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Presentation of the content

In the first article we present, *Design of a web platform for registering tourist locations in San Martín Texmelucan using augmented reality* by MORALES-ZAMORA, Vianney, PAREDES-XOCHIHUA, Maria Petra and SÁNCHEZ-JUÁREZ, Iván Rafael, with adscription in the Instituto Tecnológico Superior de San Martín Texmelucan, in the next article we present, *Novice Teachers' Perceptions of e-teaching modality* by FLORES-GONZÁLEZ, Norma, FLORES-GONZÁLEZ, Efigenia, ZAMORA-HERNÁNDEZ, Mónica, and CASTELÁN-FLORES, Vianey, with adscription in the Benemérita Universidad Autónoma de Puebla, in the next article we present, *ADDIE model as a methodology for the design of distance courses* by SANCHEZ-GARCÍA, Judith Ruby, GALEANA-VICTORIA, Luis Gustavo, FLORES-AZCANIO, Nancy Patricia and SÁNCHEZ-VÁZQUEZ, Elizabeth, with adscription in the Universidad Politécnica del Valle de México, in the next article we present, *Recommendation of account effect* by CFDI Based on Machine Learning by MONTECILLO-PUENTE, Francisco Javier & PERÉZ-MONCADA, Santiago, with adscription in the Tecnológico Nacional de México campus Salvatierra (ITESS).

Content

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Design of a web platform for registering tourist locations in San Martín Texmelucan using augmented reality

Diseño de plataforma web para el registro de lugares turísticos de San Martín Texmelucan utilizando realidad aumentada

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Abstract

This project aims to create an online tool that allows users to register, explore, and promote tourist destinations in San Martín Texmelucan using augmented reality technology, enabling visitors to fall in love with and appreciate the greatness of each place. The web platform seeks to boost tourism in the area, enhance the tourist experience, and promote the local economy by attracting more tourists and highlighting local tourist destinations. Additionally, the platform aims to provide detailed and enriched information about registered tourist spots, including photos, videos, descriptions, and user reviews, so that visitors can make informed decisions and have a more enriching experience. With this initiative, the goal is to promote tourism in San Martín Texmelucan and provide a useful and engaging tool for tourists, as well as for entrepreneurs and businesses in the local tourism sector.

Platform, Tourist, Texmelucan

Resumen

Este proyecto tiene como objetivo crear una herramienta en línea que permita a los usuarios registrar, explorar y promover los lugares turísticos de San Martín Texmelucan mediante el uso de tecnología de realidad aumentada, que permitan que el visitante pueda enamorarse y ver lo grandioso que es cada lugar. La plataforma web busca fomentar el turismo en la zona, mejorar la experiencia turística de los visitantes y promover la economía local al atraer a más turistas y promover los lugares turísticos locales. Además, la plataforma tiene como objetivo proporcionar información detallada y enriquecida sobre los lugares turísticos registrados, incluyendo fotos, videos, descripciones y comentarios de otros usuarios, para que los visitantes puedan tomar decisiones informadas y tener una experiencia más enriquecedora. Con esta iniciativa, se busca promover el turismo en San Martín Texmelucan y brindar una herramienta útil y atractiva para los turistas, así como para los empresarios y las empresas relacionadas con el sector turístico en la región.

Plataforma, Turísticos, Texmelucan

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Introduction

The web platform for the registration of tourist sites in San Martin Texmelucan using augmented reality addresses several issues. Some of them are the following:

Lack of visibility of tourist sites: many tourist sites in San Martin Texmelucan may be unknown to tourists due to lack of advertising and promotion. A web platform that includes an augmented reality feature could make these sites more visible and accessible to tourists, which would increase the number of visitors and tourism in the area.

Incomplete or inaccurate information: In many cases, tourists may have difficulty finding accurate and complete information about tourist sites in San Martin Texmelucan. A web platform that allows users to upload detailed and accurate information about tourist sites, including images and augmented reality videos, could help solve this problem.

Lack of interaction: Tourists often seek interactive and memorable experiences. A web platform that allows users to interact with tourist sites in San Martin Texmelucan through augmented reality could provide a more enriching and engaging experience for visitors.
The web platform for the registration of tourist sites in San Martin Texmelucan using augmented reality is based on several relevant theoretical aspects, including:

User experience: user experience is a key aspect in tourism and technology. According to Zhang *et al*. (2019), user experience refers to an individual's subjective perception of a product or service. In the context of tourism, user experience refers to the quality of the tourism experience offered to visitors. Augmented reality can enhance the user experience by providing interactive and enriching information about tourist sites.

Augmented reality technology: Augmented reality technology allows virtual elements to be superimposed on the real world, which can enhance the user experience and provide detailed and enriching information about tourist sites. According to Azuma (1997), augmented reality has three key characteristics: it combines virtual elements with the real world, it is interactive in real time, and it is recorded in 3D.

Web platforms: Web platforms can be used to provide detailed and accurate information about tourist sites, facilitate travel planning and booking, and collect information about tourists and their preferences. According to Buhalis and Law (2008), web platforms can be used to improve customer satisfaction, efficiency and service quality, and reduce costs.

Methodology to be developed

Analysis of the current situation

Before starting the development of the web platform, it is necessary to analyze the current situation of tourism in San Martin Texmelucan, identifying the main tourist attractions of the region, the strengths and weaknesses of the current tourist offer, and the opportunities and threats of the environment.

Definition of requirements

The functional and non-functional requirements of the web platform should be defined, including the functionality of the augmented reality application, the database of tourist sites, the web interface, security and privacy measures, and other relevant aspects.

Prototype design

In this phase, low-fidelity interfaces are designed in order to make the idea known to the user so that he/she can provide feedback on the proposal.

Architectural design

The architecture of the web platform must be designed, defining the components and modules necessary for the operation of the augmented reality application and the web interface, and establishing the interactions between them.

Prototype development

Prototypes of the augmented reality application and web interface can be developed to evaluate their functionality and usability, and adjustments and improvements can be made if necessary.

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Implementation and testing

Once the requirements have been defined, the architecture has been designed and the prototypes have been developed, the web platform can be implemented and tested to ensure that it meets the defined requirements and functions correctly.

Evaluation of results

Finally, an evaluation of the results obtained should be carried out, including the usability of the web platform, user satisfaction, impact on local tourism, and other relevant aspects. Based on this evaluation, adjustments and improvements can be made to the web platform to optimize its performance and improve its results.

For this article, the first three phases will be presented: Analysis of the current situation, Definition of the requirements, and Design of the prototype.

Step 1: Analysis of the current situation

Main Tourist Attractions of the Region:

– *Colonial Architecture:* San Martin Texmelucan has a rich colonial architectural heritage that includes churches, old houses and historic buildings that attract history and architecture lovers.

– *Gastronomy:* The region is known for its delicious food, with traditional Mexican dishes and local specialties that attract food lovers.

– *Festivals and Traditions:* San Martin Texmelucan celebrates several festivities and traditions throughout the year, such as the Sphere Fair, which attracts visitors interested in local culture.

– *Nature and Landscapes:* The surrounding area offers beautiful rural landscapes, including agricultural fields and mountains, which are ideal for ecotourism and outdoor activities.

Strengths of the Current Tourism Offering:

– *Cultural Heritage:* The preservation of the region's cultural and architectural heritage is a strength that attracts those interested in history and culture.

– *Gastronomy*: Local food is an attraction in itself and can serve as a focal point for gastronomic tourism.

– *Diversity of Offer:* San Martin Texmelucan offers a wide range of activities, from cultural tourism to nature tourism.

Weaknesses of the Current Tourism Supply:

– *Limited Infrastructure*: There may be limitations in tourism infrastructure, including lodging and transportation.

– *Insufficient Promotion*: The region may not be adequately promoting itself nationally and internationally to attract a greater number of tourists.

– *Regional Competition*: San Martin Texmelucan competes with other cities and tourist regions in Mexico, which may make it difficult to attract visitors.

Step 2 Definition of requirements

Functional requirements are presented in Table 1.

Key	Name	Description
RF001	Registry of Tourist Places:	Users should be able to register new tourist sites on the platform, providing detailed information about the site, such as name, location, description, photos and videos.
RF002	Site Exploration	Visitors should be able to explore registered tourist sites using augmented reality technology. This may include overlaying relevant information in real time, such as names and descriptions, when using the camera of a mobile device.

RF003	Search and Filters	Users should be able to search for tourist sites by name, location, or category, and apply filters to refine results.
RF004	Comments and Qualifications	Users should be able to leave comments and ratings for the tourist sites they have visited, providing useful feedback for other travelers.
RF005	User Profile	Each user should have a profile where they can manage their registered tourist sites, save their favorite places and view their past activities.
RF005	Map Integration	The platform should integrate interactive maps that allow users to easily locate tourist sites.

Table 1 functional requirements

The pseudo requirements are shown in Table 2.

Key	Name	Description
SP001	Performance	The platform must be fast and efficient, ensuring minimal loading times and a smooth user experience.
SP002	Security	Security measures must be implemented to protect user information and ensure data integrity.
SP003	Scalability	The platform must be able to handle an increase in the number of registered users and tourist sites as its popularity grows.
SP004	Usability	The user interface should be intuitive and easy to use, even for people unfamiliar with augmented reality.
SP005	Compatibility	The platform must be compatible with a variety of devices and web browsers, including smartphones, tablets, and desktop computers.
SP006	Availability:	The platform must be available 24 hours a day, 7 days a week, with a minimum planned downtime for maintenance.

Table 2 non-functional requirements

Step 3: Prototype design

For this phase the balsamiq software was used for the first proposal presented below, in figure 1 the initial screen of the system, where the visitor can see in a carousel of images the tourist sites presented randomly, as well as the menu to be able to search for places.

