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ECORFAN Journal Republic of Nicaragua

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Knowledge Area

The works must be unpublished and refer to topics of agriculture-forest, pathology-sustainable, forest, management, horticulture, engineering and integrated water useand other topics related to Biotechnology and Agricultural Sciences.

Presentation of Content

As the first article we present, *Building the future: Innovation and peace at the Autonomous University of Campeche*, by Niño-Gutiérrez, Naú Silverio and Valencia-Gutiérrez, Marvel del Carmen, with adscripction in the Autonomous University of Guerrero and Autonomous University of Campeche, as a second article we present, *Detection of training needs for university teachers in the Area of Economic-Administrative Sciences: A study at the Autonomous University of Nayarit*, by Gómez-Campos, Sinahí Gabriela, Félix-Pérez, Sirigui Garibeth, Granados-Magaña, Javier Alejandro and Maldonado-Bernal, Mónica del Rocío, with adscripction in the Universidad Autónoma de Nayarit, as third article we present, *Promoting gender equality through experiments with water rockets in distance physics class between the Technological University of Jalisco, Mexico and the Technological University of Bolívar, Colombia*, by Barrón-Balderas, Juan José, Ojeda-Caicedo, Vilma Viviana and Fausto-Lepe, Gabriela Margarita, with adscripction in the Universidad Tecnológica de Jalisco and Universidad Tecnológica de Bolívar, as fourth article we present, *Students' perceptions towards blended learning modality after COVID-19 pandemic: a case study*, by Flores-González, Norma, Flores-González, Efigenia, Castelán Flores, Vianey and Zamora Hernández, Mónica, with adscripction in Universidad Autónoma de Puebla, as next article we present *The growth exponential of the earthworm red Californian (Eisenia foetida) on a substrate of organic waste*, by García-García, Damaris Carmen, Hernández-García, Cintia Elí and Diez-Barroso-Agroz, Allan Ronier with adscripction in Polytechnic University of the Valley of Mexico, as last article we present *Quantification of heavy metals in agricultural soil of Lampotal Vetagrande Zacatecas*, by Hernández-Salas, Claudia, Olarte-Saucedo, Maricela, Moreno-Longoria, Julieta and Orta-Martínez, Felipe, with adscripction in Universidad Autónoma de Zacatecas "Francisco García Salinas".

Content

ECORFAN Journal Republic of Nicaragua 10[18]1-13: e11018113
Article

Building the future: Innovation and peace at the Autonomous University of Campeche

Construyendo el futuro: Innovación y paz en la Universidad Autónoma de Campeche

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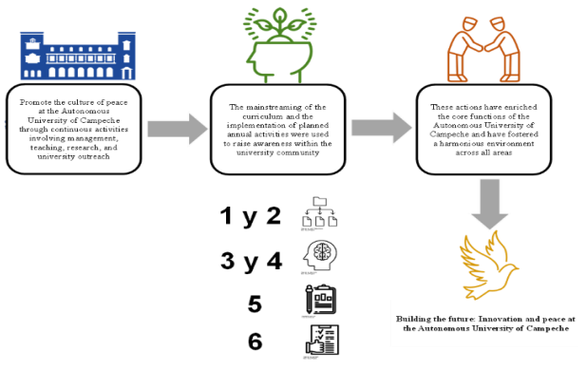
Abstract

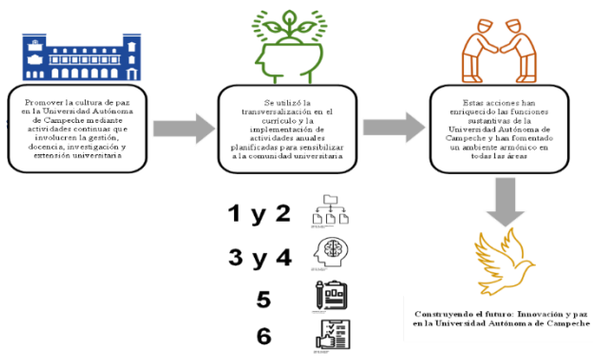
The Autonomous University of Campeche has integrated the culture of peace into its Equality and University Inclusion unit, with the aim of strengthening its presence within the institution and raising awareness among the university community. The general purpose was to promote the culture of peace through continuous activities involving management, teaching, research, and university outreach. The methodology employed was based on incorporating peace education into the curriculum, implementing a series of annually planned activities that continuously raise awareness among the entire university community. Results: these actions have enriched the University's core functions, fostering a harmonious environment across different institutional areas. Conclusions: the integration of the culture of peace and university inclusion into the curriculum is key to shaping generations committed to peace.



Culture of Peace, Higher education, Mainstreaming

Resumen

La Universidad Autónoma de Campeche ha integrado la cultura de paz a su unidad de Igualdad e Inclusión universitaria, con el objetivo de fortalecer su presencia en la institución y sensibilizar a la comunidad universitaria. El propósito general fue promover la cultura de paz a través de actividades continuas que involucren a la gestión, docencia, investigación y extensión universitaria. La metodología empleada implicó como base retomar la transversalización en el currículo, se implementa una serie de actividades planificadas anualmente que permiten sensibilizar a toda la comunidad universitaria de manera constante. Resultados, estas acciones han enriquecido las funciones sustantivas de la Universidad, promoviendo un ambiente armónico entre las diversas áreas de la institución. Conclusiones, la integración de la cultura de paz y la inclusión universitaria en el currículo es clave para construir generaciones comprometidas con la paz.



Cultura de Paz, Educación superior, Transversalización

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Introduction

In the pursuit of peacebuilding, social well-being was deemed essential, involving the integration of young people into educational and labour spheres, promoting economic development from the grassroots level, and rebuilding the social fabric (Niño-Gutiérrez et al., 2016). In this context, the decision was made to support youth rather than criminalize them; addictions were approached as a public health issue rather than a law enforcement problem. The creation of a culture of peace strengthened the community, and through education, the change was profound and enduring.

This article aims to contribute to addressing the following question: How can the Autonomous University of Campeche effectively coordinate and integrate the culture of peace, equality, and inclusion into its academic curriculum to maximize the impact of these actions on the awareness and holistic education of its university community?

To achieve peace, challenges such as extreme poverty, lack of job opportunities, increasing illiteracy, and discrimination based on ethnicity, age, sexual orientation, gender, physical condition, economic and social status, as well as all forms of structural and direct violence linked to abuse of authority, were addressed.

Consequently, the eradication of these abuses was proposed to build an environment based on principles of justice, development, and equal rights, thus promoting a democratic distribution of power. In this way, education for peace was conceived as a proposal aimed at the recognition, respect for rights, and liberation of all human beings, with the objective of achieving genuine participation in transformative processes, grounded in the creation of just and equitable societies (Paz et al., 2019).

A supporting idea for this argument is the direct relationship between peace education and social transformation. Education should not only focus on imparting knowledge but also on shaping citizens who can recognize and respect the rights of others, actively promoting their participation in processes that foster equity and justice.

By empowering individuals through human rights education and peaceful conflict resolution, the foundation is laid for the democratic redistribution of power and the development of inclusive and sustainable societies.

The holistic education of students was implemented in universities through various means: curricular, extracurricular, cultural activities, sports, and tutoring, among others, in which teachers played a significant role. This education was viewed as a means to transform the current culture and give way to a new culture of peace, which was built through human interactions.

An idea that supports this argument is the central role of multiple educational spaces (both curricular and extracurricular) in the comprehensive formation of students. These spaces not only foster academic development but also interpersonal skills and values that contribute to building a culture of peace.

It was recommended that this process begin within the family and school, involving other actors and enabling new ways of perceiving and resolving conflicts at various levels of human relationships and in spaces of social, family, school, and political interaction (Pérez & Godin, 2020).

It reinforces the importance of developing new ways to perceive and manage conflicts, which is essential for building a more equitable and democratic society. Therefore, the integration of key actors at different levels strengthens the transformation towards a culture of peace that transcends the educational environment and permeates society as a whole.

The central purpose of this paper is to analyse how the Autonomous University of Campeche has strengthened the culture of peace through its integration into the University's Equality and Inclusion Unit, highlighting the importance of integrating these themes across the academic curriculum. The aim is to demonstrate how planned and coordinated actions contribute to the continuous awareness-raising of the university community and the enhancement of the institution's core functions, promoting an environment of peace and equity among new generations of students.

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It is important to highlight the social impact of the negotiator's role in disseminating results across various social environments, promoting informational campaigns in educational institutions, family welfare institutions, and community actions, fostering spaces for discussion and debate, and adopting an active and creative stance that contributes to the prestige of reconciliation and peace (Villa et al., 2020).

It emphasizes the importance of the negotiator's role in promoting peace and reconciliation through the dissemination of results in various social environments. A statement that supports this position is that the negotiator acts as a bridge between conflicting parties and society, facilitating the flow of critical information that fosters understanding and dialogue within the community. Through educational campaigns, not only in academic institutions but also in family welfare organizations and community actions, a conducive environment for constructive discussion is created.

Additionally, the negotiator's role is essential in promoting active civil society participation in reconciliation processes, creating spaces for debate and reflection on social issues.

By adopting a creative and proactive stance, the negotiator not only strengthens conflict resolution but also helps legitimize and elevate peace processes. Thus, their function goes beyond simple mediation, becoming a key player in long-term social change.

The integration of the culture of peace into the university curriculum in any of its axes allowed university students not only to anchor educational content to their discipline or field of knowledge but also to connect with social reality, making their learning more meaningful by being oriented toward current reality. Additionally, it provided them with the ability to develop critical thinking linked to social justice and sustainable human development, recognize the nature of conflicts, and contribute to the construction of environments of solidarity and respect for equitable and mutual benefit (Ochoa, 2021).

Hence, the research question aligned with the aforementioned purpose is: How does the integration of the culture of peace into the University's equality and inclusion unit and its incorporation into the academic curriculum contribute to strengthening the core functions of the Autonomous University of Campeche (UACam) and to the continuous awareness-raising of its university community?

The study of the culture of peace at the Autonomous University of Campeche is embedded in a contemporary theoretical framework that emphasizes peace education as a cross-cutting axis in the comprehensive formation of students. This framework, supported by research from databases such as Scopus, Web of Science, SciELO, Semantic Scholar, and Dimension, highlights the importance of integrating values such as social justice, equity, and respect for human rights into educational programs. Authors like Trujillo et al. (2024), in line with perspectives on peace in higher education, stress the need to coordinate institutional actions to achieve a sustained impact on community awareness. This integration promotes a critical pedagogy that not only educates for peace but also transforms social and cultural environments through conflict resolution and democratic participation.

Methodology

This study was conducted using a qualitative approach with a descriptive-analytical design. This approach allows for the exploration and understanding of the integration of the culture of peace, equality, and inclusion into the academic curriculum of the Autonomous University of Campeche, as well as an evaluation of the impact of these actions on raising awareness within the university community.

The research was carried out at the Autonomous University of Campeche, focusing on the educational programs that have incorporated the culture of peace and equality and inclusion since the implementation of the curricula in 2009. The study participants include key members of the university community, such as faculty directors, coordinators of the Peace Committees, teachers, students, and administrative staff.

Data collection was conducted using the following techniques:

ISSN: 2414-8830.
RENIECYT-CONAHCYT: 1702902

i. *Document analysis*, the study reviewed curricula, constitutive records of the Peace Committees, annual work agendas, and other related institutional documents to analyse how the culture of peace and University Inclusion have been integrated and mainstreamed into the academic curriculum.

ii. *Participant observation*, participant observation was conducted during workshops, conferences, and peace circles organized by the Peace Committees, with the aim of documenting the dynamics of these activities and their influence on the university community.

To ensure the validity and rigor of the findings, data triangulation techniques were employed, contrasting information obtained through interviews, focus groups (Valencia-Gutiérrez et al., 2019), document analysis, and participant observation. Additionally, the results were reviewed with some key participants to confirm the accuracy and relevance of the interpretations.

The study acknowledges the potential for bias in participants' responses, as most of them are actively involved in the Peace Committees or University Inclusion actions. Furthermore, the study is limited to a single educational institution, which may restrict the generalization of the findings to other universities or educational contexts.

The contribution of this article lies in its enhancement of the understanding and strengthening of the culture of peace within the context of higher education, specifically at the Autonomous University of Campeche.

By analysing the integration of the culture of peace into the University's Equality and Inclusion Unit (EIU), the article provides a detailed insight into how mainstreaming these values into the academic curriculum and institutional activities can positively influence the university community's awareness. This study not only highlights the importance of the culture of peace as a central axis in the holistic education of students but also provides evidence of best practices implemented to ensure that these values are effectively internalized across the entire university community.

By documenting and evaluating these practices, the article offers a model that other higher education institutions could adapt and adopt, thereby contributing to the creation of a more just, supportive, and peaceful educational environment.

Moreover, the article underscores the need for effective coordination and structured planning to avoid duplication of efforts and maximize the impact of peace and equity initiatives. This approach ensures that awareness-raising actions are more effective, which in turn enriches the university's core functions in management, teaching, research, and outreach.

In sum, the article represents a valuable contribution to the field of education for peace, offering a deep reflection on the relevance and practical implementation of the culture of peace in higher education, with implications that can extend to other educational contexts and contribute to the formation of citizens committed to building a more equitable and peaceful society.

Results

Peace Education has been directed towards the teaching of conflict resolution, as conflicts are a constant in social life, reflecting the diversity of interests and perspectives. The aim has been to foster the development of attitudes, values, behaviours, and conduct such as respect for individuals, solidarity, justice, freedom, equality, tolerance, participation, among others, with the goal of contributing to the construction of a democratic culture (Esquivel & García, 2018).

A key idea supporting this argument is that peace education not only addresses conflict resolution but also fosters the development of fundamental values such as justice, equality, solidarity, and tolerance. These values are essential not only for peaceful coexistence but also serve as the foundation for building a strong democratic culture, where individuals can actively participate in social and political life, respecting the rights of others.

The emphasis on attitudes and behaviours that promote equality and freedom, as mentioned, aligns with the notion that a true democratic culture is sustained when citizens are trained not only cognitively but also ethically and emotionally.

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Peace education helps to form critical citizens who not only identify conflicts but are also capable of transforming them constructively, promoting social justice and active participation in creating more equitable societies. This highlights the importance of education that transcends the classroom and promotes peace as a daily practice in all spheres of social life.

The inclusion of cross-cutting themes in university curricula, such as environmental education, peace education, or education for equality, has underscored the value of cross-cutting approaches as a response to the purpose of education. This inclusion provided a vision for intervention and the development of social awareness and values in students from a humanistic, critical, and ecological paradigm (Picón & Frausto, 2022).

The importance of cross-cutting approaches in university curricula, such as environmental education, peace education, or education for equality. One idea supporting this argument is that these approaches allow for a comprehensive education of students, as they do not merely focus on the transmission of technical knowledge, but also promote critical and social awareness.

The inclusion of these themes facilitates the interrelationship between various areas of knowledge, helping students understand global issues from a multidisciplinary and humanistic perspective (Figure 1).

Box 1

Figure 1

Social inclusion activity at UACAm

Source: Valencia Gutiérrez, 2024

For example, peace education combined with environmental education fosters an ecopedagogical approach, where students not only learn to resolve human conflicts but also to interact ethically with their environment (Niño-Gutiérrez, 2023). This type of education promotes the development of citizens who act not only based on knowledge but also from fundamental values such as social justice and environmental sustainability, crucial factors for the development of a more equitable society, aware of its social and ecological responsibilities. Thus, the vision that education must have a transformative impact on society is strengthened, beyond the simple acquisition of technical skills (Niño-Gutiérrez, 2023).

It is necessary for universities to reflect on their responsibility to redefine their role in relation to their social function, taking on the challenges posed by a constantly changing society. From this perspective, the importance of considering a paradigm of peace culture is highlighted, and consequently, generating alternatives to prepare the actors involved in the social fabric through education (Alcaraz et al., 2023).

A notion that validates this statement is that universities should not only be centres for the transmission of technical knowledge, but also agents of social change. In facing current challenges—such as inequality, social conflicts, and environmental crises—universities must incorporate a paradigm of peace culture into their educational programs to prepare students as transformative actors within the social fabric.

This approach requires educational institutions to redefine their responsibilities, shifting towards a model of education that prioritizes social justice, equity, and sustainability. By adopting a peace culture-based approach, universities can develop educational alternatives that empower students not only to identify and solve problems but also to promote peaceful coexistence and ethical conflict resolution. This type of education transforms university training into a process that not only prepares competent professionals but also critical and engaged citizens committed to creating a more just and equitable social environment.

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Any effort made by the national and international community to build a world of peace and social justice would be ineffective if the deep sources of conflict resolution from university educational centres are not taken into account. These sources form the foundation for guiding values, attitudes, knowledge, and skills that will shape the competent professionals of the future (Islas et al., 2018).

Any national or international effort to promote peace and social justice will be ineffective if universities do not play an active role in teaching conflict resolution. An idea that supports this statement is that universities should serve as the core of social transformation since they are the institutions responsible for educating future professionals. These professionals, if educated within a culture of peace, will be equipped with the necessary skills, attitudes, and values to address and resolve conflicts ethically and peacefully, which is essential for building democratic and equitable societies.

Therefore, pedagogical processes that educate students in peace culture must be developed, facilitating the understanding of the process leading to its full realization, healthy coexistence, democratic participation, and conflict resolution (Rojas, 2018).

The development of these pedagogical processes is essential to ensure that students not only become competent professionals but also active citizens who promote peace and justice within their communities.

In this context, the role of universities is fundamental to guarantee that the values of peace are not only taught but lived and applied in everyday life, forming the foundation for sustainable and effective social transformation.

