. *Revista Brasileira de Informática na Educação*, 28, 909–933. <https://doi.org/10.5753/rbie.2020.28.0.909> [GS Search]
- Raja, R., & Nagasubramani, P. C. (2018). Impact of Modern Technology in Education. *Journal of Applied and Advanced Research*, 3, 33-35. <https://doi.org/10.21839/jaar.2018.v3iS1.165> [GS Search]
- Ramos, M. N. (2022). Educação Profissional e Tecnológica: (Re)conceituando a (contra)hegemonia. *Revista Nova Paideia - Revista Interdisciplinar em Educação e Pesquisa*, 28–43. <https://doi.org/10.36732/editoranovapaideia.2021.222> [GS Search]
- Rezende, G. U. M., Amaral, I. M. B., Vital, S. M. S., Silva, C. D. M., & Schneider, F. A. D. M. (2024). Pesquisas Inovadoras em Educação. *Revista Ibero-Americana de Humanidades, Ciências e Educação*, 07–205. [GS Search]
- Salinas-Navarro, D. E., Pacheco-Velazquez, E., & Silva-Ovando, A. C. (2024). (Re-)shaping learning experiences in supply chain management and logistics education under disruptive uncertain situations. *Frontiers in Education*, 9. <https://doi.org/10.3389/feduc.2024.1348194> [GS Search]
- Shaffril, H. A. M., Samsuddin, S. F., & Abu Samah, A. (2021). The ABC of systematic literature review: the basic methodological guidance for beginners. *Quality & Quantity*, 55(4), 1319–1346. <https://doi.org/10.1007/s11135-020-01059-6> [GS Search]
- Sidorova, M., Kopus, T., & Yurasova, I. (2024). Digital transformation for teaching management accounting: training with a simulation in an authentic professional environment. *Accounting Education*, 33(5), 621–648. <https://doi.org/10.1080/09639284.2023.2255980> [GS Search]
- Silva, J. C. K., Soliani, R. D., Satrapa, H. F. M., & Lobão, M. S. P. (2025). Public innovation policies in Acre: a systemic analysis of the regional ecosystem of Science, Technology and Innovation. *Revista Políticas Públicas*, 29(2), 970–990. <https://doi.org/10.18764/2178-2865.v29n2.2025.53> [GS Search]
- Sivarajah, R. T., Curci, N. E., Johnson, E. M., Lam, D. L., Lee, J. T., & Richardson, M. L. (2019). A review of innovative teaching methods. *Academic Radiology*, 26(1), 101–113. <https://doi.org/10.1016/j.acra.2018.03.025> [GS Search]
- Sobrinho, E. M. A., & Rivera, J. A. (2021). A utilização das TIC's de forma criativa e inovadora no contexto da Educação Profissional e Tecnológica. *Revista de Estudos e Pesquisas sobre Ensino Tecnológico (EDUCITEC)*, 7, e110321. <https://doi.org/10.31417/educitec.v7.1103> [GS Search]
- Soliani, R. D., Oliveira, D. A., Pontes, J. C. N., & Drumond, T. D. R. (2025). Professional training in Industry 4.0: a competency-based educational model. *Gestão & Produção*, 32(e2225). <https://doi.org/10.1590/1806-9649-2025v32e2225> [GS Search]
- Soliani, R. D., Pereira, R. S., Freitas, C. G., & Pereira, F. S. (2024). Gamification in Supply Chain Management (SCM) education: a practical experience with the Beer Game. *Caderno Pedagógico*, 21(2), e2865. <https://doi.org/10.54033/cadpedv21n2-104> [GS Search]

- Sousa, W. K. L., & Vasconcelos, F. H. L. (2023). Educação profissional e tecnológica e a utilização das tecnologias digitais no processo de ensino: Uma revisão sistemática da literatura. *Devir Educação*, 7(1). <https://doi.org/10.30905/rde.v7i1.632> [GS Search]
- Velez, A., & Alonso, R. K. (2025). Business simulation games for the development of Decision Making: Systematic review. *Education Sciences*, 15(2), 168. <https://doi.org/10.3390/educsci15020168> [GS Search]
- Watson, J. H., & Rockinson-Szapkiw, A. (2021). Predicting preservice teachers' intention to use technology-enabled learning. *Computers & Education*, 168:104207. <https://doi.org/10.1016/j.compedu.2021.104207> [GS Search]