Figure 1 Main screen

To register tourist sites, access will only be possible through an e-mail account and a password, where only the administrator will allow access, and will be limited to the cultural councilors of each locality and the owners of the tourist centers (see figure 2).

Figure 2 login

When registering a tourist site, you must add its name, complete address, attach it to a category, register contact information, opening hours, if discounts are applied and what type of discounts, costs, days of service. (See figure 3).

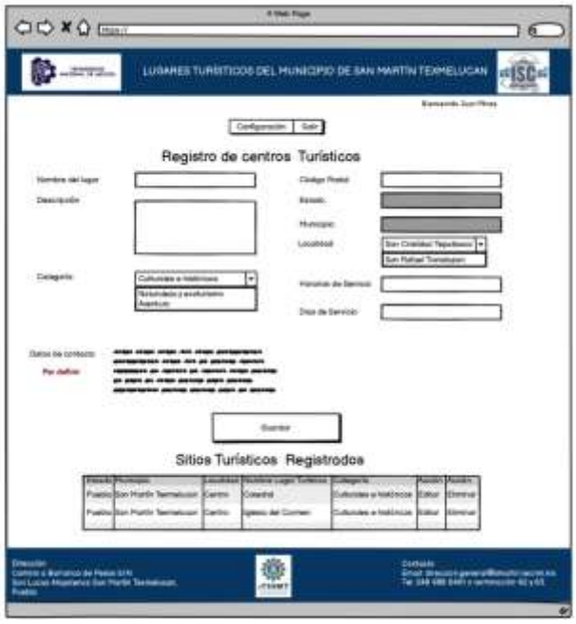

Figure 3 Tourist site registration

Once the places have been registered, visitors can search by municipality and category, as shown in Figure 4 below.

Figure 4 Site filtering

Once the filter has been made, two photographs of the place, its general data, a map with the location, and a qr code will be displayed, which can be scanned to visualize the place using augmented reality (see figure 5).

Figure 5 Search results

In addition, with the option to leave comments and rate the place once visited, which will provide a better user experience.

Results

So far, significant progress has been made in the development of the web platform project for the registration of tourist sites in San Martín Texmelucan using augmented reality. The first design of the interfaces has been completed, and these designs have been shared with the cultural councillors of the municipality to receive their valuable feedback and suggestions. This collaboration with local stakeholders is essential to ensure that the platform is relevant and beneficial to the community.

In addition, work is currently underway on the implementation of augmented reality with the creation of the first prototype, which covers two prominent tourist sites: the Parish of San Martin Texmelucan and the Hacienda de San Cristobal Polaxtla. These prototypes provide a practical demonstration of how augmented reality technology can enhance the tourist experience at these iconic sites.

The next important step is to present the proposal to the owners and managers of various tourist sites in the municipality of San Martin Texmelucan. This will not only provide an opportunity to explain the benefits and potential of the platform, but also to establish important collaborations with the owners of these sites, thus enriching the tourism offer of the region.

Conclusions

The project is moving forward in a solid and collaborative manner, with a focus on technological innovation and local community participation. The impact is positive for tourism in San Martin Texmelucan and continues towards its successful implementation.

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Novice Teachers' Perceptions of e-teaching modality

Percepciones de los profesores noveles sobre la modalidad de enseñanza digital

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Abstract

The teaching process in a virtual environment has marked a change in the skills and abilities of novice teachers to innovate their teaching practice during the post-pandemic period. Due to these implications, it is crucial to investigate this topic specifically at a higher level, the context of the present investigation. The objective is to know how they perceive this new educational modality and identify if the platforms used in their praxis are useful for their educational purposes. For this, cross-sectional-descriptive quantitative research took place on a sample of 20 novice teachers from the English Bachelor (BUAP, obtaining the following results: Teachers affirm that the modality is ideal for working in a post-contingency. However, they need the training to use ICTs with a pedagogical approach since the effectiveness and success of the teaching process depend on the knowledge and use of both. Besides, teachers perceived the Moodle platform as more acceptable than Blackboard or Schoology.

Novice teachers' perceptions, Virtual teaching, e-teaching modality

Resumen

El proceso de enseñanza en un entorno virtual ha marcado un cambio en las habilidades y habilidades de los docentes noveles para innovar su praxis durante el periodo pospandemia. Debido a estas implicaciones, es crucial investigar este tema específicamente a un nivel superior, el contexto de la presente investigación. El objetivo es conocer cómo los docentes noveles perciben esta nueva modalidad educativa e identificar si las plataformas digitales utilizadas para su praxis son útiles para sus fines educativos. Para ello se realizó una investigación cuantitativa descriptiva transversal en una muestra de 20 docentes noveles de la Licenciatura en Inglés (BUAP), obteniendo los siguientes resultados: Los docentes afirman que la modalidad es ideal para trabajar en una poscontingencia. Sin embargo, necesitan la formación en el uso de las TIC con un enfoque pedagógico, ya que del conocimiento y uso de ambas depende la efectividad y el éxito del proceso de enseñanza, además percibieron la plataforma Moodle como más aceptable que Blackboard o Schoology.

Percepciones de docentes noveles, Enseñanza virtual, Modalidad de enseñanza digital

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Introduction

The pandemic has modified the execution of plans, programmes and curricula, implementing the use of platforms, digital tools or applications that allow for innovation in the teaching-learning process in order to satisfy the individual and collective needs of learners.

However, these new digital spaces require teachers prepared to make pedagogical decisions regarding the selection of content, the creation of activities and techno-pedagogical design as well as teaching strategies and methodologies.

In this sense, knowledge management technologies enable not only access to information but also the construction of new knowledge. Taking into account the aforementioned background, the aim of this research focuses on how novice teachers perceive this new educational modality and identify whether the digital platforms used in their praxis are useful for such educational purposes.

In order to contextualise the phenomenon under study, the following sections present the theoretical conceptualisation of the main terms related to the topic in question.

Teaching practice

Teaching practice refers to the actions, strategies and approaches that teachers employ in classroom or teaching environments to facilitate student learning. Teaching practice is a key component of education and plays a fundamental role in the development of students' skills, knowledge and attitudes.

This implies knowing and determining the means, resources and ways of learning culture that involve cognitive, affective and self-regulation dimensions (Mato-Vázquez, and Álvarez-Seoane, 2019). Some of its key components for effective teaching practice are:

Instructional planning. This involves designing lessons that address learning objectives, selecting materials and using teaching methods appropriate to the learning environment.

According to Hodges *et al*. (2020), teaching practice, mainly in virtual education, requires planning that addresses the characteristics of remote teaching, as well as the use of minimal resources in a short time under the trend towards faster access to information. In this sense, the teacher uses planning as a means to respond to the characteristics of flexible learning environments, generating the appropriation of content and the improvement of digital educational tools (Castañeda and Vargas, 2021).

Effective teaching. Teachers employ a variety of strategies to present information in an understandable and accessible way, encourage student participation and facilitate active learning, including expository teaching methods, practical examples, class discussions and hands-on activities (Véliz and Gutiérrez, 2021). In general, the creation of interactive learning communities and teacher-student communication is promoted.

Active Methodologies. Application of methods that provide competences and skills for problem solving, placing the student as the central agent of this process, modifying the traditional role of receiver to active manager of their learning (Misseyanni *et al*., 2018). In this sense, these active methodologies strengthen the creativity and constant participation of students, create dynamic work environments for the development of skills and allow the incorporation of new technologies (Silva-Quiroz and Maturana, 2017).

Classroom manager. This involves creating a positive and orderly learning environment, maintaining discipline and promoting collaboration and respect among students. It also involves the generation of positive and orderly learning environments, generating respect, communication and integration of the participants, as well as managing the appropriate time to stimulate the student's attention and interest (Castañeda and Vargas, 2021). It also generates the creation of good practices understood as a series of teaching actions that encourage and favour the complex cognitive processes (autonomy, creativity, reflection, among others) of the student, in search of innovation in their praxis (Guzmán, 2018).

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Continuing professional development. Teachers seek to improve their skills and knowledge through continuing education, collaboration with colleagues and reflection on their own practice. A fundamental part of this is pedagogical training, which seeks to develop competencies for the conceptualisation, application and experimentation of knowledge, methods and strategies for teaching specific knowledge in educational contexts (Hinestroza *et al*., 2019).

Use of technology. The incorporation of technology represents new challenges; today it is increasingly important in teaching practice. This may include the use of mobile devices, computers, educational platforms and software to enhance teaching and learning. In this respect, the digitalisation of educational practice is imperative, adapting teaching strategies and trends to stimulate and encourage the development of competences and knowledge in students (Bautista and Zúñiga, 2021).

Relationships with students. Teachers establish relationships of trust and respect with students, which fosters a positive learning environment. They also seek to be responsive by being flexible and able to adapt their teaching approach to meet the particular needs of learners. This may involve differentiation, supporting students with special needs or adapting teaching resources. Assessment and feedback. The learner assesses student progress and provides feedback to help them understand their strengths and areas for improvement. This may include tests, assignments, projects, formative assessment and oral feedback. Successful teaching practice involves a combination of these elements and adapts to changing student needs and educational trends. Therefore, good teaching practice is essential to inspire and empower students to promote meaningful and lasting learning.

Innovation of teaching practice in digital modalities

Innovation of teaching practice in digital modalities is critical in an ever-changing world, which is why some of the strategies and approaches to foster innovation in teaching in digital environments focus on the application of project-based and collaborative learning (PBL), interactive multimedia content, personalised learning, adaptive learning, virtual reality (VR) and augmented reality (AR).

Project-based and collaborative learning (PBL). Designing projects that involve students in real-world problem solving and online collaboration. The fundamental basis of this model is the generation of meaningful learning, stimulating the teacher's creativity and comprehensively developing cognitive, attitudinal and value-based skills for group work (Maldonado, 2019). It also relies on tools such as Moodle, Microsoft Teams, Google classroom, Blackboard, Schoology and Trello to facilitate online collaboration.