Peace education has also been recognized for its capacity to strengthen self-esteem, allowing individuals to overcome the fear of expressing their own opinions and accepting those of others to find solutions or simply enjoy a friendly conversation. Although peace education has always been an ideal for achieving appropriate and lasting coexistence, its meaning has varied over time, presenting various, sometimes contradictory, paths to achieve it due to the diversity of values it encompasses (Castillo & Ramírez, 2020).

The impact of peace education on strengthening self-esteem and individuals' ability to express their opinions and accept those of others is highlighted. A perspective that confirms this statement is that peace education not only has a technical component for conflict resolution but also promotes emotional development and personal empowerment. By fostering confidence in communication, peace education equips individuals to engage in constructive dialogues, which is crucial for seeking peaceful solutions.

Moreover, the variability in its meaning over time, as noted in the quote, reflects the complexity of the values that peace education encompasses, such as justice, tolerance, and solidarity. These values, although sometimes seemingly contradictory, contribute to the creation of spaces where dialogue and peaceful coexistence are possible. Therefore, peace education not only focuses on teaching conflict resolution skills but also on creating a culture of mutual respect and understanding, which is essential for lasting coexistence in diverse societies.

The development of a peace education program, both in formal and informal education contexts, requires the incorporation of activities and content that allow for the experience, reflection, and projection of actions around the values and principles that constitute it (Santiago et al., 2021).

A concept that corroborates this assertation is that for peace education to be effective, it must be experiential and transformative, allowing students to internalize the principles of peace through practical experiences. By integrating activities that promote critical reflection, such as dialogue circles or conflict mediation in educational settings, students not only learn about peace theoretically but also apply it in their daily lives. This practical approach reinforces peace principles, such as justice and equity, and contributes to the creation of a sustainable peace culture within society. Additionally, informal education, through community workshops or extracurricular activities, allows for broader social projection, extending the impact of peace education beyond the classroom and generating positive change in the social and community environment.

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Therefore, an experiential approach to peace education is essential to develop individuals not only capable of understanding the concepts of peace but also of living and practicing them, thus promoting lasting and effective social transformation.

Peace has been associated with a series of practices and values that have led to its conceptualization as both an exercise and a universal right, as well as a field of analysis and object of study in the social sciences and even in the philosophy of language. The latter has articulated its ethical and political dimension, proposing its understanding through public argumentation and deliberation. Actions such as sharing, learning, socializing, or values like compassion, friendship, and empathy are often associated with a state of tranquillity that is an inherent part of human life (Gómez, 2019).

A perspective that confirms this statement is that peace is not simply the absence of conflict, but rather the active participation in practices of empathy, compassion, and friendship. These values, beyond their individual connotation, have a profound social impact, as they foster harmonious coexistence and promote mutual respect.

From the perspective of social sciences and the philosophy of language, peace acquires an ethical and political dimension, as it requires public deliberation and a space for dialogue where the rights and dignity of individuals are recognized. This approach highlights the need to conceptualize peace as a multidimensional phenomenon, extending from the personal realm to the community and global levels. The fact that everyday actions such as sharing, learning, and socializing are associated with peace demonstrates that this concept is deeply intertwined with human nature and that its practice requires an active and collective construction. This underscores the importance of educating in values such as empathy and solidarity, which are fundamental to achieving sustainable peace in both interpersonal relationships and the broader social and political spheres.

It is crucial to reflect on the fact that peace is not merely an additional topic in the curriculum but a cross-cutting axis that permeates all dimensions of higher education in Mexico.

Therefore, it is deemed necessary to implement peace education as an integral component in higher education institutions (HEIs) (Calvario, 2024).

An idea that supports this argument is that peace, as a fundamental value, must be incorporated into all academic disciplines and not confined solely to areas such as social sciences or civic education. By doing so, an integral education is created that not only promotes academic development but also fosters the personal and social growth of students.

Integrating peace education into the university system ensures that future professionals graduate not only with technical skills but also with the ability to resolve conflicts peacefully, promote justice, and actively participate in building a more equitable society.

This approach is crucial in a global context where violence, inequality, and conflicts are constant challenges. By embedding peace as a cross-cutting principle, students are shaped into socially responsible individuals who are equipped to drive positive change in their communities.

Moreover, the transversal integration of peace in the university curriculum addresses the need to transform educational environments into spaces that not only teach but also practice and embody the values of peace. This is essential for generating a sustainable culture of peace, extending from campus life to interactions in the professional and social spheres, thus strengthening the social fabric in Mexico and beyond.

Education in the 21st century presents unprecedented challenges driven by advances in science, artificial intelligence, and the understanding of brain function, which compels a rethinking of education from new perspectives.

A fundamental perspective is peace education, which empowers citizens and raises awareness of the importance of building a culture of peace. This process can only be solidified through the incorporation of a specific subject aimed at this goal, as peace is taught and learned, and conflict is transformed (Loyola, 2023).

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An idea that supports this statement is that peace education becomes an essential tool to address these challenges, not only because it empowers citizens but also because it fosters critical and ethical awareness regarding the construction of peaceful and just societies.

The rapid pace of technological and scientific advances requires education to shape individuals capable not only of handling these technologies but of doing so with an ethical approach. This is where peace education plays a fundamental role, as it prepares students to transform conflicts and promote dialogue in an increasingly interconnected world. By incorporating peace as a specific subject, it ensures that peace is not only taught and learned but lived, helping students internalize the values of cooperation, tolerance, and respect.

Moreover, peace education responds to global issues that technological advances, such as artificial intelligence, could exacerbate, such as inequality and social polarization. By including this training, educational institutions not only prepare students to face these challenges but also to transform them into opportunities to promote understanding and equity. This reinforces the importance of a comprehensive educational approach that not only trains competent professionals but also ethical citizens committed to building a peaceful and sustainable world.

Education must be grounded in a clear intentionality, which positions the field of pedagogy as the appropriate domain for reflecting on the intentionality of educational acts in the various environments designed for this purpose. In this way, pedagogy is defined as the philosophical framework that guides both the understanding of the educational process and the purpose of education itself.

A statement that supports this position is that pedagogy is not simply a set of techniques for transmitting knowledge, but rather a discipline that articulates the ethical and social purpose of education. This approach implies that education cannot be neutral; it must have a clear purpose: to form critical citizens committed to social transformation.

Intentionality in pedagogy allows educational actions to be designed with a defined purpose, which in turn guides the development of methodologies and practices that respond to the specific needs of students and society. By positioning pedagogy as the philosophical framework, its capacity to guide educational decisions towards the construction of a system that not only instructs but also cultivates values and attitudes contributing to the common good is recognized. In this sense, pedagogy provides the conceptual tools necessary to understand the ultimate purpose of education: to promote the holistic development of students, fostering both their cognitive skills and their ethical competencies.

The Chair of Peace and Peace Education does not represent new subjects or areas within the school curriculum, as these themes have been implicit in the development of citizenship competencies, principles and values, ethics, and human rights, among other subjects.

The goal is to establish a formal structure, considering that each educational institution has the autonomy to design its own institutional educational plan and curriculum (Rivas et al., 2019).

The Chair of Peace and Peace Education does not introduce completely new content into the school curriculum; rather, it formalizes themes that are already implicit in the development of citizenship competencies, ethical values, and human rights. One idea supporting this argument is that peace and peace education are fundamental to the student's holistic formation and are already present in many disciplines, though not always explicitly. Formalizing these themes through a dedicated chair allows them to be structured more coherently and systematically within the educational plan.

The autonomy of each educational institution to design its own curriculum is key to ensuring that peace values are integrated in a contextualized and relevant way, addressing the specific needs of each educational community.

This allows peace education to be viewed not as an isolated addition but as an integral part of ethical and civic education.

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By formalizing peace education, institutions are empowered to develop conscious and responsible citizens, capable of promoting social justice, peaceful coexistence, and the defense of human rights in their communities.

This approach also responds to the growing demand to educate individuals who are not only competent in their fields of knowledge but also committed to building a more just and equitable society. Thus, the formalization of peace education within the curriculum is a crucial step in transforming educational environments into spaces for social transformation.

Tolerance, respect, and diversity are fundamental pillars of the culture of peace.

Therefore, it is crucial to understand how young people perceive, value, and interpret this social phenomenon, as this understanding provides essential information for designing intervention and promotion strategies for the culture of peace that are effective and meaningful for this group.

Only through a deep understanding of social representations can we move toward a more just, supportive, and peaceful society (Calderón & Jiménez, 2024).

Tolerance, respect, and diversity are essential pillars of the culture of peace, highlighting the importance of understanding how young people perceive and interpret these values. A notion that validates this statement is that, in order to design effective strategies for peace promotion and intervention, it is crucial to understand the social representations that young people hold of these concepts.

Only through a deep understanding of these representations can educational programs and campaigns be created that truly resonate with them and promote the internalization of these values.

The success of any peace promotion strategy lies in its ability to resonate with the experiences and perspectives of young people. Youth perceptions of tolerance and respect are influenced by their social, cultural, and familial environments, making it necessary to address these differences in order to design inclusive interventions.

Understanding these diverse social representations not only facilitates the design of more effective programs but also allows for better adaptation of initiatives to specific contexts, fostering a more inclusive and sustainable peace.

Lastly, this understanding is key to promoting a more just and supportive society, as it facilitates the creation of spaces for dialogue where differences are respected and valued. By understanding how young people interpret these values, institutions can foster peaceful coexistence that encourages mutual respect and equity, which is essential for advancing toward a more cohesive and peaceful society.

The Autonomous University of Campeche has recognized the importance of strengthening the culture of peace within the institution by integrating all actions related to this theme into the Responsible Unit (RU) for University Inclusion and Equality, created in May 2019, although the culture of peace program had been initiated in 2003.

This integration seeks to coordinate activities that contribute to strengthening the culture of peace, equality, and university inclusion, areas that converge in their objectives.

To this end, peace committees were established in each faculty, with the faculty directors acting as presidents of the respective committees.

These committees include, among their members, the academic secretary, the person responsible for tutoring, the person responsible for university health, the person responsible for interculturality, the person responsible for culture and sports, the person responsible for gender, and the person responsible for peace.

The peace committees coordinate with the University Equality Unit to organize work meetings, establish an annual activity agenda, including workshops, conferences, and peace circles, with the goal of raising awareness among the entire university community: faculty, students, and administrative staff. Additionally, continuous training is provided to committee members.

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Each committee member is assigned specific activities to be carried out annually, and as a committee, they meet to conduct joint activities directly coordinated by the RU. These activities are essential for the holistic education of the University's students, so it is crucial that they are planned in a coordinated manner to avoid scheduling conflicts that could affect the awareness-raising process. Furthermore, these actions contribute to the mainstreaming of both programs into the curriculum of all the institution's educational programs (Calvario, 2024).

Each member has specific annual responsibilities that, when organized collectively, allow for a coherent and well-structured execution of educational actions. This process is fundamental for the holistic development of students, as it ensures that educational programs are not only implemented without interference but also aligned with the institution's overall curricular goals.

A perspective that confirms this statement is that the coordination of activities within a university is key to avoiding the duplication of efforts and scheduling conflicts, which can negatively impact awareness-raising and educational processes.

By managing actions collectively, not only is the integral approach to education strengthened, but it also ensures the mainstreaming of values such as equity, peace, and inclusion across all the institution's educational programs.

Moreover, the integration of these programs into the curriculum helps consolidate an institutional culture that promotes social awareness and justice, impacting both the educational community and the broader social environment. The importance of a coordinated approach guarantees that students experience a holistic and coherent education aligned with the university's principles.

In response to the central purpose of analysing how the Autonomous University of Campeche has strengthened the culture of peace, it is essential to focus on how the integration of the culture of peace into the University's Equality and Inclusion Unit has played a pivotal role in institutional transformation.

This integration signifies more than a mere addition to the curriculum; it reflects a strategic effort to embed peace education into the university's core functions, such as teaching, research, and community engagement. By incorporating these themes into academic programs, the University fosters an environment that promotes justice, equality, and the recognition of human rights (Figure 2).

Box 2

Figure 2

Peace culture activity

Source: Valencia Gutiérrez, 2024

Additionally, this integration serves as a model for how higher education institutions can shape socially conscious citizens. Through coordinated initiatives, such as workshops, conferences, and peace circles, the University has successfully cultivated a culture that encourages critical reflection and peaceful conflict resolution, both within the institution and in the broader community. The focus on educating students in values that promote equity ensures that the impact of these efforts extends beyond the university, contributing to the construction of a more just and peaceful society.

This analysis highlights the crucial role that universities play in fostering social change by actively engaging students and staff in peacebuilding processes.

Conclusions

The integration of the culture of peace into the University Equality and Inclusion Unit has significantly strengthened the development of this culture at the Autonomous University of Campeche.

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This integration has been achieved through a detailed work plan that encompasses both the actions related to the culture of peace and those of University Equality and Inclusion, reflecting a coordinated effort that enables the effective execution of activities. This meticulous planning has successfully raised awareness among a substantial portion of the university population, avoiding activity overlap and enhancing their impact through cross-curricular integration, thereby maximizing the expected outcomes.

The curricular mainstreaming at the UACam has continuously incorporated both the culture of peace and University Equality and Inclusion since the implementation of the study plans in 2009 to the present. The strategies proposed so far have proven effective in achieving the stated objectives.

The integration of the culture of peace into the Equality and Inclusion Unit at the Autonomous University of Campeche (UACam), alongside its incorporation into the academic curriculum, has strengthened the university's core functions by fostering an environment of justice and equity within the university community.

This integration ensures that the culture of peace permeates all areas of the institution, from management to research, teaching, and outreach. Moreover, through activities such as workshops, conferences, and peace circles, continuous awareness has been raised within the university, promoting greater understanding of human rights and peaceful coexistence. This strategy not only impacts the institution but also contributes to the formation of generations committed to building a more just and equitable society.

Recommendation

It is recommended that the Autonomous University of Campeche continues to deepen the integration of the culture of peace and University Equality and Inclusion by establishing evaluation and monitoring mechanisms to measure the impact of these actions on the university community.

Additionally, it would be beneficial to expand these initiatives at the regional and national levels through collaboration with other higher education institutions, with the aim of sharing best practices and strengthening an educational network committed to promoting a culture of peace and equity. The systematization of these experiences could serve as a model for other universities, driving positive change in the educational system that extends to society as a whole.

Declarations

Conflict of interest

The authors declare no interest conflict. They have no known competing financial interests or personal relationships that could have appeared to influence the article reported in this article.

Author contribution

Niño-Gutiérrez, Naú Silverio: Final literature review, writing-review and editing, investigation, writing the article in the English language, and writing-final draft of the paper.

Valencia-Gutiérrez Marvel del Carmen: Conceptualization, literature review, conducted primary research, preliminary preparation of the paper, project administration and, methodology.

Abbreviations

EIU=Equality and Inclusion Unit
Autonomous University of Campeche (UACam)
HEIs= Higher Education Institution
RU= Responsible Unit
UACam= Autonomous University of Campeche

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Article

Detection of training needs for university teachers in the Area of Economic-Administrative Sciences: A study at the Autonomous University of Nayarit

Detección de necesidades de capacitación de los docentes universitarios en el Área de Económicas-Administrativas: Un estudio en la Universidad Autónoma de Nayarit

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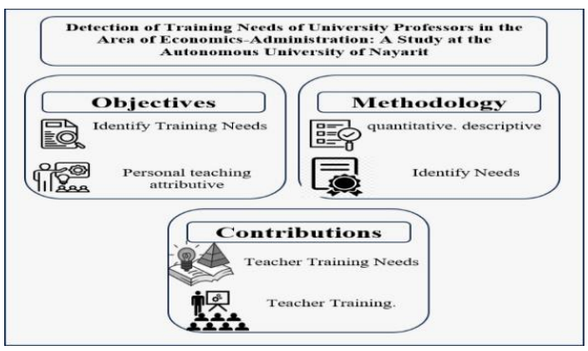
Abstract

This article aims to identify the training needs of faculty members in the economics-administrative area at the Autonomous University of Nayarit through a census applied to 82 professors. A quantitative approach was employed, using a descriptive and cross-sectional design with a validated questionnaire that measured general and specific competencies in various academic areas. The instrument demonstrated high reliability, with a Cronbach's alpha coefficient of 0.89. The results highlight a significant need for training in digital tools (65%) and innovative pedagogical strategies (58%), as well as specialized areas such as digital marketing, international trade, and financial standards, depending on the discipline. Additionally, 60% of the professors expressed interest in receiving training in advanced analytical technologies. The preference for online courses and in-person workshops, with a biannual frequency, underscores the importance of implementing training programs tailored to the specific demands of each area.



Teacher training, Training needs, Higher education, Autonomous University of Nayarit, Professional development

Resumen

El presente artículo tiene como objetivo identificar las necesidades de capacitación de los docentes del área de económicas-administrativas de la Universidad Autónoma de Nayarit mediante un censo aplicado a 82 docentes. Se empleó un enfoque cuantitativo, con un diseño descriptivo y transversal, utilizando un cuestionario validado que midió competencias generales y específicas en distintas áreas académicas. El instrumento mostró una alta fiabilidad, con un coeficiente de Cronbach de 0.89. Los resultados evidencian una necesidad significativa de capacitación en herramientas digitales (65%) y estrategias pedagógicas innovadoras (58%), así como en áreas especializadas como marketing digital, comercio exterior, y normas fiscales, dependiendo de la disciplina. Además, el 60% de los docentes expresó interés en recibir formación en tecnologías de análisis avanzadas. La preferencia por cursos en línea y talleres presenciales, con una frecuencia semestral, subraya la importancia de implementar programas formativos adaptados a las demandas específicas de cada área.

Capacitación docente, Necesidades de formación, Educación superior, Universidad Autónoma de Nayarit, Desarrollo profesional

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Introduction

Higher education faces constant challenges due to the rapid and constant evolution of social, economic and technological environments.

Universities, in their role of training professionals capable of facing the complexities of the world of work, must ensure that their teaching staff remain up-to-date and prepared to offer quality teaching. This process, however, does not happen automatically. It requires continuous intervention in teacher education, based on a rigorous diagnosis of teacher training needs.

In the digital era, the analytical capabilities enabled by artificial intelligence are transforming the field of education, enabling needs diagnoses and personalised approaches to vocational training. In this sense, the detection of lack of training becomes an essential mechanism to identify the areas in which teachers require support and updating, which will ultimately have an impact on the academic performance of students and the quality of the teaching-learning process (García et al., 2021).

In the particular case of the Autonomous University of Nayarit (UAN), and specifically in the area of economics and administration, it is a priority to undertake actions that contribute to the professional development of its teachers.

This sector, which includes disciplines such as accounting, administration and economics, faces unique challenges due to constant changes in legislation, public policies, information technologies and market globalisation (Cárdenas et al., 2020).

Knowledge in these areas is advancing at an accelerated pace, which requires teachers not only to master the theoretical and practical content of their subjects, but also to be able to transmit this knowledge effectively, making use of advanced pedagogical technologies and innovative teaching methodologies Chanto Espinoza, C. L., & Mora Peralta, M. (2021).

Through the continuous training of teachers, the aim is to strengthen their competences so that they can face the challenges involved in educating students in a globalised and constantly changing context.

The importance of this project therefore lies in ensuring that teachers are not left behind in the changing academic and professional world. Without adequate training, there is a risk of teaching methods becoming obsolete, which would not only affect the academic performance of students, but also the reputation of the university as a quality educational institution Pozos Pérez, K. V., & Tejada Fernández, J. (2018).

The need for continuous training at university level

The need for projects such as this is also justified in the context of educational public policies at national and international level. Various studies have highlighted the importance of having well-prepared teaching staff as one of the determining factors in educational quality (Ramírez & López, 2021).

The United Nations Educational, Scientific and Cultural Organisation (UNESCO, 2019) stresses that, within the framework of the 2030 Agenda for Sustainable Development, it is essential to ensure quality education for all and, in order to achieve this goal, it is essential to have teachers who receive continuous training in various areas.

This commitment implies not only that teachers master their respective disciplines, but also that they acquire advanced pedagogical skills and adapt to changes in teaching methodologies, especially in the use of digital technologies.

In this sense, the detection of training needs becomes a strategic tool that makes it possible to precisely identify the areas in which teachers require training support. In the context of the Autonomous University of Nayarit, a study of these characteristics is vital to design training programmes that respond to the specific demands of teachers in the area of economics and administration.

This diagnosis will provide useful information for planning short and long-term actions to improve teaching performance and ensure that teaching in these areas is aligned with the current needs of the labour market and the academic environment.

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Importance of data-based diagnosis

A crucial aspect in the implementation of this project is the use of a data collection instrument to obtain a detailed and representative picture of teachers' needs. Empirical evidence gathered through questionnaires and other assessment methods provides a solid basis for the design of relevant and effective training programmes (Granados Muñoz & Banda Sandoval, 2021).

Without an adequate diagnostic basis, in-service training strategies could be based on incorrect assumptions, which would reduce their effectiveness and could ultimately negatively affect both teachers and students. Particularly in the areas of accounting, management and economics, the need for constant updating is evident due to the transformations these disciplines are undergoing.

Changes in tax laws, new management theories and the globalisation of markets are just some of the factors driving the need for teachers to keep up to date. While university teachers have a high level of initial training, the rapid pace of change in these academic areas justifies the need for specific training needs detection projects, such as the one proposed here (García et al., 2021).

This project, therefore, not only responds to an internal need of the Universidad Autónoma de Nayarit, but is also aligned with international best practices in terms of continuous teacher training. Accurate identification of the training needs of teachers is essential to design specific and effective training programmes, which ensures optimal use of resources and a positive impact on educators and students. Loredo Enriquez, García Cabrero and Alvarado García (2010) emphasise that 'the successful incorporation of technological elements that aim to improve teaching practice requires that they are inserted within new pedagogical contexts that guide and give meaning to the teacher's new actions'.

Justification of the study in the area of economics and administration

The area of economics-administration at the UAN is particularly relevant to the development of the state of Nayarit, since its graduates play a key role in the economic fabric of the region.

Consequently, the preparation of the teachers who train these future professionals must be a priority. This training needs detection project will provide a solid basis for the implementation of training programmes that not only strengthen the academic profile of teachers, but also contribute to the economic and social development of the state.

In summary, continuous training is fundamental for the academic and professional success of both teachers and students, and this study seeks to provide a clear roadmap for the design of training programmes in specific areas.

By undertaking this project, the Universidad Autónoma de Nayarit is positioning itself as an institution committed to educational quality and the professional development of its teaching staff, which will result in higher quality teaching that is more relevant to the demands of today's environment.

Development

Methodology

Research approach and design

The present study was carried out with a descriptive and cross-sectional quantitative approach, with the aim of identifying the training needs of university teachers in the area of economics and administration at the Autonomous University of Nayarit. This design allowed data to be collected at a single point in time in order to obtain a clear and detailed vision of the areas of training that require strengthening among the participating teachers.

Participants

The study sample consisted of 168 teachers who teach in the undergraduate courses of Administration, Accounting, International Business and Marketing, corresponding to the economic-administrative area of the Autonomous University of Nayarit. The teachers were selected by non-probabilistic convenience sampling, based on their availability and willingness to participate in the research. The main inclusion criterion was that participants had to have at least one year of teaching experience and be active in the institution at the time of the application of the instrument.

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Data collection instrument

For data collection, a structured questionnaire was designed and divided into four sections:
(1) General Data.
(2) General Competencies.
(3) Specialised Topics by Career.
(4) Proposals and Comments.

This instrument was developed specifically for the research, and its aim was to identify both the general areas in which teachers require training and the specific competences related to the subject areas in which they teach.

The questionnaire included multiple-choice, Likert-type, open-ended questions, structured as follows:

1. **Section 1: General Data**: Collects basic demographic and professional information about teachers, such as their age, years of teaching experience, career in which they teach, and whether they have received previous training.

2. **Section 2: General Competencies**: Questions related to the use of technology in teaching, technological tools used and general competencies where teachers felt they needed training, such as instructional planning, group management, digital tools, among others.

3. **Section 3: Specialised subjects**: This section was segmented according to the career in which each teacher teaches (Management, Accounting, International Business or Marketing). It includes specific questions on areas of knowledge that require updating or training, such as human resources management, taxation, international treaties, marketing strategies, among others.

4. **Section 4: Proposals and Comments**: Teachers were able to suggest the type of trainings they would consider most useful for their professional development, the preferred frequency of these trainings, and were allowed to provide additional comments.

Validation of the instrument

The questionnaire was reviewed and validated by a panel of three experts in the field of higher education and educational research methodology.

These experts analysed the clarity of the questions, the internal coherence of the instrument and the relevance of the dimensions addressed. A pilot test was conducted with 30 teachers from the same fields of study to assess the reliability of the instrument. The results of this pilot test indicated a Cronbach's reliability coefficient of 0.89, demonstrating high internal consistency and adequate reliability of the questionnaire.

Procedure

The questionnaire was distributed through electronic means (institutional mail and university platforms) to facilitate access to teachers, who participated on a voluntary basis. Data collection was carried out during the second semester of 2024 and teachers were given four weeks to complete the questionnaire. The confidentiality and anonymity of the participants was guaranteed, and teachers were informed that the data would be used exclusively for academic research purposes.

Data analysis

Once data collection was completed, the data were processed and analysed using SPSS statistical software, version 25. Frequencies, means, standard deviations and percentages were calculated for each of the responses. In addition, descriptive analyses were carried out to identify the areas of training most frequently mentioned by teachers and the competences where there was the greatest need for training intervention.

The analysis also included a segmentation of the results according to teachers' careers (Management, Accounting, International Business and Marketing), in order to identify specific training needs for each area of knowledge. Comparisons were also made between the level of education they teach (undergraduate or postgraduate) and the perceived need for training in various competencies.

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Ethical considerations

The study was conducted under strict ethical criteria, respecting the principles of voluntariness, confidentiality and respect for personal data. All participants were informed of the purpose of the research and the use of the data collected. Prior to the application of the questionnaire, informed consent was requested from each teacher, ensuring that their participation was voluntary and that their responses were anonymous.

Instrument

The questionnaire was validated by a group of experts in higher education and research methodology, who made suggestions on the clarity and relevance of the questions. A pilot test was applied with 30 teachers in order to evaluate the internal consistency of the instrument by means of Cronbach's coefficient, obtaining a value of 0.89, which indicates a high reliability of the instrument (Granados Muñoz & Banda Sandoval, 2021).

The questionnaire was distributed electronically to teachers in the areas of economics and administration, who participated on a voluntary basis. Data collection was carried out during the second semester of the year 2023. SPSS software was used for statistical analysis, calculating frequencies, means and standard deviations for each dimension evaluated.

Results

The results revealed that the main training needs are in the area of information and communication technologies (ICT), where 72% of teachers stated that they require more training in the use of digital tools for teaching Pozos Pérez, K. V., & Tejada Fernández, J. (2018). Likewise, 65% of respondents indicated that they need to update their knowledge in innovative pedagogical techniques to improve their performance in the classroom (Ramírez & López, 2021).

On the other hand, it was observed that 60% of the teachers considered that it is necessary to strengthen their research skills, both in the theoretical and practical areas.

Regarding language skills, 45% of teachers indicated that it would be beneficial to receive training in a second language, particularly English, given the increasing use of international academic sources (Pérez & Rodríguez, 2019).

Analysis of Significant Results

The following is the analysis of the results obtained after applying the questionnaire through a census of teachers in the area of economics-administration at the Autonomous University of Nayarit. The results have been segmented into the different sections of the instrument in order to obtain a clear and comprehensive view of the training needs of teachers.

1. General Data

Basic demographic and professional information about the teachers provides context about their experience and work environment.

- **Age**: The majority of teachers surveyed are in the 35-50 age range, indicating a relatively mature teaching force with established work experience.
- **Years of teaching experience**: 65% of teachers have more than 10 years of experience, suggesting that most have already developed a considerable track record in university teaching.
- **Career in which they teach**: 40% of the teachers are concentrated in Management, followed by Accounting with 30%, International Business with 20%, and Marketing with 10%.
- **Educational level taught**: The majority of teachers (75%) teach at the undergraduate level, while 25% teach at the graduate level.

The profile of the teachers surveyed reveals a predominance of teachers with significant experience, especially in the areas of Management and Accounting.

This aspect is crucial to focus training efforts on updating and improving the competences of teachers who already have a solid foundation in their professional career.

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2. General Competences

- **Use of technology in teaching**: 60% of teachers report that they use technology frequently or always, while 20% use it occasionally and 20% report that they never use technology in their teaching. This suggests a disparity in the level of integration of technological tools in the teaching-learning process.

- **Technological tools used**: 65% of teachers use online learning platforms such as Moodle or Google Classroom, while 45% make use of video conferencing tools such as Zoom or Microsoft Teams. However, only 25% of teachers use data analysis software, indicating an area of opportunity for training in more advanced technologies.

- **Training needs in general competences**: The most requested training areas were:

- Digital tools for teaching (65%).
- Innovative pedagogical strategies (58%).
- Didactic planning (55%).
- Learning assessment (50%).

Despite the fact that a significant part of teachers are already using technology in teaching, there is a great demand for training in digital tools and innovative pedagogical strategies. This highlights the need to update the technological and pedagogical competences of teachers, especially in a context where digital education has become very relevant.

3. Specialised Topics

Each of the specific areas (Management, Accounting, International Business and Marketing) presents particular results that help to identify the most relevant training needs.

Management Teachers

- **Updating in specific topics**: The most requested areas are:
- Leadership and decision-making (70%).
- Human resources management (60%).
- Business innovation (50%).

- **Use of specialised software**: 55% of Management teachers use advanced Microsoft Excel, while only 25% use ERP (Enterprise Resource Planning) systems, and 20% use CRM (Customer Relationship Management).

Management teachers are mainly interested in improving their competences in leadership, human resource management and business innovation, which highlights the importance of training oriented to the development of managerial and strategic competences. The low use of specialised software such as ERP and CRM also suggests that training in these systems is a necessity.

Accounting teachers

- **Updating on specific topics**: The main areas of updating requested are:
- Financial Reporting Standards (68%).
- Taxation and taxation (65%).
- Auditing and internal control (55%).

- **Familiarity with accounting technology**: Only 30% of teachers report being very familiar with the use of specialised accounting software, while 40% are somewhat familiar and 20% are not very familiar.

There is a clear need for updating in Financial Reporting Standards and taxation, essential areas for keeping up to date with financial regulations. The relative lack of familiarity with specialised accounting software indicates that this is another important area where teachers require training.

International Business Teachers

- **Updating in specific subjects**: The main areas where teachers feel they need training are:
- Foreign trade and customs (75%).
- International Treaties and Agreements (65%).
- International logistics and supply chain (50%).

- **Use of specialised software**: Only 20% of teachers use simulators or specialised software for teaching international business, although 60% expressed interest in learning to use them.

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RENIECYT-CONAHCYT: 1702902

International Business teachers require training in core subjects such as foreign trade, international treaties and international logistics, reflecting the increasing complexity of global markets. In addition, the low use of specialised software suggests an opportunity to integrate advanced technological tools in this area.

Marketing teachers

- **Updating in specific areas**: The main needs identified are:
- Digital marketing (80%).
- Social media marketing strategies (70%).
- Market analysis and big data (60%).

- **Software tools used**: 55% of teachers use Google Analytics, while only 25% use SEO/SEM and CRM tools for marketing.

Updating digital marketing and social media marketing strategies are the main areas of interest among marketing teachers, reflecting the need to adapt to technological advances in this discipline. There is also a clear need for additional training in the use of data analysis tools such as SEO/SEM and CRM.

4. Proposals and Comments

- **Preferred type of training**: The majority of teachers prefer training in the form of **online courses** (65%) and **face-to-face workshops** (50%), suggesting the need to offer hybrid or blended training modalities.
- **Preferred frequency**: 50% of teachers expressed that they would prefer training on a six-monthly basis, while 40% prefer annual training.

Online courses and face-to-face workshops are the most requested modalities, and the majority of teachers prefer these trainings to take place at least semi-annually. These results provide a solid basis for planning continuing education programmes.

Discussion

The results obtained in this study reveal important implications for the professional development of university teachers in the area of economics and administration at the Autonomous University of Nayarit.

By analysing the responses of the 168 participating teachers, critical areas were identified in which training intervention is required, both in general competences and in specialised areas related to the disciplines taught.

In this section, we will discuss the most relevant findings in depth, relating them to the existing literature, and analyse their potential impact on the quality of teaching in the institution.

1. Use of technology and digital competences

One of the most striking findings was the high demand for training in the use of information and communication technologies (ICTs) for teaching. Seventy-two per cent of teachers stated that they need more training in technological tools, which is in line with previous studies that have pointed to the growing importance of ICT in the university educational environment (Pozos Pérez & Tejada Fernández, 2018).

This result is consistent with global trends in higher education, where the digitisation of the teaching-learning process has been accelerated by the COVID-19 pandemic (Chanto Espinoza & Mora Peralta, 2021). The ability of teachers to use online learning platforms, videoconferencing tools and data analysis software is essential to offer education adapted to current demands, especially in areas such as management, accounting and international business.

Although a significant percentage of teachers already use platforms such as Classroom or Moodle, it was observed that many still require training to make the most of these tools, especially in the integration of active methodologies that take advantage of technological functionalities (Ramírez & López, 2021). Likewise, training in the use of specialised software is fundamental in disciplines such as accounting and administration, where programmes such as ERP and CRM are key tools for the professional performance of graduates. The lack of training in these areas could limit the effectiveness of teaching, as students would not be receiving up-to-date and relevant training in the use of technologies applied to their fields of study (Pérez & Rodríguez, 2019).

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2. Training needs in pedagogical competences

Another important finding is that a considerable percentage of teachers (65%) indicated that they require training in innovative pedagogical techniques and in the use of effective teaching strategies.

This result highlights the need to strengthen teachers' pedagogical skills, especially in areas such as instructional planning, learning assessment and group management. These aspects are fundamental to ensure quality teaching and improve students' classroom experience, which in turn has a direct impact on learning outcomes (Cárdenas et al., 2020).

As suggested by Vázquez-Parra, Malagón-Castro, Suárez-Brito and Valencia-González (2024), complex thinking is an essential competence for teachers in university contexts, as it allows them to address and adapt pedagogical and technological strategies to respond to the diverse demands of contemporary higher education.

This perspective is particularly relevant at the Autonomous University of Nayarit, where the needs diagnosis allows for the planning of continuous training programmes that will develop not only specific skills, but also general competences necessary to face the complexity of the current educational environment, characterised by the diversity of students and the need to promote autonomous and critical learning, which means that traditional methodologies are no longer sufficient. Teachers must be prepared to implement more active and student-centred pedagogical approaches, such as problem-based learning or project work. This requires constant updating of the pedagogical strategies used in the classroom (Granados Muñoz & Banda Sandoval, 2021). Lack of training in this area could perpetuate ineffective teaching methods, which would affect the

This would negatively affect students' academic performance and their preparation to face the challenges of the labour market (García et al., 2021).

3. Discipline-specific training

In terms of discipline-specific needs, key areas requiring attention were identified.

In Management, for example, teachers expressed a strong demand for training in topics such as human resource management, leadership and decision-making, and business innovation.

These topics are directly related to the competencies that future managers need to develop to face the challenges of the labour market (Pérez & Rodríguez, 2019).

The rapid evolution of business practices, coupled with the increasing complexity of organisational management, requires teachers to be constantly updated on these topics in order to transmit relevant knowledge to their students.