Interactive multimedia content. Create engaging and current learning materials that use multimedia, such as videos, podcasts, infographics and simulations. As well as the use of platforms such as Youtube, Canva and Kahoot as teaching and learning media to enhance the transmission of information in a creative and playful way (Vázquez *et al*., 2019).

Personalised learning. It uses learning management platforms (LMS) to offer personalised content and activities focused on the needs and learning styles of students. In fact, microlearning enables ubiquitous and learner-centred intelligent learning, and is characterised by stimulating the assimilation and acquisition of new learning skills on a continuous basis with flexible and contextual content appropriate to the situation and circumstance (Maldonado, 2019; Vital, 2021).

Adaptive learning. Implement adaptive learning systems that adjust to each learner's progress and deliver content and exercises specific to their skill level. This allows for adaptive interaction through adaptive course presentation, information assembly and discovery, adaptive collaboration and memory (Kara and Sevin, 2020). Adaptive learning systems focus primarily on the areas of intelligent tutoring, cognitive uploading and stimulation, adaptive hypermedia systems in interactions and metadata generated by immersion in virtual environments.

This also promotes more motivating experiences for students, who explore the use of Virtual Reality (VR) and Augmented Reality (AR) whose main basis is the development of perception and interaction with the environment to generate immersive learning experiences and simulated practices (Véliz *et al*., 2021).

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Through such practices, students' interest and commitment to the proposed activities is increased, promoting the use of real-time formative assessment, which implies the support of online resources and assessment tools that provide immediate feedback to students, adjusting as they progress (Mollo-Flores and Medina-Zuta, 2020).

This innovation implies the presence of gamification, which integrates game elements into the curriculum in order to increase student participation and engagement.

Platforms such as kahoot and Quizlet, social networks, online communities are currently effective digital resources that in turn generate mobile learning allowing access to more current and real information (Ortiz-Colón *et al*., 2018).

Consequently, innovation in teaching practice in digital modalities should focus on improving the quality of education and achieving meaningful learning outcomes. To this end, it is important to adapt these strategies to the specific needs of students and pedagogical didactic objectives.

Teaching skills for digital practice at a novice stage

Digital teaching practice at a novice stage requires a specific set of key skills to ensure a successful transition to online teaching. Today's learners, rather than teaching new subjects, need to equip their students with skills, abilities and knowledge that enable them to construct new knowledge, thus requiring professionals skilled in the use of technology, communication skills, digital content design, and management of digital environments.

In essence, the teacher must feel comfortable using essential technological tools for the achievement of cognitive independence, which in turn demands new roles among participants. Given these premises, the demands materialise in the development of new tools for teaching and learning, tutoring and attention to individual differences, among other competences that novice teachers in the 21st century must develop (Espinoza, 2018).

Thus, the teacher also needs to be a manager of active participation in virtual environments through discussions, collaborations and projects in order to maintain engaged learning. At the same time, they must create, manage and promote environments of empathy and willingness to exchange ideas and group social growth, seeking to develop self-reflection and continuous improvement skills (Espinoza, 2020). In this regard, teachers need to be able to reflect on their digital practice, learn from feedback and seek out new learning opportunities. These skills can be developed through training and continuous practice.

Online teaching can be challenging, but with time and experience, the novice teacher can become an expert in digital teaching practice.

Tools that promote praxis in digital modalities

Praxis refers to the active application of theoretical knowledge in practice or action. In the context of digital modalities education, praxis refers to the effective integration of theory and learning in online teaching. Hence, one of the effective tools for this teaching practice in digital modalities is the use of learning management platforms (LMS) such as Moodle, Canvas or Blackboard that allow the teacher to create online courses, host resources, communicate with students and evaluate their progress (Vargas-Murillo, 2021).

Similarly, another digital resource is the multimedia content creation system (Camtasia, Adobe Spark or Screencasta) to generate videos, presentations and other multimedia content that allow the teacher to collect, provide feedback and monitor student learning.

On the other hand, there are also technological resources such as social learning platforms, Edmodo networks, Schoology, blogs, wikis, online social networks (Twitter, Facebook or LinkedIn) that encourage interaction and collaboration between students and teachers, promoting a more social approach to learning and resource sharing. Another example is the online portfolios Mahara or Google Sites that allow students to create and maintain digital evidence to show their work and progress.

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Simulation and virtual reality tools (SimScale or virtual labs) that naturally stimulate participants' immersion in the virtual environment through realism, engagement and interactivity (Michaelis and Michaelis, 2020; Sousa and Rodrigues, 2021).

These tools can help teachers create an effective online learning environment that promotes praxis, allowing students to apply their knowledge in authentic situations. However, it is important to remember that the choice of tools must be aligned with the learning objectives and the specific needs of the students.

Methodology

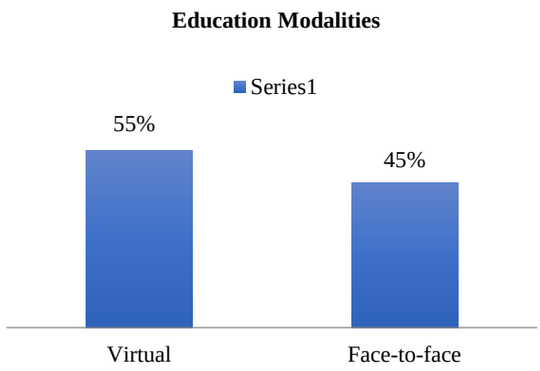
The enquiry assumed a quantitative perspective with a descriptive and cross-sectional scope. As the main empirical procedure, a Likert-type questionnaire was used to determine the perceptions of novice teachers in relation to the virtual mode and to identify the platforms that re useful in this mode.

With regard to data collection, the questionnaire was administered at a single point in time at the end of the 2023 course.

The sample consisted of 20 novice teachers with similar characteristics: first time teaching an online course, recent graduates of the Bachelor's Degree in English Language Teaching, and aged between 23 and 30 years old.

For the data analysis, three dimensions extracted from the questionnaire will be taken into account, namely: educational modalities, teaching attributes and platforms used to teach their classes.

Results



Graph 1 New students' perception of the virtual modality
Source: Own Elaboration

The graph shows a preference for the virtual mode. In fact, 11 (55%) new teachers say that the virtual modality is ideal for post-contingency work. This is due to its advantages such as progressive progress at the students' pace, ubiquitous learning and availability of content, avoiding time and space barriers, as pointed out by Pisani and Piotet (2009).

On the other hand, the sample points out a fundamental aspect that the virtual environment favours, which focuses on promoting active learning dynamics where the student is the protagonist of their process (Flores-González, 2022) and the new teacher can offer a variety of content according to the learning styles and level of science proficiency of their students through multi-formats, giving a personalised and punctual follow-up to each activity through personalised spaces on the platform.

Another element is the high percentage of participation observed in these environments, since being mediated by technology, the participation of the student community is interactive and asynchronous or synchronous.

In general, teachers point out that the virtual modality not only contributes to the process of teaching and learning content but also to the appropriation of digital skills, the development of autonomy, critical-reflective thinking, collaboration, evaluation and self-evaluation processes and, most importantly, sustainability.

In contrast, 9 (45%) teachers point to the face-to-face modality as a possibility to carry out their praxis, expressing their preference because it is a face-to-face process that allows them to control and monitor learning appropriately, avoiding situations that occur in virtual environments such as concentration difficulties, social isolation, connectivity problems, commitment and responsibility for learning and autonomy. Some of the most valued characteristics of this modality are the development of social and emotional skills. However, they also mentioned that the virtual modality can be a suitable complement to the virtual modality and serve as a support to reinforce knowledge in independent and personalised spaces.

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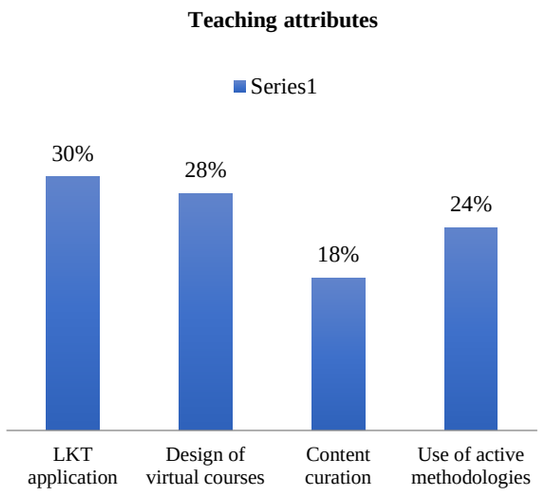

Graph 2 Fundamental attributes for mediation by technology
Source: Own Elaboration

The sample considers that in order to work in a virtual modality it is necessary for the new teacher to possess basic characteristics that allow them to embed their praxis in a digital space. In this sense, they identified the following attributes:

a) Application of ICT (30%). Pedagogical training in the use of ICT as learning and knowledge technologies and not merely instrumental is inevitable; otherwise, the teacher will design activities with the use of technology for informative rather than formative purposes. In fact, ICTs were perceived as a trigger for educational cultural change that requires teachers to:

– Updating of knowledge and continuous digital competences (Tobón and Salazar, 2018) that allow the use of tools and applications for the construction and deconstruction of new knowledge.

– Reconceptualisation of the teaching process where the role of the teacher is that of designer, monitor, creator and curator of content, in addition to those assigned in traditional education.