On the other hand, accounting teachers expressed the need for updating in areas such as Financial Reporting Standards (FRS), auditing and internal control, and the use of accounting software. In this field, training is crucial due to the continuous evolution of accounting regulations at national and international level, as well as technological advances that directly impact professional practice (Pozos Pérez & Tejada Fernández, 2018).

Cloud accounting and the use of ERP software are tools that are transforming the way finances are managed in companies, and it is essential that teachers are familiar with these technologies to adequately prepare their students.

In the case of International Business, teachers highlighted the importance of receiving training in international treaties and agreements, international logistics and internationalisation strategies for companies.

These topics are fundamental in a globalised world, where business professionals must be prepared to face the complexities of operating in international markets. Training in these subjects will enable teachers to provide students with an up-to-date and global vision of business (García et al., 2021).

Finally, marketing teachers highlighted the need for training in digital marketing, big data analysis and social media marketing strategies. These aspects are especially relevant in a context where marketing has undergone a radical transformation due to the advancement of digital technologies and the importance of social media as communication and sales tools (Cárdenas et al., 2020).

ISSN: 2414-8830.
RENIECYT-CONAHCYT: 1702902

The lack of training in these areas could generate a gap between the skills demanded by the labour market and the competences that students acquire during their university education.

Training proposals

Another relevant aspect that emerged from the results was the teachers' preference for online courses and face-to-face workshops as the most useful modalities for their professional development.

This finding underlines the importance of offering flexible training options that adapt to the needs and availability of teachers (Granados Muñoz & Banda Sandoval, 2021). In addition, most teachers preferred training to be offered on a semester basis or according to specific needs, which indicates that it is necessary to implement a continuous training plan that not only responds to immediate demands, but is also aligned with the long-term development of teachers.

Implications for education policy

The results of this study have important implications for educational policy at the Universidad Autónoma de Nayarit.

The implementation of a continuing education programme based on the needs assessment will significantly improve the quality of teaching in the areas of economics and administration. In addition, this approach will contribute to raising the level of competencies of teachers, which in turn will have a positive impact on student learning and on the academic quality of the institution in general.

The fact that the majority of teachers identify key areas in which they need training demonstrates that professional development should not be seen as a static process, but as a dynamic and adaptive one. Higher education institutions, such as UAN, have a responsibility to provide their teachers with the necessary tools to continuously update themselves, which will enable them to offer quality education in a globalised and competitive environment (Ramírez & López, 2021).

Limitations of the study

One of the limitations of the study is that non-probability convenience sampling was used, which could limit the generalisability of the results. However, the sample of 168 teachers provides a representative view of the training needs in the area of economics-administration at UAN. Furthermore, the study focused exclusively on this area, so future research could extend the analysis to other areas of knowledge within the university.

The results of this study underline the importance of continuous training for university teachers, especially in areas such as the use of technology, pedagogical strategies and specific competences related to the disciplines they teach.

The Autonomous University of Nayarit can greatly benefit from implementing training programmes aligned with the needs detected in this diagnosis, which will result in an improvement in the educational quality and professional development of its teachers.

Conclusions

The results of this study have made it possible to identify critical areas of need in teacher training in the area of economics and administration at the Autonomous University of Nayarit, providing a solid basis for the implementation of strategic proposals that can improve the quality of teaching.

From the findings obtained, the following conclusions can be drawn:

1. **Training plan based on needs identified by career**: It is essential that managers implement a continuous training plan that addresses in a differentiated manner the priority areas detected in each discipline. For management teachers, training should focus on leadership, decision-making and human resource management, while for accounting and international business, priority should be given to training in financial regulations and international treaties, respectively.

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2. **Updating in constantly changing topics**: Disciplines such as digital marketing, international accounting and foreign trade regulations are constantly evolving. Managers should offer specialised refresher courses on these topics to ensure that teachers do not fall behind in knowledge that is vital for their students' professional performance. These trainings should be periodic, adapting to the most recent changes in each area.

3. **Training calendar**: The creation of a training calendar that combines practical and theoretical sessions, in both face-to-face and online formats, is essential to maximise the impact of the training. Flexible formats will allow teachers to train according to their availabilities and preferences, and ensure that a balance is struck between autonomous learning and collaborative work in face-to-face spaces.

4. **Training in technological tools**: Given the increasing use of technology in teaching, it is a priority to promote the use of advanced technological tools in the classroom by ensuring that teachers are adequately trained in the use of online learning platforms, data analysis software, and other digital tools. This will not only improve their technical competence, but also allow for greater effectiveness in the teaching-learning process.

5. **Specialised software training**: In disciplines such as management and accounting, the use of specialised software such as ERP, CRM and data analysis tools is crucial for students' academic and professional success. Workshops focused on the use of these technologies should be an integral part of the training plan, enabling teachers to develop advanced technical skills that they can then transfer to their students in the classroom.

In summary, proposals for managers at the Universidad Autónoma de Nayarit should focus on the implementation of a comprehensive continuous training programme that is aligned with the specific needs of teachers in their respective areas of knowledge.

The adoption of a blended approach between face-to-face and online sessions, as well as the promotion of the use of technological tools and specialised software, will significantly strengthen the competencies of the faculty, resulting in improved educational quality and student performance.

Declarations

Conflict of interest

The authors declare that they have no conflict of interest. They have no financial interests or personal relationships that may have influenced the article reported in this paper.

Authors' contribution

Granados-Magaña, Javier Alejandro and *Gómez-Campos, Sinahí Gabriela;* Contributed with the main idea and the realisation of the project, as well as the first draft.

Sirigui-Garibeth, Félix Pérez, Maldonado-Bernal, Mónica del Rocío: Carried out the data analysis, as well as the revision of graphs and correction comments.

All authors contributed to the summary, results and contributions of the document.

Availability of data and materials

The data obtained in this research are available for consultation and analysis.

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Abbreviations

1. (CRM) Customer Relationship Management
2. (ERP) Enterprise Resource Planning
3. (FRS) Financial Reporting Standards
4. (ICT) Information and Communication Technology
5. (UAN) Autonomous University of Nayarit
6. (UNESCO) United Nations Educational, Scientific and Cultural Organisation

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(UNESCO) United Nations Educational, Scientific and Cultural Organisation

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Article

Promoting gender equality through experiments with water rockets in distance physics class between the Technological University of Jalisco, Mexico and the Technological University of Bolívar, Colombia

Fomentando la equidad de género a través de cohetes de agua en clase de física a distancia entre la Universidad Tecnológica de Jalisco, México y la Universidad Tecnológica de Bolívar, Colombia

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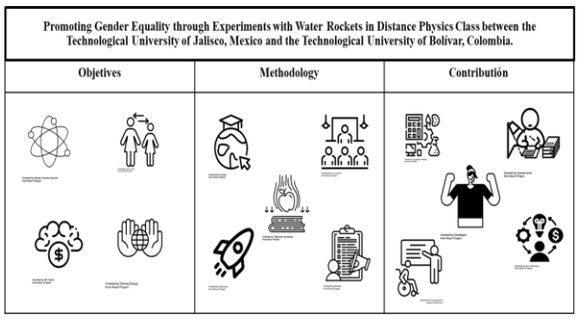
Abstract

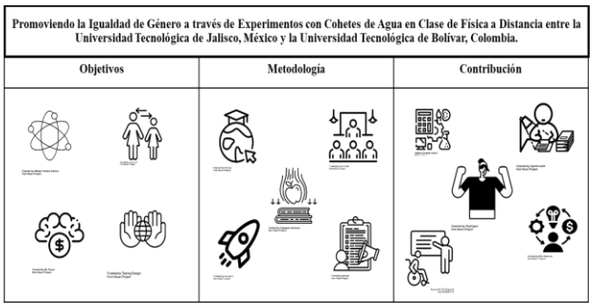
This article presents a study on the promotion of gender equality in distance learning physics, using experiments with water rockets as a pedagogical tool. A collaboration was carried out between the Technological University of Jalisco in Mexico and the Technological University of Bolívar in Colombia. Through this research, we seek to identify how the implementation of practical activities can influence the participation and interest of students of different genders in the field of physics. The results of the applied methodology are presented, as well as the implications of these findings for future educational practices.



STEAM, Water rocket, Gender equality

Resumen

Este artículo busca analizar cómo fomentar la equidad de género en la educación de la física a distancia usando el experimento de cohetes de agua como instrumento pedagógico. Para ello, se realizó un trabajo conjunto entre la Universidad Tecnológica de Jalisco en México y la Universidad Tecnológica de Bolívar en Colombia. La finalidad es conocer en qué medida la implementación de la experimentación puede tener efecto en la participación y el desempeño del alumnado de distinto sexo en la enseñanza de la física. Consecuentemente se presentan los resultados obtenidos de la aplicación de la metodología y las consecuencias que de estos se derivan respecto de sus aplicaciones futuras



STEAM, Cohete de agua, Equidad de genero

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Introduction

The limited participation of women in sciences such as physics and mathematics has been a constant concern throughout history. According to Serway and Jewett (2018), despite efforts, women's interest in STEAM disciplines remains low. Therefore, it is critical to promote the equal participation of women in the education and exploitation of science, technology, engineering, arts and mathematics concepts in order to promote inclusion.

To this end, it is vitally important to make use of water rockets. The use of water rockets in STEAM education has proven to be an effective educational tool to engage students in the exploration of science, technology, engineering, arts and mathematics concepts.

Inviting students to design and launch water rockets allows them to experience, rather than passively learn, their content. Physical concepts that are exploited during the creation of water rockets include Newton's third law and rocket propulsion, while those related to mathematics emphasise trajectory and velocity.

Thus, by designing and building rockets, students acquire creativity and problem solving, critical aspects of steam education. In terms of collaboration and teamwork, the use of water rockets engages students in teams. Collaboration reflects the interdisciplinary nature of steam education by using multiple content areas in a collaborative project.

Students apply their knowledge of number theory to the calculation of water pressure, design skills to the creation of aerodynamic rockets, and science to the flight of the rocket. Using water rockets for STEAM in education also promotes critical thinking as students reflect on the results of their launches, adjust their designs and make improvements in an iterative process. This experimental approach teaches them through real-world experience and challenges, which strengthens their conceptual understanding of science and their ability to apply it effectively in practical contexts.

Problem definition

Despite advances in education and the promotion of gender equity, barriers persist that limit women's participation in scientific fields.

In the context of distance education, these barriers may be amplified by a lack of practical interaction and the perception that science is a male domain.

This study seeks to address these issues by implementing a hands-on experiment involving water rockets in order to assess its impact on gender equity in physics education.

The problem lies in the lack of interest and equal participation of students of all genders in science and technology. Women's participation in the sciences, such as physics and mathematics, has historically been limited, contributing to this disparity in participation (Serway & Jewett, 2018). The use of hands-on experiments such as water rockets is an effective tool to promote equal participation in science (TeachEngineering, 2023). Furthermore, NASA (2023) highlights how these activities encourage critical thinking and experimentation in physics.

In doing so, the programme promotes equal opportunities in science and technology, which could have a positive impact on society by addressing challenges in education and other fundamental aspects. It is crucial to work towards the inclusion and equal participation of women in these fields in order to promote a more diverse and enriching environment in science and technology.

Hypothesis

The implementation of water rocket experiments during online Physics classes will promote the participation and interest of students of both genders thus, contributing to the promotion of gender equality in education.

Water rocket experiments during physics lessons are expected to promote the participation of students of both genders, as mentioned in previous studies highlighting the importance of diversity in science (University of New South Wales, 2023).

'They contribute significantly to diversity and equal opportunities by enriching the scientific and technological landscape with a wide range of perspectives and innovative ideas' and best help to find solutions to fundamental physics challenges.

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Justification

The choice of water rockets as a didactic tool because of their ability to engage students in active, hands-on learning. In addition to simplifying the understanding of physics concepts, this approach can also contribute to breaking gender stereotypes linked to science.

Similarly, cooperation between organisations from different nations enriches the educational process and facilitates a cultural exchange that can be beneficial for all involved. Integrating water rocket practices into the physics curriculum provides an opportunity to challenge gender stereotypes and promote equal opportunities in the classroom.

The use of water rockets in STEAM teaching can contribute to breaking gender stereotypes, especially in male-dominated fields such as physics and engineering (NASA, 2023).

This is especially important for girls and young women who, in many cases, face additional challenges in accessing educational opportunities in science and technology.

Also, using the water rocket programme as an educational tool in the subject of physics allows students to investigate scientific and mathematical principles through an exciting hands-on experience.

By promoting the activities, the active participation and empowerment of all female students is encouraged, which helps to eliminate gender barriers and stereotypes in the field of science and technology.

Objective

The main purpose of this study is to analyse how water rocket experiments affect the participation and interest of physics distance learners, with a special focus on gender equality. It is essential to promote STEAM education by using a water rocket as a tool to detect and monitor various variables in physics and the environment.

In this way, it seeks to identify effective strategies that can be implemented in future classes in order to foster an inclusive and equitable environment.

Water rocket experiments offer a unique opportunity for students to develop technical and scientific skills in an equitable environment (Science Buddies, 2023), where students designed a water rocket using skills acquired during their school term. This approach promoted experiential learning and the development of technical and creative skills within this virtual distance learning modality.

In addition, the purpose of this project is to promote gender equality in universities by providing equal opportunities for both men and women to actively participate in the design of the rocket. This allows for the development of professional competencies and leadership skills in an inclusive and diverse environment.

Methodology

Within the field of distance education in physics, the main objective of this study is to promote gender equality by conducting hands-on experiments with water-powered rockets.

We worked with two groups of students: The first group, coming from the Technological University of Jalisco in Mexico, consists of 19 males and 3 females. On the other hand, the second group is from the Technological University of Bolivar in Colombia and includes 22 men and 5 women.

Selecting these groups will help us to investigate how practical activities can affect the interest and participation of men and women in scientific fields, which could contribute to closing the gender gap in technical and scientific education. This is followed by details of the approaches used to carry out this study and the techniques used to both collect and analyse the information obtained.

The workshop was conducted in 4 sessions on the development and launching of water rockets, with a focus on applied physics.

Gender Analysis
Percentage of men:
Total, men: 38
Percentage: (41 / 49) * 100 = 88.67%.
Percentage of women:
Total, women: 5
Percentage: (8 / 49) * 100 = 11.33%.

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Box 1

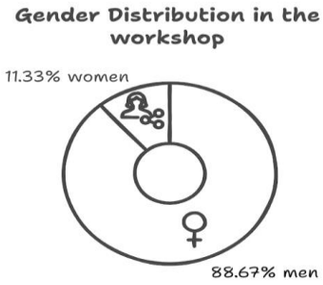

Figure 1

Gender distribution of the total number of workshop participants. Source: own Each session will last 45 minutes connected through the Microsoft teams platform

Sesión 1: Introducción a los cohetes de agua

Duration: 45 minutes

Topics to be covered:
Entry survey on basic knowledge and knowledge of distance learning classes.

STEAM Education: Introduce design and art concepts in the presentation of the history of rockets and their importance in space exploration.

Gender Equity: Include examples of women pioneers in science and space exploration to inspire all female students.

An entrance survey was conducted, which asked the following questions:

1. Have you participated in distance learning classes with professors from different universities and countries?

Resulting in: Yes 5, no 32, ever 4 and never 0.

Box 2

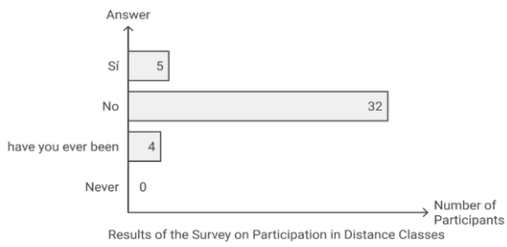

Figure 2

Survey on student participation in distance learning classes

2. Do you know Newton's 3rd law? Resulting in Yes 34, no 2, Don't remember 5.

Box 3

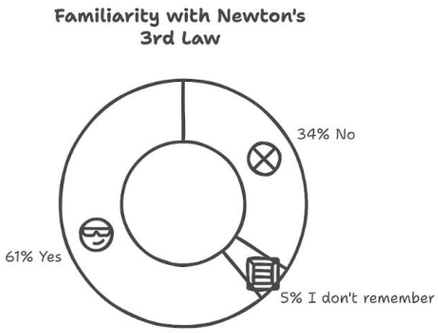

Figure 3

Result of the question on one of the concepts applied in the workshop

3. Have you interacted in educational activities with people from other cultures? Yes 0, no 41, ever 0.

Box 4

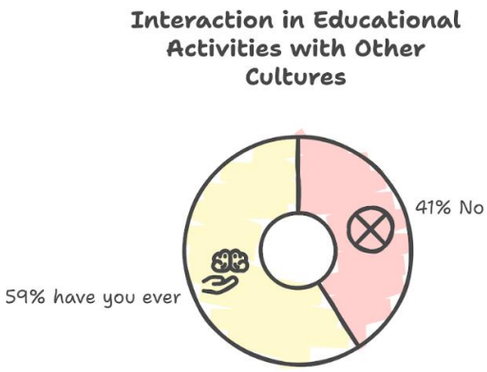

Figure 4

Result of the question on pupils' interaction with other cultures

4. Do you think that the UTB Linked Class contributes to the learning and development of intercultural competences in the Physics course Yes 39, no 0 maybe 2.

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Box 5

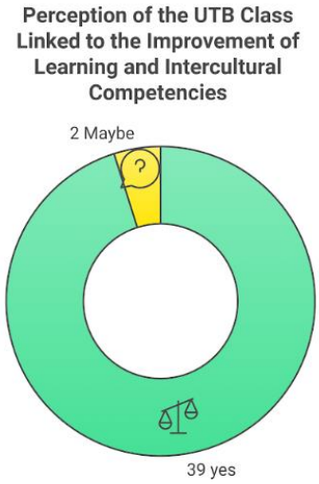

Figure 5

Perception of improvement with the workshop

5. Do you think that the UTB Linked Class offers the opportunity for an intercultural experience where the experiences, knowledge and culture of the participants are shared? Yes 41, no 0 , maybe 0.