– Implementation of a pedagogical culture that favours evaluation, assessment and self-assessment through the use of new technologies.

b) Design of virtual courses (28%). Novice teachers suggest them as the second most important element for working in virtual environments, given that the success of the learning process depends on the organisation of the course and its interactivity in order to trigger significant learning situations. It is important to point out that technology and ICT by themselves do not contribute in an ideal way to the learning process although they are considered innovative resources, since it is the design, creation or curation of contents and the experience and professional profile of the teacher what makes the virtual modality an ad hoc space for student-centred education in a socio-technological and multicultural context.

c) Content curation (18%). The creation of content is a crucial element in virtual environments and is also perceived as complicated by teachers. However, it is necessary to bear in mind that the technical-pedagogical design of a virtual course does not necessarily have to be created from scratch. On the contrary, teachers can take up content already created and hosted in different applications or other sources to adapt them to the requirements of their subject and the needs of their students (Guallar *et al.*, 2020) through the phases of searching for resources, selecting content, creating new products from the content retrieved and disseminating the new material.

d) Use of active methodologies (24%). These were perceived as the third most important principle for digital praxis due to the fact that the virtual modality demands active student participation. In view of this, an appropriate method is active methodologies that encourages collaborative work and autonomy (Peralta and Guamán, 2020), contributing directly to student commitment, responsibility and participation, avoiding rote learning through problem solving and reflective and creative critical thinking.

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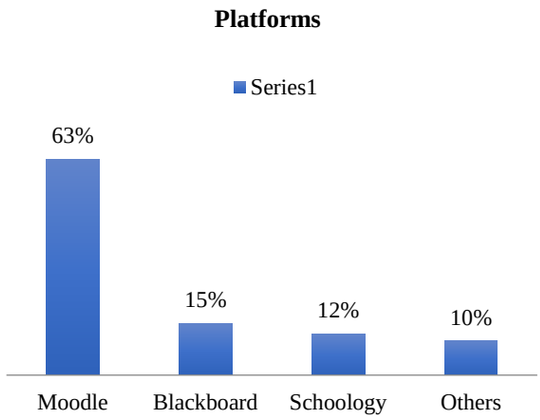
In fact, teachers perceived that this methodology fostered collaborative networks between students and teachers that in turn fostered student competences, transforming empirical practice into innovative virtual experiences as pointed out by Gómez-Hurtado *et al* (2020).



Graph 3 Platforms to mediate their praxis
Source: Own Elaboration

When working in virtual environments, novice teachers confirm that there are different platforms to embed their praxis. However, from their perception, the most used platform was Moodle (63%) followed by Blackboard (15%), Schoology (12%), Google classroom and Dokeos (12%).

The reasons for platform choice depended on the advantages they offered for the research context, which are described in the following lines.

– Moodle. In this case the perception is high and positive due to the characteristics of this platform such as its interaction environment, learning promotion, information flow and flexibility for the teaching-learning process in terms of time and space.

In addition, its learning management system allows to design, manage, monitor, evaluate and report the students' process through structured reports. Moreover, as it is a free platform, it can be linked to other applications or tools, contributing to a more dynamic, innovative and gamified course.

Regarding knowledge management, it enables the storage and retrieval of information from the students' activities and interrelationships between teacher and students.

– Blackboard. Novice teachers state that it is a user-friendly platform that focuses on promoting communication between students and teacher through the interactions of applications such as discussion forum, diaries, announcements and chats. While it is true that this platform favours the flow of activities, teachers perceive it as a platform that demands knowledge of HTML code for integration.

– Schoology. The study sample considers it to be an appropriate medium for working on educational content and above all useful for revision, correction of exams, homework and projects. However, its use was limited due to the cost per student taking into account the large groups.

– Google classroom and Dokeos. For the former, teachers recognise its usefulness for the implementation of blended learning projects, promoting communication and collaborative work, which integrated with its suite favours the socialisation of information without limitations through its functions such as Google Forms, Drive, Google Sheets and YouTube, although its perception is low, as it is not possible to structure contents in sequence and it is incompatible with scorm contents.

In the case of Dokeos, it provides several techniques and tools for the design of classes and multi-format content with a user-friendly interface. At the same time, it stimulates collaborative work and participation among the virtual community, making it possible to include face-to-face classes. Despite these advantages, teachers used it less frequently because of the availability of applications, technological dependence and limited compatibility that it implies.

Conclusions

In short, nowadays digital praxis is inevitable due to the disruptions that education contemplates. This leads to an urgent need to update teachers in order to meet the educational demands based on their plans, programmes and study objectives.

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In this sense, it is concluded that the virtual modality is on the increase. Furthermore, there are essential qualities for teachers who work in these environments that have a direct impact on their practice and the teaching-learning process, as they allow the application of technologies for learning and knowledge, content curation, the design of virtual courses with the use of active methodologies. All of the above embedded in platforms such as Moodle, Blackboard, Schoology, Google classroom and Dokeos.

Finally, it should be noted that this study contributes to the field of language teaching as it points out the indispensable elements for working in such environments in an appropriate manner.

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ADDIE model as a methodology for the design of distance courses

Modelo ADDIE como metodología para el diseño de cursos a distancia

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Abstract

The ADDIE model is an iterative approach aimed at designing and implementing distance learning courses that are adaptable to the needs and characteristics of students. It allows for improvements and adjustments in each of its phases, ensuring a quality learning experience for students immersed in virtual environments. This article reflects on the experience of designing distance courses for a postgraduate educational program using this methodology, highlighting the advantages and challenges that arose during the process.

Virtual learning environments, ADDIE Model, Instructional Design, LMS, Chamilo, Virtual Classrooms

Resumen

El modelo ADDIE es un enfoque iterativo orientado al diseño e implementación de cursos a distancia adaptables a las necesidades y características de los estudiantes, permite mejoras y ajustes en cada una de las fases que lo conforman lo que garantiza una experiencia de aprendizaje de calidad para los estudiantes que se encuentran inmersos en los ambientes virtuales. El presente artículo hace una reflexión luego de la experiencia de diseñar cursos a distancia para un programa educativo de posgrado siguiendo esta metodología destacando las ventajas y desafíos que surgieron durante el proceso

Entornos virtuales de aprendizaje, Modelo ADDIE, Diseño Instruccional, LMS, Chamilo, Aulas Virtuales

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1. Introduction

During the months of April and May 2020, an educational technology project was developed based on the implementation of an emerging virtual learning ecosystem using the LMS (Learning Management System) Chamilo platform, so that students of the master's degree in Image and Creativity in Education at the Institute for Cultural Integration in the municipality of Tultepec in the State of Mexico could continue with their studies; at first, there were no definite plans to transfer face-to-face education to an online environment, the necessary training was not available for managers and academics, and time was something that had to be considered. The confinement caused by COVID-19 established a series of restrictions that permeated the delivery of face-to-face courses, so it was urgent to move all academic management to a virtual environment (Cencia Crispín, Carreño Colchado, Eche Querevalú, Barrantes Morales, & Cárdenas Baldeón, 2021).

To achieve the above, a strategy based on the ADDIE methodology was adopted, which consists of a systematic approach covering the phases of analysis, design, development, implementation and evaluation (Branch, 2010a), each of these representing a critical stage in the process of designing and developing a course or learning programme for an online environment. In the design of distance learning courses it is fundamental to follow a methodology that guarantees an effective and meaningful learning experience for students, if in addition to this it is considered that there are situations in which time is an important factor for its rapid implementation, the challenge takes a direction towards innovation and creativity (Ruipérez & García, 2020).

The ADDIE methodology was developed in the 1970s by the United States Air Force Training Projects Agency. Although its origin is in the military, its systematic approach and effectiveness for course design have led to its adoption in various fields, including education, corporate training and online course development. This methodology has been widely used for the development of distance learning courses due to its systematic and structured approach, which allows for the creation of high quality learning materials and their adaptation to the needs of the target audience.

Its stages are analysis, design, development, implementation and evaluation and the first letters form the meaning of ADDIE (Guerra Genskowsky & Carrasco Medanic, 2009). It is important to note that the ADDIE methodology is highly flexible and adaptable. This means that it can be adjusted according to the specific needs of each educational project, allowing the incorporation of emerging approaches and innovative technologies for the creation of distance learning courses (Branch, 2010a) (Carrillo & Roa, 2018).

1.1 Advantages of the ADDIE methodology

The systematic approach of the ADDIE model considers a structured and systematic approach to instructional design. Each phase (analysis, design, development, implementation and evaluation) (Pacheco, 2020) is addressed in a sequential manner which ensures that each aspect of the design process is carefully considered. Some advantages of the model are listed below:

– Adaptability: ADDIE is highly adaptable and can be applied in a variety of educational contexts and for different audiences. It can be adjusted to the specific needs of each project, making it a versatile model for the design of distance learning courses.

– Focus on results: The ADDIE methodology focuses on the achievement of specific learning outcomes. By constantly analysing and evaluating course design and implementation, it ensures that learning objectives are effectively achieved.

– Continuous Improvement: The ADDIE model promotes a continuous improvement approach to course design. Through the Evaluation phase, valuable feedback is obtained from learners and areas for improvement are identified, allowing adjustments to be made and the quality of the course to be optimised in future iterations.

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– Learner-centred approach: ADDIE places emphasis on understanding the needs and characteristics of the target audience. This allows for the development of content and teaching strategies that are tailored to the learning preferences of the learners, which can improve the effectiveness of the course.

There are other models that can be used as a reference for the design of distance learning courses in virtual classrooms, Among the most prominent are the SAM (Succesive Approximation Model) which focuses on rapid interaction and continuous revision of the design which makes early versions of the course experimental and learning experiences diverse across generational cuts of learners.

The Dick and Carey model follows a sequential approach, but tends to be more prescriptive and detailed in the planning and development of instructional design and the Kemp model, which focuses on constructivist learning principles, while sharing some elements with ADDIE is not as popular (Walter & O Carey, 2014).