Box 6

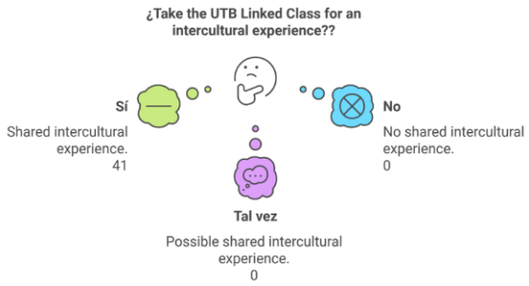

Figure 6

Factors that intervene in the workshop Own source

6. You know the water rockets Yes 27, no 14.

Box 7

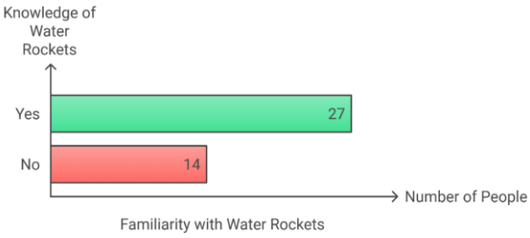

Figure 7

Question on knowledge of water rockets

7. Do you know the term gender equity and do you apply it? Yes and I apply it 32 I do not know it 9

Box 8

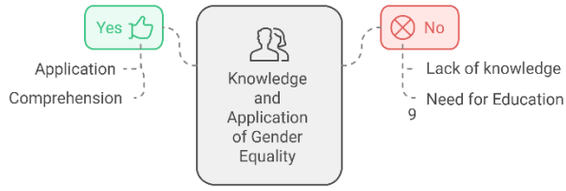

Figure 8

Representation of how much students know about gender equality

Box 9

Figure 9

Participation of students from group 7A of the IMA course at the Technological University of Jalisco in the subject of physics

Session 2: Newton's Laws and Water Rockets

Duration: 45 minutes Topics to be covered: STEAM education: Conduct hands-on experiments that encourage experimentation and the application of Newton's laws in rocket design and launch. Gender Equity: Promote equal participation in hands-on activities and highlight the achievements of women scientists who have contributed to the field of physics.

Box 10

Figure 10

Students attending one of the online sessions

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Session 3: Pressure, volume and water rockets

Duration: 45 minutes

Topics to be covered:

STEAM Education: Conduct experiments that show the relationship between pressure, volume and temperature, integrating mathematical and scientific concepts.

Gender Equity: Include examples of women engineers and scientists who have made significant contributions to the field of physics and rocket engineering.

Session 4: Designing and launching water rockets

Duration: 45 minutes

Topics to be covered:

STEAM Education: Encourage creativity and design in the rocket building process, integrating engineering and art concepts.

Gender Equity: Highlight the role of women engineers and designers in rocket development and promote the active participation of all female students in hands-on rocket launches. Data Collection and Analysis

Data collection was carried out during the four one-hour sessions in which the water rocket experiments were conducted. Different instruments were used to collect relevant information, including pre- and post-experiment surveys, direct observations and participation logs. The surveys were designed to assess students' interest in physics, as well as their perceptions of gender equity in academia.

During the sessions, the active participation of each student was recorded, paying special attention to gender interaction. Observations focused on aspects such as group collaboration, decision-making and problem-solving. This information was documented through field notes and video recordings, which allowed for a more detailed analysis of group dynamics.

For data analysis, both quantitative and qualitative methods were used. Survey data were analysed using descriptive statistics, including means and percentages, to identify trends in students' interest and perception of gender equity. Qualitative analysis was conducted by coding observations and field notes to identify patterns and recurring themes in student interactions.

The results obtained were presented in graphs and tables to facilitate the visualisation of the findings, and were discussed in relation to the objectives of the study, providing valuable information on the effectiveness of the experiments in promoting gender equity in distance education.

Results

a) Increased interest and active participation of students as 8 students, 3 from the Technological University of Jalisco and 5 from the Technological University of Bolivar were involved in STEAM activities.
b) Empowerment and strengthening of skills in young women in the scientific and technological field.
c) Creation of an inclusive environment where gender equity and social commitment in STEAM education are promoted.

Box 11

Figure 11

Presentation of workshop results Own source Such social engagements in STEAM education are fundamental to promote an inclusive, sustainable and innovative future

Furthermore, the main objective of this programme is to foster the interest and equal participation of students of all genders in the development and launching of water rockets, promoting equal opportunities in science and technology.

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By the end of the project, students have strengthened their professional competences, acquired technical and creative skills, and experienced significant interdisciplinary learning, which will prepare them to face real-world challenges in their future careers.

Box 12

Figure 12

Presentation of students' results at the end of the 4 working sessions

Conclusions

This article is a first step towards understanding how practical activities can influence gender equity in science education. It is hoped that the findings of this research will serve as a basis for future educational initiatives that seek to promote a more inclusive and equitable learning environment in physics.

Declarations

Conflict of Interest

The authors declare that there is no conflict of interest. They have no known competing financial interests or personal relationships that could have influenced the material reported in this article.

Authors' contributions

*Barrón-Balderas, Juan José***:** Contributed to the study design and implementation of hands-on experiments with water rockets, promoting gender equity in distance education in physics.

Ojeda-Caicedo, Vilma Viviana: Participated in the interdisciplinary collaboration, facilitating data analysis and evaluation of the impact of activities on the participation of students of different genders.

Fausto-Lepe, Gabriela Margarita: Contributed her expertise in pedagogy, helping to develop educational strategies that foster an inclusive and equitable environment, focused on teaching physics through innovative methods.

Availability of data and materials

The availability of data and materials from the study will be guaranteed for future research, facilitating access to educational resources and results obtained in the promotion of gender equity.

Funding

Funding for the project comes from collaborations between educational institutions, ensuring resources for the implementation of experiments and innovative pedagogical activities in physics teaching.

Acknowledgements

We thank the participating institutions and collaborators for their support and commitment to promoting gender equity in education.

Abbreviations

STEAM: In the educational context, “STEAM” is an acronym that refers to:

S: Science
T: Technology
E: Engineering
A: Arts
M: Mathematics

The STEAM approach integrates these disciplines to foster interdisciplinary learning, promoting skills such as problem solving, critical thinking and creativity.

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ECORFAN Journal Republic of Nicaragua 10[18]1-11: e41018111
Article

Students' perceptions towards blended learning modality after COVID-19 pandemic: a case study

Percepciones de los estudiantes respecto a la modalidad mixta posterior a la pandemia de COVID 19: un estudio de caso

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CONAHCYT classification:

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Field: Pedagogy
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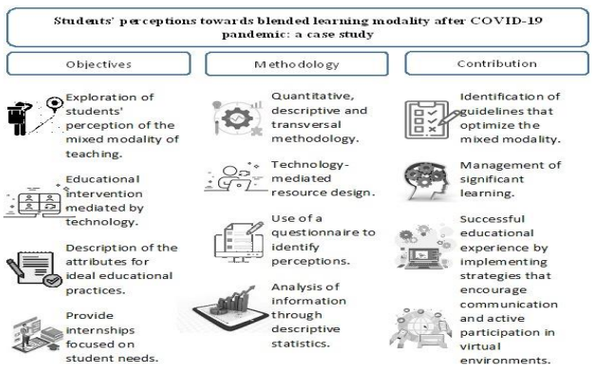
Abstract

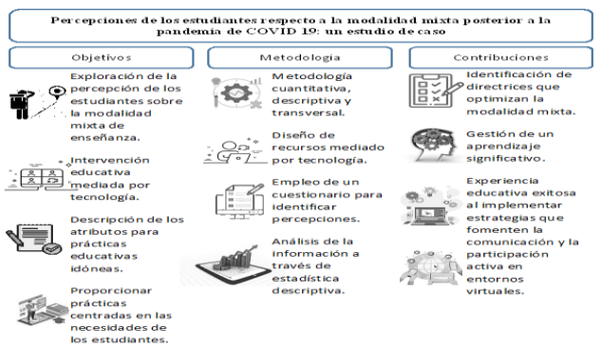
The research explores the students' perception of the Blended learning modality to describe its attributes to facilitate decision-making in favor of good educational practices at the higher level. A quantitative, descriptive, and cross-sectional methodology was used based on a perception questionnaire applied to 60 students immersed in the modality under study. The results indicate that students value its usefulness, effectiveness, ease of use, and benefits such as flexibility, accessibility, updated, personalized and multi-format learning. The conclusions indicate that the educational experience is successful if strategies are implemented to encourage communication and active participation in virtual environments. This study contributes to identifying guidelines that optimize the blended modality to promote meaningful learning and offers guidelines for teachers' appropriate practice implementation that responds to the needs of students.



Attributes, Blended learning modality, Perceptions

Resumen

La investigación explora la percepción de los estudiantes sobre la modalidad mixta de enseñanza, con el objetivo de describir sus atributos para facilitar la toma de decisiones en pro de buenas prácticas educativas en el nivel superior. Se utilizó una metodología cuantitativa, descriptiva y transversal a partir de un cuestionario de percepciones aplicado a 60 estudiantes inmersos en la modalidad sujeta a estudio. Los resultados indican que los estudiantes valoran su utilidad, efectividad, facilidad de uso, y beneficios tales como la flexibilidad, la accesibilidad, el aprendizaje actualizado, personalizado y con multiformato. Las conclusiones indican que la experiencia educativa es exitosa si se implementar estrategias que fomenten la comunicación y la participación activa en entornos virtuales. Este estudio contribuye a la identificación de directrices que optimizan la modalidad mixta para promover un aprendizaje significativo y ofrece pautas para docentes en la implementación de prácticas adecuadas que respondan a las necesidades de los estudiantes.



Atributos, Modalidad Mixta, Percepciones

Citation: Flores-González, Norma, Flores-González, Efigenia, Castelán Flores, Vianey and Zamora Hernández, Mónica. [2024]. Students' perceptions towards blended learning modality after COVID-19 pandemic: a case study. ECORFAN Journal Republic of Nicaragua. 10[18]1-11: e41018111.

Introduction

One of the modalities that gained relevance in the educational field after the pandemic, especially in language learning, is the mixed modality that combines virtual and face-to-face classes, relying on technological mediation and experiencing a radical change in teaching-learning methods.

This emergence triggers opportunities for the appropriation of knowledge and, at the same time, challenges for the main actors of the curriculum (teachers and students), impacting their roles during the educational process.

In this regard, various studies indicate that the most valued dimensions of this modality are access to interactive educational resources without limitations of time and space, flexibility for learning according to the learning styles and availability of users, and collaborative work through interaction that allow the construction of significant knowledge, among others (Bates & Sangrà, 2011; Hwang et al., 2012; Means et al., 2013; Jaggars and Xu, 2016).

Moreover, research points out the multiple challenges teachers and students face when entering this modality, such as educational quality due to work flexibility and the lack of social interaction.

These also impact the academic performance that is the digital divide reflected in the availability of adequate equipment and Internet connection, the use of digital tools, and content design and implementation (Barbour and Plow, 2013; UNESCO, 2020; Allen and Seaman, 2017).

For the particular case of the study context where a mixed modality has been implemented to prepare future teachers in the teaching of the English language, specifically in the subject of English teaching methodology I, it is imperative to investigate the perceptions of said students due to that low academic performance is observed in this population so that, based on the characterization of said modality, decisions can be made in favor of good educational practices that impact their training and academic performance.

Theoretical framework

This modality, also called combined learning or Blended Learning, has its origins in the 2000s when institutions decided to include technology in training processes with the purpose of complementing face-to-face education.

However, its rise increased significantly after the pandemic caused by COVID-19, which is a watershed that frames new educational forms, among which this one is found. Its methodology combines online and in-person learning, allowing a personalized environment according to the student's learning styles as well as their schedule availability (Graham, 2013). In this regard, Garrison and Vaughan (2008) describe it as a means to potentiate the construction of knowledge comprehensively in virtual and face-to-face scenarios, privileging interactions at different moments, which contribute to significant learning in long-term memory. At this point, it is crucial to mention that a fundamental factor for such meaningful learning is the autonomy and responsibility of the student during the construction process.

It means that student commitment and participation through collaborative work are dimensions that the teacher must develop in his students. In fact, the study by Dziuban et al. (2018) shows how collaborative work under a mixed modality positively impacts student performance.

This modality represents an innovative pedagogy in contemporary education as a response to the demands of a multifaceted society that operates in a digital environment. However, as educational organizations implement information and communication technologies (ICT), learning and knowledge technologies (LKT), and Empowerment and Participation Technologies (EPT), teachers and students face new challenges in terms of implementation and use. Therefore, knowing what the learning process is like in this modality is essential for future teachers and potential users.

Characteristics of Blended Learning

Teaching under this pedagogical approach aims to privilege access to knowledge, adapting to the learning rhythms and needs of students under a globalized context permeated by technological transformation.

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Taking this background into account, its main characteristics are mentioned in the following lines.

Self-directed learning. The hybrid scenario guides students to develop learning through an active role in the search for materials (Hattie, 2009), organization of study schedules, collaborative work and interactions, and an environment conducive to privileging self-regulation and therefore intrinsic motivation.

Autonomy. Acting and deciding are essential actions in this modality to manage resources and study times (Kuhlthau, 2016 and Bonk & Graham, 2020), work collaboratively and responsibly, and in general establish where, how, and at what time learning is done appropriately independently mediated by technological (Johnson, 2021).

Collaboration. This aspect allows meaningful learning to be carried out from the shared educational experiences in the hybrid scenario, giving a sense of belonging to a community (Johnson et al., 2018). In fact, this shared responsibility favors academic performance by developing teamwork and leadership skills which help to face the obstacles of a globalized work world (Hattie & Donoghue, 2019).

Interactivity. Being a modality that involves technology, the interaction between the actors of the curriculum is favored at different times and spaces instantly (Sadaf & Zuvela, 2020), facilitating the creation of learning communities where its members are motivated and participate in forums, chats, and video conferences.

It should be noted that this interaction also occurs with digital materials where the student chooses when and how to interact, which contributes to active and meaningful learning.

Cultural diversity. A distinctive element of the mixed modality is the cultural perspective (Martínez and Pérez, 2022) since integrating digital resources from different contexts and in various languages, traditions, customs, lifestyles, and forms of communication are appreciated, allowing analysis and understanding of realities from different angles.

In other words, the modality destroys socioeconomic and geographic barriers, allowing students to invest in a multicultural and intercultural educational environment (Gómez, 2023 and Ramírez, 2023)

Continuous evaluation. The mixed modality includes continuous evaluations (varied and integrated) since constant feedback and adaptation of teaching strategies are required for successful learning, among which are projects, teamwork, self-evaluations, co-evaluations, and hetero-evaluations.

At this point, it is worth highlighting that the purpose of continuous evaluation is to stimulate self-assessment and reflection in students in favor of metacognition, which arises from hybrid activities (Martín et al., 2022) through the collaborative or individual online work and face-to-face projects (Pérez & Gómez 2023), resulting in lasting and significant learning.

Digital skills. It is a methodology mediated by technology, an essential attribute for its users is the possession or development of digital skills that allow them to manage and use tools for interaction with the content and their learning community, and these, in turn, connect them with the global world of work (Llorente & Rodríguez 2021 and González & Martínez 2022).

In this regard, Pérez & López (2023) state that these competencies promote an inclusive hybrid education that reduces gaps in use and access to technology, providing students with elements for a digitalized environment.

Other characteristics of this modality lie at the operational level, which makes it comprehensive and innovative. Some of them are:

The virtual modality has no temporal or spatial boundaries, which contributes to the accessibility of knowledge (Eynon & Malmgren, 2019 and González & Ramírez, 2020). This variability leads to another characteristic called flexibility, where students can choose the times and locations to study and work with their digital community, a highly appreciated aspect in today's society where students can balance their multiple responsibilities (work, family, and school).

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In addition to this, the hybrid modality encourages the personalization of learning by presenting its content through multiple formats (audiovisual and interactive material) that adapt to the needs and learning styles of users in authentic social and cultural contexts

(Pérez, 2021 and Morales & López 2022); an element that motivates them to learn by giving them control over their learning, generating an equitable and inclusive space. These multi-formats guide the diversity of resources that promote permanent participation through digital platforms (Dias & Diniz, 2014).

Last but not least, this hybrid approach reduces costs, allowing educational institutions to optimize their infrastructure-related resources and channel them to other needs for quality education.

The teaching profile in a Blended Modality

In recent years, the hybrid modality has evolved by leaps and bounds, demanding requirements of the teaching profile that permeates their role, methodology, strategies, and content design, among others. The attributes of said teaching profile are mentioned below.

a. Instructional designer. In face-to-face and virtual modalities, the teacher becomes an instructional designer and must plan so that students can participate in both environments (Romero et al., 2022) and link the activities to the objective to obtain desired results.

b. Learning facilitator. This dimension refers to the role teachers play in creating a learning environment that combines the virtual and the in-person, including digital technologies in their praxis through collaborative learning that focuses on the interaction of students and content (López, 2023). In this task, the adaptation of the curriculum and its digital design are fundamental pieces to satisfy the demands of the students as well as the inclusion of active methodologies to encourage their interest and active role.

c. Communicator. As it is known communication is fundamental in the teaching-learning process. At this point, in this modality, the teacher must use different channels (in-person and digital) to keep their students immersed in the teaching dynamics and committed to their learning (Silva & Pérez, 2023).

d. Evaluator. This role is exhaustive since the design of the evaluation instruments must include digital and face-to-face components under a flexible and receptive approach, focusing their teaching according to student's needs (Fernández, 2023).

e. Socio-emotional promoter. Taking into account that they work in two different scenarios, teachers must develop the socio-emotional factors in their students (self-control, empathy, assertiveness, frustration tolerance, self-confidence, and responsibility), adapting the educational resources and methodology for meaningful learning (López & Rodríguez, 2022).

f. Leader. As in any job, leadership plays a fundamental role in praxis. The teacher is a model for his students and a source of inspiration and motivation (Hernández & Torres, 2023).

g. Mediator. It allows interaction between the actors involved in the educational process. Here, the teacher is a bridge of connection between students and the interactive content, collaboratively promoting exchanges of experiences (Pérez, 2020). Therefore, the role involves managing technological tools to trigger learning and enrich the construction of knowledge, demanding that the teacher not only be a content expert but also in the appropriate use of learning and knowledge technologies.