The ADDIE model is chosen for this project, which is part of a series of works aimed at finding different strategies and methodologies that promote and boost the learning process through the use of information and communication technologies. (Sanchez-García, Flores-Azcanio, & Galeana-Victoria, 2022) The model was selected for the theoretical reference identified at the time and for the facilities provided by the Chamilo platform. At this stage of the project, the virtual classrooms were developed, so the main objective of this research is to present the results obtained after implementation, as well as the reflections obtained during the process.

2. Theoretical framework

2.1 Context of distance education and its relevance in the digital age

Distance education experienced a significant transformation in today's digital age, also known as online education or e-learning, refers to the mode of delivery that allows students to access educational content and engage in learning activities without the need to be physically present in a traditional classroom.

The Horizon reports produced by the NMC (New Media Consortium) and EDUCAUSE Learning Interactive are constantly referenced for their stance of promoting an objective and analytical view of educational trends and from there a series of E-learning characteristics are mentioned such as access to education without geographical barriers, flexibility and self-management of learning, variety of educational resources and technologies, personalisation of learning, collaborative learning and knowledge networks, continuous training and professional updating (Johnson *et al*., 2016) (Ruipérez & García, 2020) (Salinas Ibáñez, 2004).

The pandemic of 2020 accelerated the adoption of distance education worldwide (Redacción, 2020) and educational institutions found it necessary to adapt quickly to virtual environments to ensure continuity of learning. Over time it has brought profound changes in the way students access education and how the teaching and learning process takes place.

The relevance of distance education lies in its ability to provide broad and flexible access to education, allowing individuals to train and update their knowledge continuously and in line with the demands of today's world of work (Ibarra, Ortega, & Ortiz, 2003).

2.2 Learning theories and methodologies in the design of distance learning courses

The theory of behaviourism has as a fundamental principle that learning is the result of the interaction between external stimuli and observable responses of the individual, emphasising the use of positive and negative reinforcement to encourage desired learning behaviours (Aparicio Gómez & Ostos Ortiz, 2018). Course design based on this theory focuses on clear presentation of content, repetition and practice to reinforce learning, activities and assessments are structured to measure observable student performance (Van Merriënboer & Sweller, 2005). On the other hand; constructivist theory views learning as an active process in which the student constructs meaning from their experiences and prior knowledge, meaningful learning is promoted through problem solving.

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Project-based learning and active student participation in the educational process in course design encourages the creation of collaborative learning environments where students can share ideas, reflect on their experiences and build knowledge together (Ortiz Granja, 2015).

Connectivism theory describes that knowledge is distributed in a network of connections and information systems. Learning is about connecting to this network and knowing how to access relevant information, and course design under this approach incorporates digital technologies and tools that enable students to access resources and subject matter experts, fostering lifelong learning and the ability to filter, evaluate and create information in the digital age (Quintana, Vidal, Torres, Castrillejo, & Nodos, 2006). Learning theories vary according to the learning objectives being pursued, and it is common for instructional design approaches to combine several theories to suit different learner needs or different educational contexts. An overview of learning theories is described in Table 1.

Aspect	Behaviourism	Constructivism	Connectivism
Fundamental principle	Learning based on external stimuli and observable responses.	Learning is an active process where the learner constructs meaning from his or her experiences and prior knowledge.	Knowledge is distributed and learning occurs through network connections.
Educational approach	Reinforcement and practice to encourage desired behaviours.	Problem solving, project-based learning and active student participation.	Access to relevant information and learning through online connections.
Role of the learner	Passive receiver of information and stimuli.	Active knowledge builder through interaction and reflection.	Network connector, seeking and sharing information and resources.
Role of the teacher	Transmitter of knowledge and organiser of learning.	Facilitator of learning, guide and support in the process of knowledge construction.	Designer of networked learning experiences and facilitator of connections.
Learning environment	Structured and focused on observable outcomes.	Collaborative, flexible and student-centred.	Networked, enriched by technology and online interaction.
Teaching strategies	Direct instruction, repetition and reinforcement.	Collaborative learning, projects and reflection.	Use of technology and social networks to access and share information.
Assessment	Measurement of observable outcomes and conditioned responses.	Assessment of meaningful learning and deep understanding.	Assessment of access to relevant information and ability to connect online.

Table 1 Comparative table between the different learning theories that serve as the main focus for instructional design

Instructional design is a systematic and planned approach to the creation and development of effective learning experiences. It aims to design courses, programmes or educational materials in a strategic and structured way, ensuring that learning objectives are achieved in an effective and meaningful way for learners (Smith & Ragan, 1999). The process involves several stages which may vary according to the approach or theory of learning used:

– Needs analysis: Identifying the learning needs of the target audience and the objectives to be achieved.

– Content design: Creation of a teaching and learning plan, including the selection of pedagogical strategies, learning activities, assessments and educational resources.

– Development: Creation of educational materials and resources, such as presentations, videos, exercises, etc.

– Implementation. Implementation of the course or educational programme, ensuring that it follows the designed plan.

– Evaluation. Evaluation of the instructional design and student learning to determine if the objectives were achieved and to make improvements in future interactions.

Throughout the history of instructional design since its inception in 1960 by Robert Gagné (Al-Eraky, 2012) its use has been promoted by various experts in education and pedagogy, in the 1960s a number of principles for effective teaching were developed and applied in various teaching materials. Some influential (most influential) authors were Benjamin Bloom, who developed a taxonomy of educational objectives that classifies learning objectives into different cognitive levels (Guskey, 2005). David Merril proposed a model called Component Display Theory which focuses on presenting educational content in a clear and sequential manner. Robert Mager developed the Objective-Based Approach model that focuses on establishing clear and measurable objectives before designing the course content.

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Finally, we remember Dick and Carey who proposed a systematic model of instructional design that follows 9 stages for course planning and development (Walter & O Carey, 2014).

Instructional design and the ADDIE model are closely related, as instructional design is a methodological approach used to guide and structure the process of designing learning experiences, in the ADDIE model instructional design provides a theoretical and practical framework for planning and developing effective learning experiences that conforms to the sequential structure of the model.

2.3. Stages of the ADDIE model and the role of instructional design

Instructional design plays a key role in each of the phases of the ADDIE model, according to the text Instructional design: The Addie approach by Robert Maribe Branch describes the 5 stages of the model (Branch, 2010a) that allow an efficient digital content production, being the evaluation the one that allows the possibility to update, expand or improve the contents for a better adaptation to the learning conditions and needs.

– *Analysis:* In this stage, instructional design focuses on identifying learning needs, target audience and specific educational objectives. An assessment is made of the characteristics of the audience, the resources available and the constraints of the educational environment.

– *Design:* This is where instructional design comes into play by establishing the overall structure of the course or learning experience. It determines the pedagogical strategies, instructional resources, learning activities and assessment methods that align with the learning objectives identified in the analysis phase.

– *Development:* During this phase, the instructional design is materialised through the creation of the educational content and resources. Learning theories, best pedagogical practices and appropriate methodologies are used to develop materials that facilitate the achievement of the learning objectives.

– *Implementation:* The implementation of the instructional design is carried out by putting into practice the course or learning experience created. Here the structure and pedagogical strategies previously defined in the instructional design are followed.

– *Evaluation:* Finally, the instructional design relates to the evaluation phase by analysing the effectiveness and efficiency of the course or learning experience. Data are collected to measure the achievement of the learning objectives and identify areas of improvement for future iterations.

There are some advantages to combining the ADDIE model with instructional design, firstly, there is a systematic and structured approach to the design of learning experiences which ensures careful planning and consistent alignment with educational objectives. The learner-centred approach that exclusively focuses on understanding the needs and characteristics of the target audience ensures that the learning experience is relevant and meaningful to learners. A third advantage is the adaptability that emphasises the relationship between instructional design and the ADDIE model allowing for the adaptation and customisation of learning experiences for different contexts and audiences, which optimises the effectiveness of the design and finally the continuous improvement that aligns with the evaluation phase of the model (Carrillo & Roa, 2018) (Branch, 2010b).

3. Methodology

As part of the methodology used for the development of this article, we opted for a mixed methodology that combines qualitative and quantitative approaches (Hernández-Sampieri, Fernández-Collado, & Baptista-Lucio, 1991) in order to obtain the most complete and enriching vision possible of the impacts and effectiveness of the ADDIE model in the design of distance learning courses and the experience of implementing the model at the Institute for Cultural Integration to promote the educational offer of the Master's degree in Innovation and Creativity in Education.

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In general terms, the activities carried out included the design of the study, which basically consisted of defining the research objectives, which were to analyse the application of the ADDIE methodology in the design of distance courses on the Chamilo platform in order to promote the educational offer of the Master's degree in Innovation and Creativity in Education at the Institute for Cultural Integration. For the above, once the distance courses were used by the students, we proceeded to collect data through a survey to evaluate the experience obtained, in addition to some interviews with teachers, managers and collaborators involved in the design and teaching process of the distance course. The next step was the analysis of the quantitative and qualitative data for subsequent comparison and understanding to help draw a series of conclusions and reflections. The aim of using this methodology is also to get a holistic picture of how the ADDIE model influenced the distance learning course design process.

3.1 Steps of the ADDIE model applied during the process of designing distance learning courses for the Master of Innovation and Creativity in Education

For the purpose of documenting this article, we took into consideration the experience obtained with the development of distance courses of the subjects of the first and second semesters of the Master's Degree in Innovation and Creativity in Education, such as: current learning theories, teacher training and creativity, philosophy of new technologies, educational context of the 21st century, didactic use of the Internet and degree seminar I. Once the respective educational programmes, syllabuses and reference bibliographies for each one had been consulted, the didactic materials produced at the time of the confinement during the COVID-19 pandemic began to be reviewed, which meant the beginning of the monitoring of the model in the stages, the whole process being as follows:

– *Analysis:* In this stage, a comprehensive analysis of the learning needs and educational objectives set out in the programmes was carried out. The profile of the students enrolled in the 2019-2021 programme was identified, their characteristics and specific requirements to be considered during the design of each course and to be adjusted to their needs.