Methodology

The objective of this study is to describe and characterize the students' perceptions of the mixed teaching modality in the specific context of the subject Methodology of teaching in English I in the bachelor's degree in English teaching at a public university in the State of Puebla.

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The research has a quantitative approach with a descriptive scope and cross-sectional, which enables a precise exploration of the opinions of the participants at a specific time.

The sample consists of 55 students who study the aforementioned subject in a hybrid educational context. This selection seeks to obtain an adequate representation of students' perceptions taking into account that the use of hybrid approaches has permeated the educational field, especially after the changes imposed by the pandemic (González & Rodríguez, 2021).

Regarding the instrument used for data collection, a structured questionnaire was applied, based on a Likert-type scale that measures the degree of agreement of the students according to different statements. This questionnaire comprises 60 items, distributed in four categories: usefulness, effectiveness, ease of use, and benefits of the mixed modality.

The choice to measure these dimensions aligns with the literature that indicates the importance of measuring multiple dimensions of the student experience to obtain a broad description to interpret the phenomenon under study (Martínez et al., 2022).

It is worth mentioning that the validity of the questionnaire was carried out through a review process by experts in the area to ensure that the items adequately measure the proposed dimensions to obtain reliable results. The reliability of the questionnaire was calculated using Cronbach's alpha coefficient, obtaining high internal consistency, which reinforces the quality of the data collected.

Data collection was carried out at a single moment (summer 2024) to analyze the phenomenon at a specific time, avoiding possible biases that may arise from temporal variability (López & Fernández, 2023).

To interpret participants' perceptions in a clear and effective way, the data analysis was carried out based on the five aforementioned categories, using descriptive statistical techniques that allow us to visualize the trends and patterns in the students' responses as Pérez & Sánchez (2020) mention.

Results

This section presents the results according to the four categories described in the methodology.

Box 1

Table 1

Usefulness of the modality. M=Mean, Mdn=Median, SD=Standard deviation

Dimension	M	Mdn	SD
Interactive communication through applications	4.3	4.0	0.5
Learning accessibility	4.6	4.6	0.5
Flexibility in terms of time and space	4.4	4.1	0.4
Technology-mediated assessment	3.9	4.2	0.5

Interactive communication through applications gave an average of 4.3, which indicates a positive perception of the respondents. The median of 4.0 shows that a high number of students value this dimension positively, even though the standard deviation is 0.6 which indicates some variability in the responses.

According to Moreno et al. (2021), tools that allow interactive communication promote students' commitment to their learning process.

This highlights the importance of using technological tools that contribute to interaction in a learning environment.

Regarding accessibility to learning, a mean and median of 4.6 and a standard deviation of 0.7 were obtained. These data show high satisfaction with the accessibility offered by digital tools.

For Gómez and Pérez (2022), accessibility is an essential element for students to adopt self-managed learning. In addition, this factor is decisive in breaking down the technological barriers that limit learning opportunities.

Flexibility in terms of time and space showed a mean of 4.4 and a median of 4.1, which reflects a positive assessment. About the standard deviation, a value of 0.4 was obtained, showing high cohesion in the various questions. It shows that the majority of participants are favored with this flexibility.

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According to Ramírez (2023), flexibility in the educational process allows students to manage their time and space according to their learning needs and the context in which they operate, improving their training experience. Therefore, flexibility is a determining factor for the student to adapt to current learning. The technology-mediated evaluation reached a mean of 3.9, a median of 4.2, and a standard deviation of 0.5. These results show a more mixed scenario. Even though the median is positive, the mean shows that some students may have reservations about this approach. According to López (2023), evaluation is a determining challenge in digital environments. However, it also provides opportunities for formative and continuous evaluation.

In conclusion, the data obtained show that, although interactive communication, accessibility, and flexibility are recognized and valued positively, technology-mediated evaluation is a scenario that has a range of opportunities and improvement.

According to Fernández (2022), to insert the use of technology, a detailed approach is required to increase its effectiveness and acceptance. In summary, it is essential to continue exploring and adapting technology implementation to teaching to contribute to meaningful learning experiences.

Box 2

Table 2

Effectivess of the modality based on students' feelings. M=Mean, Mdn=Median, SD=Standard deviation

Dimension	M	Mdn	SD
Motivated	4.9	4.8	0.5
Active	4.3	4.5	0.5
Frustrated	0.2	0.1	.9
Confident	4.6	4.7	0.4
Confused	2.1	2.2	0.4

In table 2, the results indicate the average level and variability of participants' responses. In this sense, the motivated dimension shows the highest average (4.9), which means a high level of motivation among the respondents. This result agrees with the statements of Deci and Ryan (2020), who maintain that a hybrid environment that favors autonomy and competition can enhance intrinsic motivation.

The active dimension presents an average of 4.3, which marks a positive aspect but is slightly lower than motivated. This finding is consistent with the idea that physical and mental activity correlates with emotional well-being (Kern et al., 2021). Regarding its closeness to the motivated and active means, motivation can be a precursor to the active state; a fact that reinforces the need to promote motivation in various contexts.

In contrast, the frustrated dimension shows an average of 0.2, which reflects a very low level of frustration, interpreted as an indication that participants feel generally satisfied with their current circumstances. According to Seligman (2022), a low level of frustration is associated with a high level of general well-being, statements that coincide with the results observed in this research.

The secure dimension, with a mean of 4.6, also indicates a high level of trust among the participants. This finding is consistent with literature that highlights the importance of self-confidence in task execution and decision-making (Bandura, 2021). Therefore, the proximity of this measure to that of motivation points out that a state of security can reinforce personal motivation, thus facilitating the construction of meaningful learning.

Finally, the confused dimension, with a mean of 2.1, reveals a moderate degree of confusion among participants, which is not alarming, but it is essential to consider that confusion can hinder learning and adaptation (Nussbaum, 2023). In general, understanding emotions and clarifying goals are crucial to minimizing confusion and boosting levels of motivation and security.

Box 3

Table 3

Intuitive use. M=Mean, Mdn=Median, SD=Standard deviation

Dimension	M	Mdn	SD
Logical organization	4.5	4.3	0.4
Friendly user	4.9	4.9	0.5
Immediate feedback	4.6	4.7	0.4
Clear and simple interface	4.3	4.4	0.5
Tutorials	4.1	4.0	0.5

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Table 3 presents five dimensions related to the user experience where aspects such as logical organization, user-friendliness, immediate feedback, clarity of the interface, and the availability of tutorials as guides for use are evaluated.

In the dimension of logical organization, the average is 4.5 with a median of 4.3 and a standard deviation of 0.4 that indicates users consider the structure of the content adequate although there is some variability in the responses. In this regard, Nielsen (2022) maintains that good logical organization is crucial to improve navigation and facilitate the user experience.

User-friendliness stands out with a mean of 4.9 and an identical median, indicating high satisfaction. The standard deviation is 0.5, indicating some uniformity in the responses. These facts coincide with the studies of Hassenzahl (2021) arguing that a friendly design improves user satisfaction and encourages greater use of it.

Immediate feedback, with an average of 4.6 and a median of 4.7, is another positive aspect that points out the importance of receiving responses in the interaction with the system. This data aligns with the statements of Bargas-Avila & Hornbæk (2020), who emphasize that immediate feedback maintain the user's attention and motivation in the learning process.

The interface dimension with a mean of 4.3, a median of 4.4, and a standard deviation of 0.5 highlights that there is room for improvement although most users are satisfied with it. In these sense, Garret's (2023) research supports this need, remarking that a simple interface is vital to ensure that users can perform tasks, impacting their academic performance.

Lastly, the tutorials obtain a mean of 4.1 and a median of 4.0, with a standard deviation of 0.5. This suggests that while users find the tutorials useful, there could be opportunities to enrich this offering. According to the research of Mica et al. (2022), effective tutorials are essential for a good user experience, as they make it easier to understand and learn the system.

Box 4

Table 4

Advantages of the blended learning. M=Mean, Mdn=Median, SD=Standard deviation

Dimension	M	Mdn	SD
Ideal for sharing educational resources	4.3	4.3	0.4
Promoter of collaborative work among curriculum agents	4.5	4.5	0.5
Flexibility in terms of space and time	4.1	4.2	0.5
Access to the construction of knowledge in different scenarios	4.2	4.1	0.4
Updated information	4.4	4.3	0.5
Personalized learning	4.5	4.5	0.4
Construction of knowledge through different formats	4.0	4.0	0.5

Table 4 shows how in this context, each of the dimensions contributes to a more collaborative and flexible educational environment.

The first dimension has a mean and median of 4.3 and a standard deviation of 0.4. This indicates a high perception of effectiveness in the use of the platform for the distribution of educational materials. In this vein, Rodríguez (2021) comments that the sharing of digital resources encourages collaboration and active learning between students and teachers, underlining the importance of having tools and platforms that facilitate accessibility to educational content.

The second dimension presents an average of 4.5, which indicates that users consider the modality to be very effective in promoting collaboration, as pointed out by Gómez (2022) when considering that the platforms allow interaction between different actors in the educational process; a key aspect for the development of learning communities. The high score on this dimension highlights the need for a collaborative approach in contemporary education.

The third dimension obtained an average of 4.1, which reflects a positive perception, although slightly lower compared to other dimensions. Flexibility is essential in modern learning, as argued by Pérez (2020), who maintains that the possibility of learning in different contexts and schedules enhances student performance. Therefore, while flexibility is appreciated, there could be areas for improvement.

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The fourth dimension yields an average of 4.2, evidencing that the modality is effective in providing access to diverse learning opportunities. These findings coincide with López (2023) in maintaining that the diversity of learning scenarios enriches the educational experience and promotes student autonomy, showing that this ability to access multiple scenarios is crucial in current education.

The fifth dimension also shows a high score with an average of 4.4. This means that updating content is vital in a constantly changing world. As mentioned by Martínez (2021) in his study, the relevance of educational materials depends on their updating and adaptation to the current needs of the labor market. This frames the need to maintain a dynamic database that reflects the evolution of knowledge.

The sixth dimension with an average of 4.5 reveals that users highly value personalization in their educational process. Such customization can be essential to individual students' needs. These results coincide with Fernández (2022) who mentions personalized learning impacts students' academic training and performance. Therefore, the high rating in this dimension shows a positive approach towards adaptive learning.

Finally, the seventh dimension has a mean of 4.0. Although it is an adequate score, it indicates that there is room for improvement in the diversification of learning formats that are related to teachers' digital competencies. As García (2023) says in his study, multiple formats can facilitate students' understanding and interest. Consequently, it is crucial to continue exploring ways to integrate different media for knowledge construction.

In summary, the results reveal that the blended modality is highly valued in collaboration, customization, and access to up-to-date resources. However, potential areas of opportunity are also identified, especially in flexibility and diversification of learning formats. At this point, it is imperative to emphasize that the combination of these dimensions is essential to fostering an educational environment that responds to student's needs in a digital revolution.

Conclusions

In conclusion, the study on perceptions about the mixed modality reveals that this form of teaching is highly valued by its users in aspects such as use, efficiency, and intuitiveness. So, combining face-to-face and online methods facilitates more dynamic and adaptable learning according to the student's appreciation. In addition, collaboration between peers has also been favored, enhancing teamwork and the exchange of ideas and offering constant access to updated resources that significantly enrich the educational process. However, although the results are positive, areas of opportunity have been identified for good learning experiences, which lie in flexibility, specifically in planning activities and the diversification of learning formats, alluding to the possibility to personalize the educational experience further.

Declarations

Conflict of interest

The authors declare no interest conflict. They have no known competing financial interests or personal relationships that could have appeared to influence the article reported in this article.

Author contribution

Flores-González Norma: Contributed to the elaboration of every single section of the article.

Flores-González, Efigenia: Work on the methodology, results and literature review sections.

Castelán-Flores, Vianey and *Zamora Hernandez Mónica:* Helped to collect data.

Availability of data and materials

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Abbreviations

UNESCO	United Nations Educational, Scientific and Cultural Organization
ICT	Information and Communications Technology

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LKT	Learning and Knowledge Technologies
EPT	Empowerment and Participation Technology

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Article

The growth exponential of the earthworm red Californian (*Eisenia foetida*) on a substrate of organic waste

Crecimiento exponencial de la lombriz roja Californian (*Eisenia Foetida*) en un sustrato de residuos orgánicos

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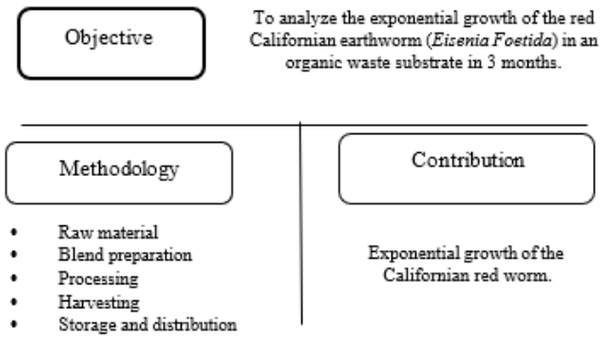
Abstract

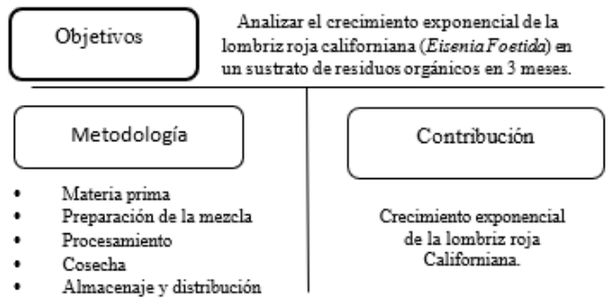
Vermiculture has an ecological approach due to the recycling of the different substrates used in its feeding; it also has a biotechnological approach due to the microbiological and biochemical phenomena that occur in the fermentation process of the worm feeding on organic materials; it also provides a simple, rational and economical response to the environmental problem. The Californian red worm (*Eisenia Foetida*) doubles its population after 3 months; the objective of this project is to record the progress and exponential growth of the Californian red worm as well as its growth rate after these 3 months with a substrate of organic waste.



Vermicompost, exponential growth, Californian red worm

Resumen

La lombricultura tiene un enfoque ecológico debido al reciclado de los diferentes sustratos utilizados en su alimentación; también tiene un enfoque biotecnológico debido a los fenómenos microbiológicos y bioquímicos que se producen en el proceso de fermentación de la lombriz al alimentarse de materiales orgánicos; además proporciona una respuesta sencilla, racional y económica al problema medioambiental. La lombriz roja californiana (Eisenia Foetida) duplica su población al cabo de 3 meses; el objetivo de este proyecto es registrar el progreso y crecimiento exponencial de la lombriz roja californiana así como su tasa de crecimiento al cabo de estos 3 meses con un sustrato de residuos orgánicos.



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Vermicompost, crecimiento exponencial, lombriz roja californiana

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Introduction

Composting represents a highly beneficial area of opportunity in our country, as it allows reducing the costs of transporting and disposing of waste, with the corresponding risk of contamination and proliferation of harmful fauna, in addition to obtaining a marketable product. Although composting has gained popularity and there are countless manuals and techniques, it is necessary to disseminate this practice among the community to solve the problems of organic waste contamination and offer low-income families a way to earn income, thus contributing to social well-being.

Vermiculture is an agricultural activity and consists of the technical breeding of worms in captivity, the immediate objective of which is the production of worm humus, which is an entirely organic fertilizer, and additionally, a larger quantity of worms, which are called breeding stock or vermicompost biomass, which constitute an important source of protein.

Vermiculture has an ecological approach due to the recycling of the different substrates used in its feeding, and a biotechnological approach due to the microbiological and biochemical phenomena that occur in the fermentation process of the worm when feeding on organic materials, in addition to providing a simple, rational and economic response to the environmental problem. Vermiculture is a growing business and will in the future be the fastest and most effective means of soil recovery in rural areas.

The California red worm (Eisenia Foetida), originally from Eucrasia, has been intensively bred since the 1950s in California (USA) and is used on more than 80% of the world's farms, making it the most widely cultivated species in the world due to its hardiness, tolerance to environmental factors, reproductive potential and capacity for crowding.

The focus of this project will be on the calculation of the exponential growth of the Californian red worm (Eisenia Foetida) in vermicompost having as its main food organic waste, the duration of this project will be estimated at 3 months, since the Californian red worm after this time doubles its population.

This exponential calculation is essential since by having a constant growth rate after this time it is possible to accurately calculate the exponential growth in a given time, whether in days, months or years without the need to manually count the Californian red worms.

Background

Vermiculture as a technique has its origins in 1936 in Los Angeles, USA, with Dr. Tomas Barret. In 1758 Carl von Linnaeus implemented the “Natural System”, which included for the first time a species of earthworm, Lombricus terrestris.