– *Design:* Entering the second stage of the model, the general structure of each of the distance learning courses is established. The topics or modules to be addressed were determined, as well as the necessary educational resources made up of links, electronic documents, video materials, podcasts, infographics, among others. The Chamilo system has modules dedicated to the capture of information regarding the syllabus, learning objectives and assessment strategies.

– *Development:* In this phase, educational content was created and learning materials were developed for the most important topics, shared electronic presentations, videos, interactive activities and online assessments were produced. Multimedia resources were used to enhance the learning experience in the virtual environment, they were set up in each virtual classroom enabling interaction functionalities such as discussion forums, sending and receiving private messages, collaborative wiki sites and chats.

– *Implementation:* Once the materials and resources were ready, the publication and configuration of each virtual classroom began, the platform allowed the configuration of lessons, activities, tasks and internal repositories for the publication of documents and support materials that teachers can manage with the group privately. The site administrator organised the registration and management of users by making a number of adjustments to the overall configuration to ensure data security, flexibility and resource utilisation. Teacher training was key as part of the implementation process, a 10-hour training course was organised for teachers to learn about the management of their content, the assessment process, the assignment of tasks and the design of knowledge assessment activities or tests. An email address was provided for login through the address https://iictultepec.edu.mx to be able to log in from a web browser from a personal computer or a mobile phone.

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– *Evaluation:* The evaluation phase was crucial to measure the effectiveness of the course. Data was collected on student performance, learning satisfaction and the effectiveness of the educational materials. This data is used to make improvements in future iterations of the course and to ensure that the learning objectives are achieved and formed the basis for the publication of this article.

3.2 Evaluation of courses developed and results obtained in students

In order to collect data on the students' experience, a survey-type evaluation instrument was designed, consisting of 15 items that sought to determine the level of satisfaction with the learning needs, the quality of the content, learning time of the virtual classroom functionalities, communication with the course teacher and technical support, and feedback during learning, among other points.

The type of survey collected numerical data on a Likert scale (from 1 to 5) was entitled Evaluation of the Distance Learning Course in the Master's Degree in Innovation and Creativity in Education and had the following instructions at the beginning: Answer the following questions about your experience of the distance course. Use a scale from 1 to 5 to indicate your level of agreement with each statement, where 1 means strongly disagree and 5 means strongly agree. You may optionally provide additional comments at the end of the survey.

1. The course content was relevant to my learning needs.
2. The course design facilitated my understanding of the topics presented.
3. The learning activities enabled me to apply the concepts in a practical way.
4. The resources provided were useful to my learning process.
5. The pace of the course was adequate and allowed me to progress at my own pace.
6. Communication with the instructor was clear and timely.
7. The assessments and feedback were relevant to my learning.
8. The platform or tool used for the course was easy to use.
9. The graphic design and presentation of the content was appealing.
10. The course provided me with new skills or knowledge useful for my personal or professional development.
11. The interaction with other students in forums and activities was enriching.
12. The time allotted to complete the activities was sufficient.
13. I would recommend this course to others interested in the subject.
14. The technical support and assistance was effective in case of problems or doubts.
15. Do you have any additional comments or suggestions for improving the course?

The instrument included a drop-down list to select any of the courses Current Learning Theories, Teacher Education and Creativity, Philosophy of New Technologies, Educational Context of the 21st Century, Didactic Use of the Internet and Degree Seminar I to issue an evaluation for each course. The students were told that at the end of their respective courses they should answer the closing survey, with 27 participants providing the necessary data.

Figure 1 shows the results of the survey for the didactic use of the Internet course, which shows the general concentration of questions with the answers obtained, in question number 8 The platform or tool used for the course was easy to use shows a low result, then in figure 2 the teacher training and creativity course has a number of differences over the previous one as the clarity of the platform and the time allocated were not satisfactory while figure 3 shows a trend that the pace of the course and communication with the advisor was not adequate.

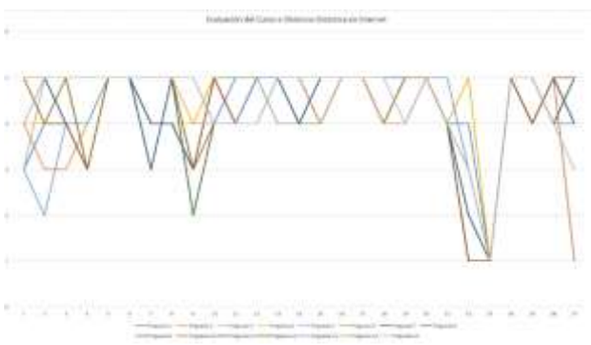

Figure 1 Evaluation of the Distance Learning Course Educational Use of the Internet

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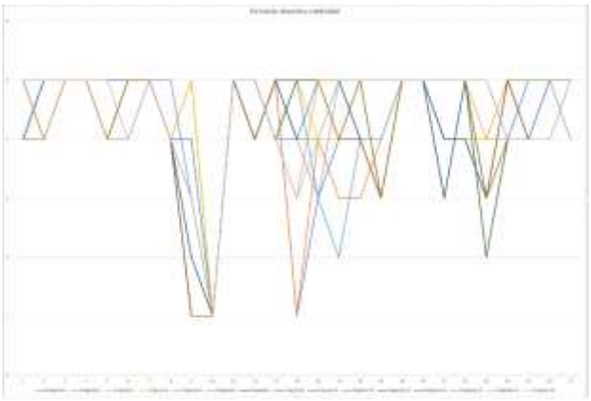

Figure 2 Evaluation of the Teacher Training and Creativity course

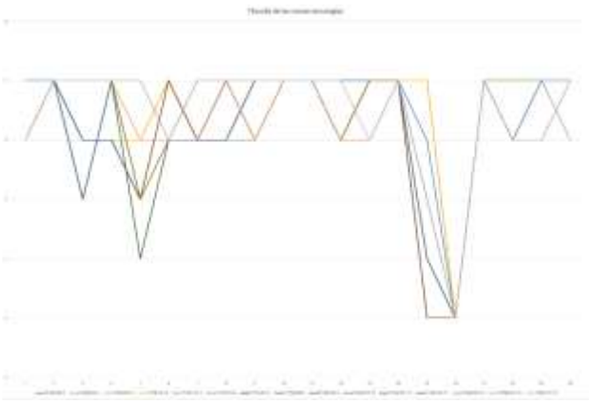

Figure 3 Course evaluation Philosophies of new technologies

It should be noted that the design of distance learning courses following the ADDIE methodology involved analysing in a general and emergent way the needs that arose given the conditions of distance work, as well as the learning objectives that were previously established for all the courses that were being taught, the characteristics of the student community, the limitations in terms of the use and management of computer resources, and the limitations in terms of the use and management of computer resources.

One of the advantages offered by the methodology is the ability to adapt content in a sequential manner, divided into phases such as knowledge survey questionnaires or diagnostic assessments, comprehension activities, readings, discussion and reflection forums, debates and the possibility of generating a small wiki site, practice questionnaires and a final assessment that will allow the accreditation of the course in general. The students carried out their feedback questionnaire considering the overall learning experience.

3.3 Collection of qualitative data from teachers and administrative staff

1. In the case of the teachers and administrators, five personalised interviews were conducted via video conference with the aim of finding out their general impressions, comments and teaching experience, reflecting on the training received for the mastery of the platform, functionalities and problem solving to the possibility of creating content, assessing learning and monitoring each student, during the training the teachers identified the basic functionalities such as the announcement sections, assessments, tasks, forums, wiki, links among others.

During the interviews for each teacher and academic administrator, trends were detected in the opinions that pointed out that the platform was confusing in a certain sense at the beginning, as for the assignment and evaluation of tasks they mentioned in general that it was not possible to give extended times to students for the delivery of tasks individually and the visualisation of them was not comfortable in mobile devices and even in web browsers. However, the simplification of the topics in lessons, the possibility to show transparency in the evaluation process and the generation of evidence is very intuitive compared to other platforms. It was also commented that the use of other external resources such as video conferencing tools, interactive content, electronic documents and multimedia resources help to make the learning experience sequential and orderly.

Once the video lectures were completed, they were stored in a repository for analysis and a narrative report was produced describing the comments collected, as a summary, the main ones are shown below: the following were presented:

– "The platform is not clear in the management of tasks".
– "I had a hard time setting up the Wiki site, the students did not manage to complete the activity and I could not find a way to evaluate it".
– I ended up uploading almost all the class material in the files section".
– I liked the fact that I was able to do face-to-face assessments and assign grades".

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- "The evaluation section does not allow many adjustments on the progress of the course, before possible contingencies you cannot modify much".
- "I liked the platform, I will most likely continue to use it once we return to the classroom".
- I really enjoyed the lessons section".
- The experience on mobile devices is very slow and confusing".

Results

It is important to keep in mind that, although Chamilo offers a solid platform for the implementation of virtual classrooms, it is necessary to have an adequate planning and instructional design methodology to guarantee an effective learning experience. The ADDIE methodology allows to personalise the learning experience in a simple and emergent way, giving meaning and sense to the fact of using an electronic platform. The MA in Educational Innovation and Creativity now has an alternative that worked during the period of confinement. After the release of distance learning courses, it was essential to have adequate training for educators, students and academic administrators as well as the technical support necessary to ensure smooth operation.

As with any open licence system, it is important to emphasise that the system's smooth operation depends on a number of technical and infrastructure considerations that must be addressed at the time, and that it is essential to have a technical support person to provide advice, training and attend to incidents at all times so that the number of failures, forgotten passwords and general queries can be dealt with efficiently.