According to Compagnoni, worm farming was born and developed in North America with Hugh Carter in 1947, and then spread to Europe, Asia and America. In 1988, thanks to some research, another species of earthworm was found, superior to the traditional one, the *Eisenia Foetida* . (Rodríguez, 1996)

Concept of vermiculture

Vermiculture is a biotechnology that uses domesticated earthworms (Eisenia foetida) as work tools. Under certain conditions (temperature, humidity, pH), various organic materials can be recycled and used to produce humus and worm meat as a final product. This technology has applications in agriculture with production systems that require recycling solid waste into high-quality organic fertilizers, which generates economic benefits, and worm biomass that can be used to feed birds, fish and pigs. (Heras Sierra, 2015)

Vermicomposting process

Raw material

A wide variety of organic waste can be used, however, it is more feasible to use pre-consumer waste of plant origin (vegetable peels), excluding citrus fruits because their acidity conditions affect the worm population. Preparation of the mixture.

Necessary preparations for materials to be added to vermicomposting include particle size reduction of waste, mixing, moisture control, and inoculation with live strains of microorganisms and worm castings.

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Vermicompost producers recommend feeding worms with partially decomposed materials, to avoid excessive heat production when organic matter accumulates and decomposes due to its high carbon content, although practice has shown that worms can be fed with "fresh" waste when a correct carbon/nitrogen ratio is sought and animal waste (meat, fish and seafood, poultry and dairy) is avoided.

Inoculation: It is advisable to inoculate the container with mature vermicompost and worms of the *Eisenia Foetida species* (Californian red worm).

Harvest

It is generally suggested to harvest vermicompost six months after the system has been in operation, when the contents have acquired a dark brown colour. The worm moves to the upper layers of the container through a mesh, while the compost remains at the bottom.

Californian red worm (Eisenia foetida)

The red worm (RW) is commercially known by the nickname "Californian" because it was in this US state where the first intensive worm farms were developed in the 1950s. The reproduction of worms in captivity treated with bovine manure compost has produced the highest breeding values (expressed as number of offspring at 14 and 21 days and total offspring per cocoon). This type of feeding was the most efficient at all times of the year, increasing its value even more in spring and summer (Toccalino et al., 2004)

Box 1

Table 1

External morphological characteristics of the earthworm Eisenia foetida (EF). (The numbers indicate the number of segments in which each of the characters is found)

Character	Eisenia foetida
Color	Wine red in colour. Orange or yellow stripes at the end of the body.
Shape	Slightly flattened dorsoventrally.
Quetas	Lumbricin.
Length (cm)	6-9
Number of segments	96-118
Weight (g)	0.3-1
Clitellus	[26-33]
Male pores	15-With papillae. Globose shape. 1 pair in the shape of an eyelet.
Female pores	14. 1 lateroventral pair.

Source: (Melendez Gomez, 2003)

Factors to consider when planting Californian red worm

- **Location:** They can be placed in shaded areas such as pergolas, under trees that do not have tannin, moss, galleries, ecological boxes and in open fields, placing high layers of grass for protection, thus avoiding evaporation and allowing easy access.

The surface must be almost flat, not have a slope greater than 20% and not be exposed to flooding. Drainage ditches must be made with very good water availability. It is necessary to orient the beds in the same direction as the prevailing winds.

- **Lighting:** Earthworms are very sensitive to ultraviolet rays, which can cause their death. It is therefore advisable to place them in shaded or covered areas.

- **Humidity:** This is one of the most influential elements. Errors, whether due to a lack or excess, have negative consequences for the production of humus as well as for the reproduction and fertility of the worm. Humidity should be maintained between 75% and 80%, since humidity levels below 70% are unfavorable for breeding and levels below 55% are death levels.

- **Temperature:** The ideal temperature is between 15-24ºC, as close as possible to the body temperature of the worm, which is 19ºC. Above

30ºC the worm can withstand the temperature well, but at the cost of lower production and a decrease in humus production.

- **pH:** A determining factor for good vermiculture is to have a pH between 6.5 and 7.5 and the optimal values are between 6.8 and 7.2. (Fuentes Yague, 1987).

- **Aeration**: Earthworms require air for their vital process and therefore it is necessary to remove the beds with a rake at least every seven days. (Somarriba Reyes & Guzmán Guillén, 2004).

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Exponential growth

Exponential growth (EG) describes a hypothetical model of population growth in which space and resources are available in an unlimited manner.

As a result, the rate of population growth increases with each new generation.

According to this model, a population grows rapidly and continues to grow indefinitely.

There are two different types of exponential growth:

Discrete Growth: is modeled with:

$$y_t = y_0(1+k)^t \quad [1]$$

Where growth occurs at specific intervals.

Continuous Growth: It is modeled with:

$$y = y_0 e^{kt} \quad [2]$$

Where growth is continuous over time.

Both formulas are essential in different contexts and allow to adequately model the behavior of variables that grow exponentially, either in discrete intervals or continuously.

Regarding this project to calculate the exponential growth of the earthworm population we will be using the continuous exponential growth formula since this formula is used to model situations in which the population grows continuously and at a constant rate, which is characteristic of exponential growth.

In the first instance it must be assumed that:

$t =$ time (days)
$t = 1$ $(\emptyset)$ initial value
$t_0 = 0$
$y =$ population
$k =$ growth rate
In an equation it would look like this:

$$y = f(t)$$

But we need to focus the equation on the population that varies with respect to time giving the following equation:

$$\Delta y = \Delta t$$

Every increase in time increases the population.

The population change will be the population multiplied by the increase in time.

Population growth is the number of inhabitants in time X multiplied by the temporary increase, but it must grow with respect to the growth rate.

$$\Delta y = ky\Delta t$$

It is written as follows:

$$\frac{\Delta y}{\Delta t} = ky$$

Therefore, this expression also passes in its differential form:

$$\frac{\mathrm{d}y}{\mathrm{d}t} = ky$$

This equation must be integrated, but you can't have two differentials on one side, so it separates as it was originally:

$$dy = ky\,dt$$

The variable y must be changed to the other side:

$$\int_y dy = \int k\,dt$$

Once we have the expression, we integrate it.

According to the integration formulas, when integrating the

$\frac{dy}{y}$ is equal to $\ln y$:

$$\ln y = \int k\,dt$$

The k is a constant, so only dt is integrated:

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$\ln y = kt + c$

Since this is an explicit problem, it is assumed that *c is:*

Yeah

$y = y_0$
$t = t_0 = 0$

Replacing :

$$\ln y_0 = k(0) + c \quad \rightarrow \quad c = \ln y_0$$

Substitute *c* in the solved integral:

$\ln y = kt + \ln y_0$

The value of y remains as is and may change from one day to the next.

$y_0 =$ poblacion inicial

$\ln y = kt + \ln y_0$

The two are joined Inby only one side:

$\ln y - \ln y_0 = kt$

By the law of logarithms the subtraction of two

Inis $[\ln a - \ln b = \ln(\frac{a}{b})]$:

$$\ln \frac{y}{y_0} = kt$$

What is needed is clarification $y$to calculate the population.

He Ingoes over to the other side as his opposite:

$$\frac{y}{y_0} = e^{kt}$$

Cleaning y_0:
$y = y_0 e^{kt}$

Mathematical expression that describes exponential population growth.

It is used for both exponential growth and exponential decay.

Calculation of the growth rate

The growth rate (GR) is the index that indicates the growth or decrease in the population amount during a specific period.

You will use the discrete exponential growth equation, which is used when growth increments occur at discrete intervals (e.g., annually, monthly, etc.), rather than continuously.

The discrete exponential growth formula $y_t = y_0(1 + k)^t$is derived from the idea of applying a constant growth rate over discrete time intervals. Here is a step-by-step explanation of how this formula is derived:

$\ln y = kt + \ln y_0$

Definition of discrete growth:

The quantity y is assumed to grow at a constant rate at discrete intervals. $k$at discrete intervals. That is, after each period, the quantity grows by a percentage of its previous value. $k$percentage of its previous value.

In a first period, the initial amount $y_0$increases according to the growth rate k. The new value
y_1 will be:

$$y_1 = y_0 + y_0 \cdot k = y_0(1 + k)$$

In the second period, the new value y_1 grows again at the same rate k:

$$\begin{aligned} y_2 = y_1 + y_1 \cdot k &= y_1(1 + k) \\ &= y_0(1 + k)(1 + k) \\ &= y_0(1 + k)^2 \end{aligned}$$

Following the same pattern, after the third period, the value will be:

$$\begin{aligned} y_3 = y_2 + y_2 \cdot k &= y_2(1 + k) \\ &= y_0(1 + k)^2(1 + k) \\ &= y_0(1 + k)^3 \end{aligned}$$

This period is repeated for any number of periods. t Generalizing, after t the periods, the value will be:

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$$y_t = y_0(1+k)^t$$

From the discrete exponential growth formula we will clarify k.

Where:

y_t = final population
y_0 = initial population
t = time

Compensation k for calculating the growth rate:

We go $y_0$to the other side of the operation, we multiply by what happens when we divide:

$$\frac{y_t}{y_0} = (1+k)^t$$

The same is done with the exponential $t$since in exponential it goes to the other side as a radical:

$$\sqrt[t]{\frac{y_t}{y_0}}$$

The 1 is added and subtracted as it is added, obtaining:

$$\sqrt[t]{\frac{y_t}{y_0}} - 1 = k$$

By the law of radicals we know that $\sqrt[n]{a^m} = a^{m/n}$we can observe the formula as follows:

$$(y_t/y_0)^{\frac{1}{t}} - 1 = k$$

Adjusting the equation we obtain:

$$k = (y_t/y_0)^{\frac{1}{t}} - 1$$

If k is positive, the population grows.
If k is negative, the population decreases.

In any case, population variation can be expressed as a function of the growth rate, that is, the percentage variation:

Razón del crecimiento = Tasa de crecimiento $\times 100$

In cases where the growth rate is zero, we are talking about a population in equilibrium: the population is neither increasing nor decreasing. This means that the birth and death rates are equal.

Methodology

General steps for establishing a vermicompost plantation

Preparing the vermicomposting box

Using the drill, a hole was made on one side with a diameter of 2 cm, this hole was made with a 16 mm drill bit, this hole is to place the ½ inch bit wrench.

This key will be in the lower center of the box, so that the leachate exits through here. The key was installed in the box and reinforced with hot silicone to prevent leaks and keep it in place (Fig. 1).

Box 2

Figure 1

Perforated plastic box for vermicompost with a pointed key already fitted

Source: Own elaboration

Inside the box and to collect even more leachate, there will be a ½ inch female adapter, around this female adapter there will be a mesh cloth, to prevent the worms from exiting through the faucet (Fig. 2).

Box 3

Figure 2

Perforated plastic box for worm composter with a ½ inch female adapter and a 1/2 inch male key on the inside of the box, with 0.5 cm perforations on the sides

Source: Own elaboration

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Eight holes with a diameter of 0.5 cm were drilled separately on the sides of the box, which will serve as ventilation for the box (Fig. 3).

Box 4

Figure 3

Perforated plastic box for worm composter with a ½ inch female adapter and a 1/2 inch male key on the inside of the box, with 0.5 cm perforations on the sides

Source: Own elaboration

To prevent the worms from escaping through the 0.5 cm holes on the sides, a cloth mesh was placed over the holes. Rectangles of mesh measuring 8.5 x 6 cm were cut and glued with hot silicone for better adhesion (Fig. 3).

Box 5

Figure 4

Vermicompost box with the first layer of substrate (dry leaves and branches)

Source: Own elaboration

Layer 1. Dry leaves and branches as a substrate for vermicompost

Dry leaves and branches were chosen as the main substrate for the vermicompost, since this allows the soil to aerate. In this first layer it only occupied 5 g and had a height of 1 cm (Fig. 4).

Layer 2. Composted soil

As a second layer, previously composted soil was placed on the vermicompost to speed up the vermicomposting process a little; 1 kg was added and the vermicompost had a height of 2 cm (Fig. 5).

Box 6

Figure 5

Vermicompost box with the second layer, composted soil

Source: Own elaboration

Layer 3. Sowing Californian red worms in the vermicompost

In this third layer the worms were added, there will be a total of 6 Californian red worms, one of the worms still has its clitellum developing (Fig. 6), the lake of each of the worms will be described below.

Box 7

Figure 6

Image of the 6 Californian red worms that will be in the vermicompost

Source: Own elaboration

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Layer 4. Organic waste

For the fourth layer, organic waste should preferably be cut into cubes smaller than 2 cm to increase the speed of waste decomposition, allowing the worms to perform efficient processing, which on this occasion will be administered, watermelon, lettuce and tomato, adding 45 g to the vermicompost (Fig. 7).

Box 8

Figure 7

Vermicompost box with the fourth layer, organic waste

Source: Own elaboration

Layer 5. Crushed eggshell

In this fifth layer, crushed eggshell is essential since it is an excellent fertilizer and controller of soil pH. It should preferably be crushed to better take advantage of its benefits. In this case, 12 g of eggshell were added (Fig. 8).

Box 9

Figure 8

Vermicompost box with the fifth layer, crushed eggshells

Source: Own elaboration

Layer 6. Dry leaves

As a sixth and final layer, dry leaves will help prevent excess moisture and allow better aeration. In this layer, the dry leaves will be smaller and slightly crushed. 5 g were added to the vermicompost with a height of 1 cm (Fig. 9).

Box 10

Figure 9

Vermicompost box with sixth layer, plus crushed dry leaves

Source: Own elaboration

Finished vermicompost

Final height: 4.5 cm.
Final weight: 2.2 kg (Fig. 10

Box 11

Figure 10

Vermicompost box on scale with all layers already completed

Source: Own elaboration

During these three months you will have a large cloth bag, since the worm humus must be in a dark place, and the bag will also allow better aeration.

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As a final point, the vermicomposting box should be at an inclination of approximately 30°, since with vermicomposting some of its final products are humus and leachate, the leached liquid should not remain stagnant at the bottom of the box, so the inclination helps to better drain this leachate (Fig. 11).

Box 12

Figure 11

Finished vermicompost box with a cloth bag covering it

Source: Own elaboration

Results

Worms were counted manually to trace growth and obtain a growth rate.

Below are the graphs with the results obtained in 100 days.

Box 13

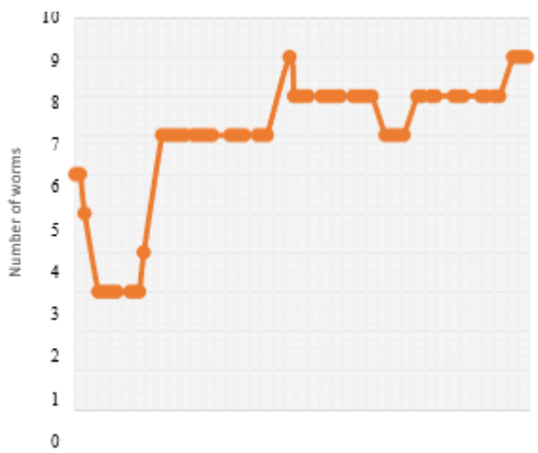

Figure 12

Graph of the exponential growth of the Californian red worm over a period of 100 days

Source: Own elaboration

Box 14

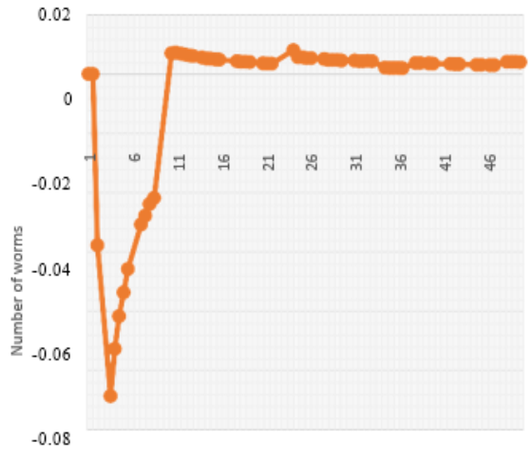

Figure 13

Graph showing the growth rate of the California red worm over a period of 100 days

Source: Own elaboration

The growth rate data was obtained using the unclouded formula of discrete exponential growth. As the days passed, the growth rate remained constant at 0.004.
Having already 100 days of growth, the growth rate can be concluded as:

$k = 0.004$
Growth rate = 0.4%.

This explains why the growth of the Californian red worm increases by 0.4% in 100 days. The formula for continuous exponential growth

$y = y_0 e^{kt}$ applies to future dates:
Data:
$y_0 =$ 6 worms
$k = 0.004$
$t =$ years

Box 15

Tabla 2

Exponential growth of the California red worm over the year

Years	Number of worms
1	25
2	111
3	479
4	2062
5	8881
6	38244
7	164680
8	709105
9	3053379
10	**13147727**

Source: Own elaboration

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Getting this graph:

Box 16

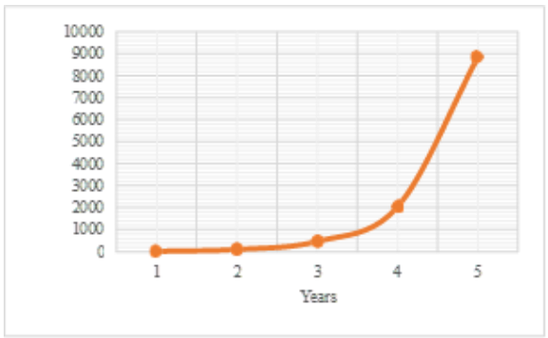

Figure 14

Exponential growth of the California red worm in the first 5 years

Source: Own elaboration

Box 17

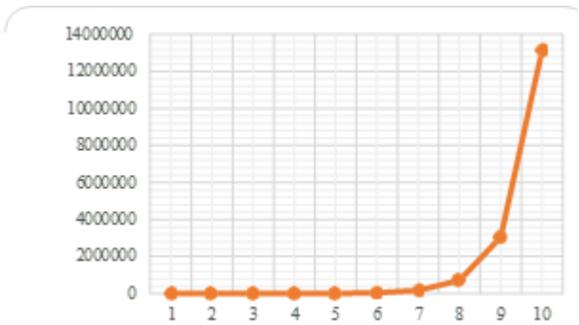

Figure 15

Exponential growth of the California red worm in the 10 years

Source: Own elaboration

Conclusions

The project did not start in the best way, since days after having started the project, unfortunately of the 6 worms that were initially there, 3 worms died, so there are only 3 worms left in the project, it is estimated that it was due to the lack of humidity, in question that the growth rate remained in negative numbers for 13 days, exactly from day 3 to day 20, which was the day that when checking the vermicompost box there were new worms.