Teachers require very punctual and specific training, in addition to the fact that the teacher's disposition must be constant. Let's remember that during the COVID-19 pandemic, many teachers had to learn several tools in a short time, which led many of them to drop out and only comply with the minimum necessary.

According to the students, the overall experience is good, although the confusion in the interface at the beginning caused difficulties at the end of the course and everyone knew how to identify the main functions of the platform, the production of content had no problems so the ADDIE methodology worked in this case, according to the results of the surveys in terms of content design there were no problems or comments about it so that in a next project is now planned to adapt the contents to the hybrid mode.

Acknowledgement

In a general way, we would like to extend a special recognition and thanks to the Instituto de Integración Cultural IIC for the facilities and trust in the realisation of this project, to the students of this institute for their continuous feedback as well as to M. en G. Luis Gustavo Galeana Victoria and Dr. Nancy Patricia Flores Azcanio, members of the Cuerpo Académico Tecnologías Emergentes of the Universidad Politécnica del Valle de México, for their constant enthusiasm and important contributions for the realisation of all the works that have been carried out up to the moment.

Conclusions

- The ADDIE procedure for the creation of emerging courses for distance education in a hybrid model, allows the optimisation of rapid content production, coherent structure and sequence as well as the possibility of continuous improvement.
- Instructional designers find a viable alternative for the production of virtual learning classrooms by creating techno-pedagogical scripts, SCORM lessons in less time following the methodology.
- Positive evaluation by the postgraduate students in general.

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Recommendation of account effect by CFDI Based on Machine Learning

Recomendación de cuentas afectadas por CFDI basado en aprendizaje automático

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Abstract

This work presents a neural network model for recommending accounts that a CFDI affects. FactureApp is an invoicing application with different services developed by the company LionDev S.A de C.V. The accounting module for generating policies based on Boolean algebra is one of their main services. This application implements the laws established in the Federal Tax Code and applied by the Tax Administration Service SAT of Mexico. This work defines the elements of the CFDI that can be used to determine the account it will affect. Also, the modeling and training of neural network with 327 input data, a hidden layer with 364 neurons and an output layer of size 200 is presented. Python and the Keras module of TensorFlow are used to model and train the network. Also, an API based on the Flask Framework is modeled for requesting recommendations. At the end of this article, improvements in the model and work that must be developed to integrate it into production are discussed.

FactureApp, machine learning, SAT and CFDI

Resumen

En este trabajo se presenta el modelo de una red neuronal para la recomendación de cuentas que un CFDI afecta. FactureApp es una aplicación de facturación con diferentes servicios desarrollada por la empresa LionDev S.A de C.V. Uno de estos es la modulo contable de generación de pólizas basadas en algebra booleana. Esta aplicación implementa las leyes establecidas en el Código Fiscal de la Federación y aplicadas por el Servicio de Administración Tributaria SAT de México. En este trabajo se definen los elementos del CFDI que pueden ser usados para determinar las cuenta de este va a afectar. También, se presenta el modelado y entrenamiento de una red neurona con 327 datos de entrada, una capa oculta con 364 neuronas y una capa de salida de tamaño 200. Para el modelado de la red se utiliza Python y el módulo Keras de TensorFlow. También, se modela una API basada en el Framework flask para la solicitud de recomendaciones. Al final del presente artículo se discuten mejoras en el modelo y trabajo que se debe desarrollar para integrarlo a producción con la aplicación.

FactureApp, aprendizaje automático, SAT y CFDI.

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1. Introduction

One of the most widely used tools for problem solving is Machine Learning, (Sarker, 2021). ML has been used in image classification systems, speech recognition, text generation, virtual actor animation, automatic robot navigation, to name a few (Negi and Rajesh, 2019). In terms of invoice analysis, clafication systems have been developed, a task that was previously performed manually (Tarawneh et. al, 2019). In (Bardelli, *et al*, 2020) a paper is presented where the electronic invoice in XML format is examined to facilitate some accounting tasks such as determining the nature of bank transfers.

In particular, this work presents a neural network to simplify the process of creating accounting policies. This process consists in defining the conditions to generate the digital tax receipts CFDI's (SAT, 2023) stamped in the FactureApp platform (Facture, 2023), then some rules are created to define the accounting accounts that will be affected. Finally, the policy is generated with its respective accounting entries. In this work a neural network is trained to define a policy recommendation system based on the possible accounting accounts that can modify the CFDIs. This is achieved by creating a neural network model and training it with CFDI's and policies already generated.

The Facture App platform of LionsDev S.A. de C.V., in order to automate the creation of accounting policies, requires the end user, who is generally an accountant, to enter a set of rules. These rules are constructed using Bool algebra. Here, it challenges users to train and develop Boolean algebra skills. Python (Python, 2023) and the modules: tesnsorflow (Abadi *et al*., 2015), pandas, numpy, keras, sklearn and flask were used to implement the neural network. It is used in the Anaconda development environment.

2. General aspects of machine learning and fundamentals of accounting issues

In this section the fundamental concepts of machine learning and policy generation are presented. As well as, the definition of the data of interest.

2.1. General steps for problem solving using machine learning

Machine learning follows the following phases for problem solving: data generation, data pre-processing, model generation, model evaluation, parameter tuning and release.

2.2. Accounting policies

An accounting policy is a physical or digital document that reflects the accounting movements of an organisation. It provides an accurate record of its operations and helps to make financial decisions. An accounting entry is the notation or record that reflects some economic movement of a company or person. This movement can be an inflow or outflow of money. In general, accounting entries are assets, liabilities and equity.

An accounting policy must contain the following data: a) information on the type of policy; b) item with accounting account, sub-account and auxiliary accounts; c) CFDI vouchers; d) taxes, e) RFC and the amount covered by the policy. There are different types of policies. A journal policy records and attaches the vouchers of business transactions that do not generate bank movement in the business account. The outgoing policy records all outgoing cash movements, e.g. payroll payments, payments to creditors, among others. A third type of policy is the income policy, which records movements that generate an inflow of money to the company's account.

In Mexico, Article 28 section. IV of the Fiscal Code of the Federation (CFF) mentions that the persons who, in accordance with the fiscal provisions, keep the accounting of the company must comply with the monthly entry of the accounting information, through the official page of the SAT, in the rule 2.8.1.6 of the SAT talks about the compliance of the delivery of the accounting in electronic media in a manual way. In general terms, it mentions that the information submitted must be in XML format; legal entities must send the accounting information no later than the first 3 days of the second subsequent month; it mentions that individuals must send it monthly no later than the first 5 days of the second subsequent month; it also states that issuing taxpayers must send the information in monthly files every four-month period.

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This work is done using the Facture App platform. Within the modules, there is the accounting automation module. This tool is used to reduce and optimise the work time of the accountants. It creates rules and conditions for the initial configuration of a chart of accounts where the policies of the accounting entries will be created automatically.

To automate the creation of policies, it is first necessary to define the condition that allows to obtain the CFDIs that are of interest, for example, PPD (payment in deferred instalments) that belong to an issuer with a particular RFC. At this point, the rules that must be complied with are defined for each receipt or concept. The rules that are defined have the form SI (condition1) OP (condition2) OP (...), where OP refers to a Boolean operator.

An example of a rule is:

IF (RFC of issuer contains IVDNNNNNN)
and
(Voucher payment method EQUALS PPD)

Once the rules have been created, they must be associated to the accounting records. Subsequently, the rule is applied to identify the CFDIs that comply with the rules and from these the policies are generated automatically.

Within the company Liondev SA de CV it was found that the end users, accountants, have difficulties in the use of the automation module for the generation of policies. Specifically in the definition of the rules to filter the CFDIs of interest for the creation of accounting policies. This paper addresses the use of IA for the creation of accounting policies from a CFDI as a source document.

2.3. Definition of the dataset variables

Based on the previous section, the attributes of interest of a CFDI XML are payment method, voucher type, payment method, CFDI usage and product or service key. A CFDI receipt is shown in Figure 1.

Figure 1 XML of a CDFI, with its different fields

The values of the payment method variable are: PUE (payment in a single exhibition) and PPD (payment in instalments or deferred). For the voucher type variable: I (income), E (expenditure), T (transfer), N (payroll) and P (payment) are used. The form of payment is a variable that indicates the means by which the products or services can be paid, see Table 1.

Method of payment	Description
01	Cash
02	Nominative cheque
03	Electronic funds transfer
04	Credit card
05	Electronic purse
06	Electronic money
08	Food vouchers
12	Payment in kind
13	Payment by subrogation
14	Payment by consignment
15	Forgiveness
17	Compensation
23	Novation
24	Confusion
25	Remission of debt
26	Prescription or lapse of time
27	To the satisfaction of the creditor
28	Debit card
29	Service card
30	Advance payment application
31	Payment intermediary
99	To be defined

Table 1 Values for the form of payment variable.

The CFDI use variable is the option that best describes the use of the CFDI for deductions. Given that the list is very long, only some of these are shown: G01 (Acquisition of goods), G02 (Returns, discounts or rebates), G03 (General expenses), I01 (Construction), D01 (Medical fees), S01 (No tax effects), CP01 (Payments), CN02 (Payroll) and P01 (To be defined). For the product or service code, this allows you to identify the concept you wish to invoice, in the catalogue provided by the SAT it has 52 thousand options.

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This code is made up of 8 digits: division (first two digits), group (next two digits), class (next two digits), subclass (last two digits). For example, the code 50201706 refers to the following:

– 50: Food, beverages and tobacco.
– 20: Beverages
– 17: Coffee and tea
– 06: Ground coffee.

In order to use this type of information, it must be converted to numerical values. One technique is using cardinality of the dataset, another technique is applying hash code (when the amount of data is very large).

3. Machine learning model for generating account recommendations

The model proposed is a neural network for data classification. Given the input sets, the response of the network is a probability vector, where each value indicates the probability of belonging to a class. In particular, the resulting vector in our case will indicate the probability of making movements in the accounting accounts.

3.1. Input data

To train the network, an initial dataset of dimension 5 with 2226 records was created. This data has the format shown in Table 2.

No	Method of payment	Method of payment	Type of voucher	Use of CFDI	Product or service key
0	PUE	1	INGRESO	I02	01010101
1	PPD	99	INGRESO	S01	10101500
2	PUE	2	INGRESO	I05	10101500
2225	PUE	99	NOMINA	I04	10224700

Table 2 Format of the data record. The product or service key was separated according to the form in which it is coded. Therefore the record has dimension 8

The data set consigns 200 accounting accounts represented by consecutive numbers. For the above input data, their output values are shown in Table 3.

No.	y(exit
0	**0**
1	**1**
2	**2**
2225	**37**

Table 3 Table of desired output values, of the accounting accounts to be assigned

Since the data to be trained are few, this dataset was increased. Using two strategies: randomly duplicating a record and artificially generating new ones with known data up to 71232.

Now the coding of the data was done using the One-Hot technique (Hancock, 2020), where all possible values for each input variable are presented and a value of 1 is assigned only to the value corresponding to the value of the input in Table 2. This results in an input vector of 327 binary entries, thus obtaining a sparse matrix of 71232 rows x 327 columns, the rows corresponding to the number of records.

This data set is divided into two sets, a test set and a training set, divided into 25% and 75% respectively.

3.2. Definition of the neural network model

To define the neural network, the TensorFlow keras library is used. The network is composed of an input layer of 327 neurons; a hidden layer of 364 neurons with ReLu activation function and L2 regulator; and finally an output layer with 200 neurons with softmax activation function, see Figure 2.

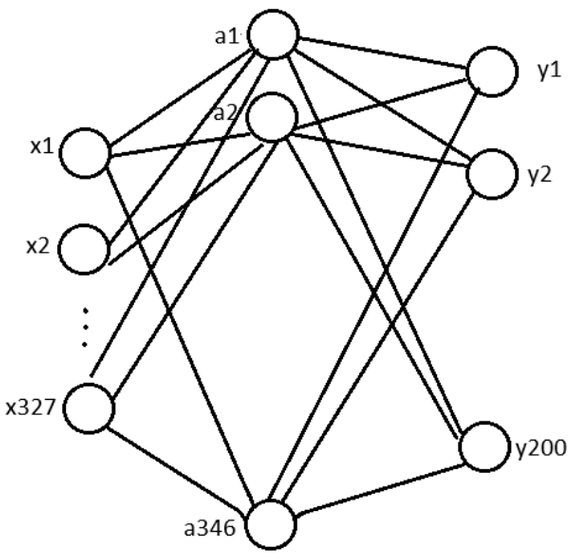
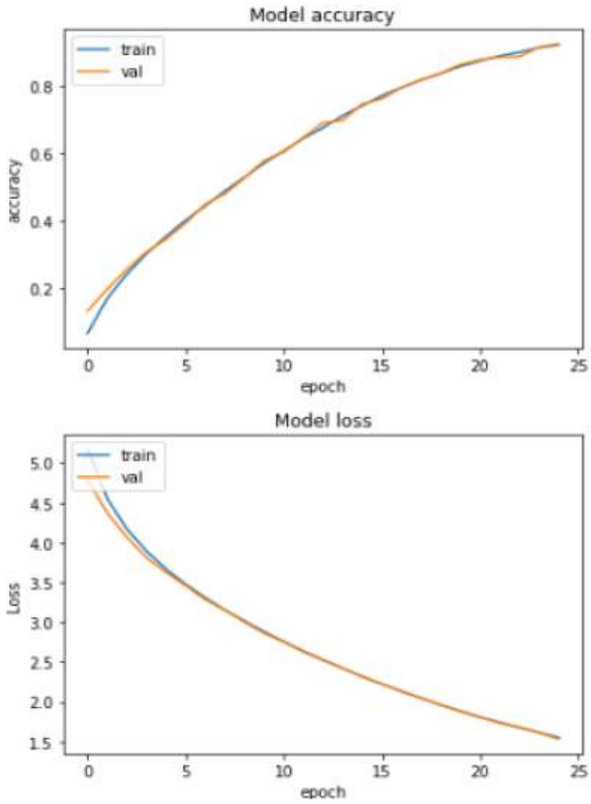


Figure 2 Neural network with 327 inputs, a hidden layer of 346 neurons and 200 outputs

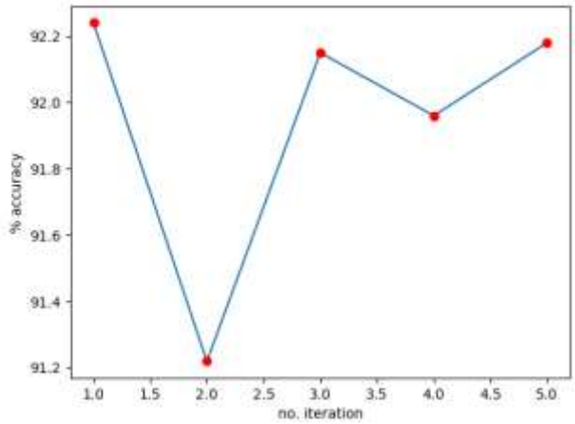
3.3. Training the neural network

To train the neural network, the cross-validation technique defined in 5 iterations was used. The validation consists of evaluating by training using subsets of data and evaluating with the complementary set.

It was defined 75% for training and 25 for validation. In addition, 25 epochs per iteration are used. Figure 1 shows the loss function and the percentage accuracy for the first iteration of training. In Graph 2, the evolution of the accuracy over the 5 iterations is presented. From the graph an accuracy of 92.18% is obtained, hence in this model in the first iteration a maximum value of 92.24% is obtained. However, the use of cross-validation and training by epochs is intended to avoid over-fitting the network over-fitting of the network.



Graph 1 Model accuracy and network loss function, during first iteration.



.

Graph 2 Accuracy of the model during the 5 iterations, it is observed that the maximum value is found in the first iteration.

The trained model is stored in a h5 and json format for future use. The JSON file stores all the characteristics and architecture configurations of the neural network and the .h5 file stores the value of the neural network hyperparameters generated in the training process.

4. API for prediction of accounting accounts that modifies the CFDI

To create the API, tensorflow was used to load and evaluate the model; sklearn for One-Hot encoder, numpy matrix operations and the mini framework flask for creating web applications. The prediction API workflow consists of first loading the prediction model. The json format consists of the format shown in Figure 3. Within the format are the fields from section 3.1, as well as the number of recommendations that correspond to the accounts that this CDFI should modify. With the data included in the request, the input values are created using sklearn's One-Hot.

```
{
    "data":{
        "metodoDePago": "PUE",
        "formaDePago": "1",
        "tipoDeComprobante":"INGRESO",
        "usoCFDI":"I02",
        "claveProdServicio": "01010101"
    },
    "numberRecommendations":5
}
```

Figure 3 json representation of the request

Subsequently, the input is submitted and the model is evaluated. The response is generated by sorting the results of the network, the first 5 are encoded and sent in a json format. The format of a response is shown in Figure 4.

```
{
    "prediction": [
        1,
        191,
        135,
        143,
        87
    ],
    "text": "Esta es la predicción..."
}
```

Figure 4 Request response format, indicating the possible categories that the CFDI is to be modified

5. Results obtained

A first result was the analysis of the CFDIs to determine the structure of the input and output data using the One-Hot technique. At this point, a proprietary database was generated in which, given a CFDI, the account to be modified is categorised. A second result obtained was the creation of a neural network for the suggestion of the categories or accounting accounts that are likely to modify the CFDI. During training, an accuracy of 92.18% was obtained. Also, a web API was created to make recommendations of the movements of accounting accounts that are modified by a CFDI.

6. Acknowledgement

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7. Conclusions

This work presented a neural network model for account recommendations that a CFDI can modify. Fields of a CFDI that are of interest to determine the account were defined, and how to code these entries was also presented. However, further collection of information from records needs to be analysed to train the model so that it can be moved into production. Also, the creation of different models with more neurons and more hidden layers can be explored. More experimentation with real data and end users is needed. Another area of opportunity is the development of interfaces that allow users to query and collect data to train the network or modify the model.

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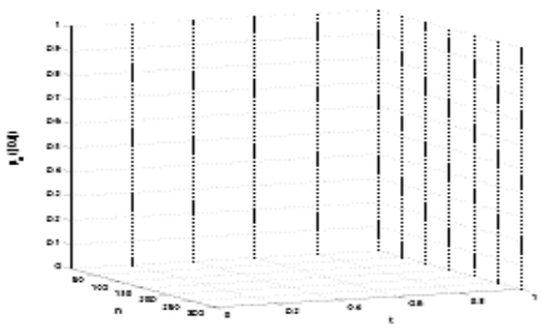

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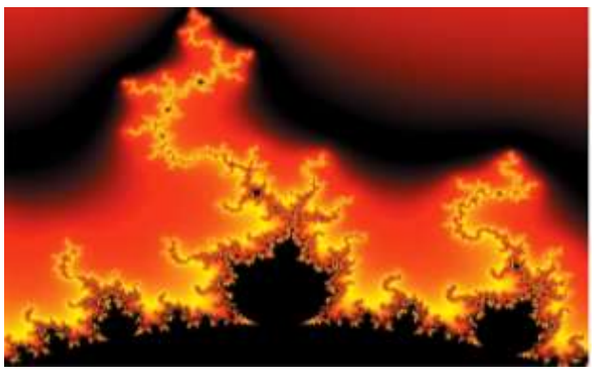

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