California red worms had improved reproduction starting on day 20 of the project, and then had slow reproduction, with one or two new worms approximately every month; growth remained linear in March.

Later, exactly in the first days of March, the population of the 3 worms that resided increased to 7 worms, giving a growth rate of 0.007 for the 20th day. From this day on, the population has remained stable. There are deaths of worms whose cause is unknown, but the population is constantly recovering.

As the days go by, the growth rate decreases only by tenths, but as the days go by, this growth rate does not vary by tenths, it remains constant, so it could be considered that the growth rate can be the constant that at the end of the project can be used to calculate the exponential growth of the Californian red worms over several days, months or years, and give exactly how many worms there will be in the time that is desired to know, without having to count the worms manually.

At first there was no knowledge on the subject so this affected the project at the beginning, if the project could be repeated with what had already been learned there would surely be no negative numbers in the growth rate.

Declarations

Incompatibility

The authors declare that they have no conflict of interest. They have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

Author's contribution

Garcia-Garcia, Dámaris Carmen: I contributed to the start of the project, giving the first initiative to work with the Californian red worm.

Hernandez-Garcia, Cintia Elí: I contributed to the monitoring of the project, in addition to being an advisor and trainer for the project.

Diez-Barroso-Agraz, Allan Ronier: I contributed to the financing of the project as well as providing the contractor to contribute to this project.

Garcia-Alvarado, Lizeth: I contributed to the writing of the article and to the realization of the project together with the authors.

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Funds

Box 18

Tabla 3

Quotation of materials used in the project

Material	Price	Cost	Shipment
Box	$200.00	$124.00	
Plastic tip wrench	$50.00	$33.50	
½ inch female adapter		$6.50	
Drill	$500.00	$462.00	
Moisture meter	$160.00	$153.82	
Distilled water	$140.00	$115.00	$91.00
Beaker	$200.00	$196.00	$79.00
Mixing spoon	$225.00	$128.00	$79.00
pH meter	$250.00	$237.00	$99.00
Total	**$1725.00**	**$1724.82**	

Source: Own elaboration

Expressions of gratitude

We would like to thank IntGen Technologies de México SA de CV for their financial contribution to the project.

Abbreviations

RW	Red Worm
USA	USA
IS	Eisenia foetida
GRAM	Growth rate
E.G	Exponential growth

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Article

Quantification of heavy metals in agricultural soil of Lampotal Vetagrande Zacatecas

Cuantificación de metales pesados en suelo agrícola de Lampotal Vetagrande Zacatecas

Hernández-Salas, Claudia*[a], Olarte-Saucedo, Maricela[b], Moreno-Longoria, Julieta[c] and Orta-Martínez, Felipe[d]

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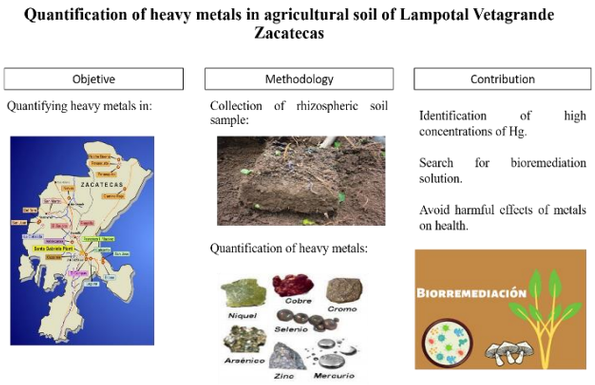
Abstract

Soil contamination with heavy metals (PMs) is a serious environmental and public health problem. These produce conditions that range from damage tovital organs to cancerous developments. The objective of this research was to quantify metals in agricultural fields of Lampotal. The concentration ofMPs was determined in samples of agricultural soils from Lampotal, Vetagrande Zacatecas and plant species from the study site were identified in agricultural fields. The sample results for As, Pb and Cd are in a normal range, while for Hg, the concentrations are high (M1=405.20 ppm,M2=225.37 ppm, P3=246.14 ppm and P4=285.80 ppm). Environmental pollution is a serious problem that must be addressed immediately. The concentration of Hg at the sampling site is high,while, for Cd, As and Pb, the values are within the permitted range of standard 147-SEMARNAT/SSA-1-2004



Pollution, Heavy metals, Agricultural soil

Resumen

La contaminación del suelo con metales pesados(MPs) es un grave problema ambiental y de salud pública**.** Estos producen afecciones que van desde daños en órganos vitales hasta desarrollos cancerígenos. El objetivo de esta investigación fue cuantificar metales en campos agrícolas de Lampotal. Se determinó la concentración de MPs en muestras de suelos agrícolas de Lampotal, Vetagrande Zacatecas y se identificaron especies vegetales del sitio de estudio en campos agrícolas. Los resultados de las muestran para As, Pb y Cd están en un rango normal, mientras que para Hg, las concentraciones son altas (M1=405.20 ppm, M2=225.37 ppm, P3=246.14 ppm y P4=285.80 ppm). La contaminación ambiental es un problema grave que se debe atender de forma inmediata. La concentración de Hg en el sitio de muestreo es alta, mientras que, para Cd, As y Pb, los valores están dentro del rango permitido de la norma 147-SEMARNAT/SSA-1-2004.

Contaminación, Metales pesados, Suelo agrícola

Citation: Hernández-Salas, Claudia, Olarte-Saucedo, Maricela, Moreno-Longoria, Julieta and Orta-Martínez, Felipe. [2024]. Quantification of heavy metals in agricultural soil of Lampotal Vetagrande Zacatecas. ECORFAN Journal Republic of Nicaragua. 10[18]1-5: e61018105.

Introduction

Soil contamination with heavy metals (PMs), due to the discharge of untreated mining waste, is an important problem and threat to ecological integrity and human well-being (Gil-Martínez, 2020).

Over time, the problem has been increasing due mainly to anthropogenic activities. Worldwide, pollution by PMs increases daily due to different human activities, such as mining, metallurgy, agriculture and waste from urban areas that generate a large amount of waste combined with PMs (Pouresmaieli et al., 2022).

Industrial activities have the potential to contaminate soils with a wide variety of heavy metals (Obiri-Nyarko et al 2024). In the case of mining, it is due to poor management of "mining tailings", which causes pollution problems in states such as Zacatecas, San Luis Potosí, Durango, Guerrero and Sonora. (Yáñez et al., 2003; Meza-Figueroa et al., 2009; Mireles et al., 2012; Cortés-Jiménez et al., 2013).

As a result of mining exploitation, a large amount of waste or tailings is continually generated. These are generally characterized by having very high concentrations of various potentially toxic elements that can be toxic (Sánchez-López et al., 2017).

MPs are those chemical elements that have a density equal to or greater than 5 g/cm3 when they are in elemental form, or with an atomic number greater than 20, excluding alkali or alkaline earth metals (Velusamy et al., 2022).

The main receptor that comes from anthropogenic pollution is the soil. These metals do not behave as statically unalterable elements, but rather follow a dynamic course.

The dynamics of MPs in the soil can be classified mainly into four pathways: a) mobilization to surface or groundwater, b) transfer to the atmosphere by volatilization, c) absorption by plants and incorporation into food chains, and d) retention of MPs in the soil in different ways: dissolved in the soil solution or can be fixed by adsorption, complexation or precipitation processes (Navarro-Aviñó, Aguilar, & López-Moya, 2007).

Metals most likely to cause problems include Cu, Cd, Hg, Mg, Co and Ni. They are considered toxic if they are harmful to the growth or metabolism of cells when exceeding a certain concentration; some of them constitute serious poisons even at very low concentrations. The toxicity of these MPs is proportional to the ease of being absorbed by living beings, a metal dissolved in ionic form can be absorbed more easily than in elemental form, and if it is finely reduced it increases the possibilities of its oxidation and retention by the various organs (Vega and Reynaga, 1990). Copper, lead, nickel and cadmium are elements that are found in low concentrations in the environment. Their increase in ecosystems is due to anthropogenic processes, making the environment toxic for living beings and being a risk factor for human health , causing irreversible damage (Khan et al., 2021). Recent studies have investigated heavy metal contamination of soils and suspended sediments in a Nurzec River basin (eastern Poland), focusing in particular on the effects of land use in the basin. (Bojanowski, 2024).

Methodology

The collection of rhizospheric soil samples was collected from agricultural fields of Lampotal, Vetagrande Zacatecas, which was obtained in the month of September 2022.

Rhizospheric soil sample

The rhizosphere soil was taken approximately 15 to 20 cm deep. The samples were collected in plastic bags and stored at room temperature until later analysis in the laboratory. The soil samples were obtained by taking four sub-samples at 4 agricultural sites of interest, thus forming a representative sample.

Of these samples, 3 repetitions were analyzed. The samples were taken to the Chemical Analysis Laboratory of the Academic Unit of Chemical Sciences of the Autonomous University of Zacatecas, where the quantification of MPs was carried out by atomic absorption spectroscopy prepared based on a certified PE PURE brand standard of 1000 ppm Pb.

Results

The soil samples collected at the study site were analyzed in the special studies laboratory of the Academic Unit of Chemical Sciences of the Autonomous University of Zacatecas.

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As can be seen in Table I, II, III and IV, the results of plots 1, 2, 3 and 4 are shown. The tables show the repetitions carried out in each of the plots, as well as the values obtained from arsenic, lead, mercury and cadmium in each of the samples.

Box 1

Table 1

Concentrations of MPs in soil from plot 1. Values of As, Pb, Hg and Cd in the soil samples

Parcela 1	Arsénico ppm	Plomo ppm	Mercurio ppm	Cadmio ppm
M1 SA1	1.90	32.38	400.00	3.81
M1 SA2	1.98	29.77	456.53	3.97
M1 SA3	1.99	61.84	359.07	3.99
	5.88	123.99	1,215.60	11.77
	1.96	41.33	405.20	3.92

M1 SA1=Sample 1, repeat 1, M1 SA2= Sample 1, repeat2, M1 SA3= Sample 1 repeat 3.

Con 2, M2 SA3= Sample 2 repeat 2, M2 SA3= Sample 2 repeat 3

Box 2

Table 2

Concentrations of MPs in soils of plot 2. Values for As, Pb, Hg and Cd in the soil samples

Parcela 2	Arsénico ppm	Plomo ppm	Mercurio ppm	Cadmio ppm
M1 SA1	1.99	35.91	239.38	1.99
M1 SA2	1.98	41.68	198.49	1.98
M1 SA3	1.99	67.50	238.24	1.99
	5.97	145.09	676.11	5.97
	1.99	48.36	225.37	1.99

M1 SA1=Sample 2, repeat 1, M2 SA2= Sample 2, repeat2, M2 SA3= Sample 2 repeat 3.

Box 3

Table 3

Concentrations of MPs in soils of plot 3. Values for As, Pb, Hg and Cd in the soil samples

Parcela 3	Arsénico ppm	Plomo ppm	Mercurio ppm	Cadmio ppm
M3 SA1	2.00	43.97	219.87	9.99
M3 SA2	2.00	29.95	179.71	3.99
M3 SA3	1.99	89.70	338.85	5.98
	5.99	163.62	738.43	19.97
	2.00	54.54	246.14	6.66
M3 SA2	2.00	29.95	179.71	3.99

M3SA1=Sample 3, repeat 1, M3SA2= Sample 3, repeat 2, M3SA3= Sample 3 repeat 3.

Box 4

Table 4

Concentrations of MPs in soils of plot 4. Values for As, Pb, Hg and Cd in the soil samples

Parcela4	Arsénico ppm	Plomo ppm	Mercurio ppm	Cadmio ppm
M4 SA1	1.99	99.64	259.07	1.99
M4 SA2	1.99	103.50	318.47	5.97
M4 SA3	2.00	101.96	279.89	4.00
	5.98	305.10	857.43	11.96
	1.99	101.70	285.80	3.98

M4SA1=Sample 4, repeat 1, M4SA2= Sample 4, repeat 2, M4SA3= Sample 4 repeat 3

The figure I shows the comparison of the concentration values in ppm of Pb of each of the analyzed soil samples, graph II shows the results of Cd, graph III shows the results of Hg, while graph IV shows the results of the As samples.

Box 5

Figure 1

Pb concentration in soil samples from plot 1

Box 6

Figure 2

Cd concentration in soil samples from plot 2

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Box 7

Figure 3

As concentration in soil samples from plot 3

Box 8

Figure 4

Hg concentration in soil samples from plot 4

Conclusions

Environmental contamination by PMs in the State of Zacatecas is a serious problem that must be addressed immediately, since there are different sites contaminated with PMs in the state of Zacatecas, such is the case of the agricultural fields of Lampotal, Vetagrande, Zacatecas, where high concentrations of Hg were found, which exceeds what is established in standard 147-SEMARNAT/SSA-1-2004, while for other metals, the values turned out to be within the normal range in this investigation.

Declarations

Conflict of interest

Los autores declaran no tener ningún conflicto de intereses. No tienen ningún interés financiero en conflicto conocido ni relaciones personales que pudieran haber influido en el artículo presentado en este artículo.

Author contribution

Hernández-Salas, Claudia: Contributed by taking soil samples and identifying the site of interest and contributed to the writing of this article

Olarte-Saucedo, Maricela: Contributed to soil processing to quantify heavy metals.

Moreno-Longoria, Julieta: Contributed to the search for the background and analysis of the data obtained from the research.

Orta-Martínez, Felipe: Contributed to the writing of this article

Availability of data and materials

Open databases were accessed for this research, since platforms such as Google Scholar, Scopus, and Mexican Official Standard NOM-147-SEMARNAT/SSA1-2004 served as the basis for said work.

Funding

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Abbreviations

Cd Cadmium
Cu Copper
HM Heavy Metals

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Article

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[a] Affiliation institution, Researcher ID, ORC ID, SNI-CONAHCYT ID or CVU PNPC [No.10 TNRoman]
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CONAHCYT classification:
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Area:
Field:
Discipline:
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DOI: https://doi.org/
Article History:
Received: [Use Only ECORFAN]
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Keywords [In English]
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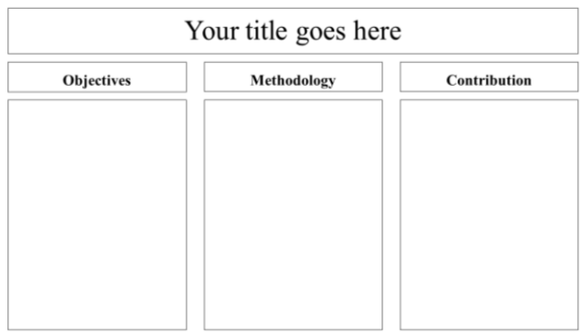
Abstract [In Spanish]
Must contain up to 150 words
Graphical abstract [In Spanish]



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Citation: Surname, Name 1st Author, Surname, Name 1st Co-author, Surname, Name 2nd Co-author and Surname, Name 3rd Co-author. Article Title. ECORFAN Journal-Mexico. Year. V-N: Pages [TN Roman No.10].

Introduction

Text in TNRoman No.12, single space.

General explanation of the subject and explain why it is important.

What is your added value with respect to other techniques?

Clearly focus each of its features.

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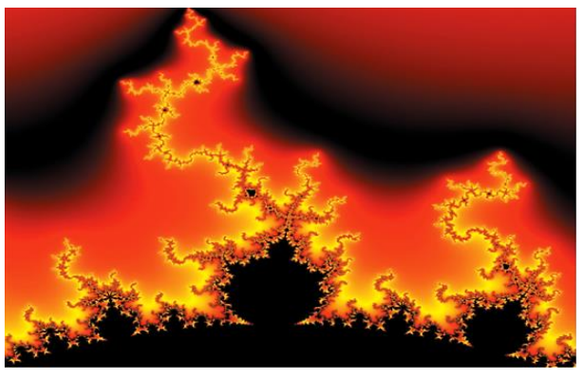

Figure 1

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Box

Table 1

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For the use of equations, noted as follows:

$$Y_{ij} = \alpha + \sum_{h=1}^{r} \beta_h X_{hij} + u_j + e_{ij} \quad [1]$$

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Methodology

Develop give the meaning of the variables in linear writing and important is the comparison of the used criteria.

Results

The results shall be by section of the article.

Conclusions

Clearly explain the results and possibilities of improvement.

Annexes

Tables and adequate sources.

The international standard is 7 pages minimum and 14 pages maximum.

Declarations

Conflict of interest

The authors declare no interest conflict. They have no known competing financial interests or personal relationships that could have appeared to influence the article reported in this article.

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Author contribution

Specify the contribution of each researcher in each of the points developed in this research.

Prot-
Benoit-Pauleter, Gerard: Contributed to the project idea, research method and technique.

Availability of data and materials

Indicate the availability of the data obtained in this research.

Funding

Indicate if the research received some financing.

Acknowledgements

Indicate if they were financed by any institution, University or company.

Abbreviations

List abbreviations in alphabetical order.

Prot-

ANN	Artificial Neural Network

References

Use APA system. Should not be numbered, nor with bullets, however if necessary numbering will be because reference or mention is made somewhere in the Article.

Use the Roman alphabet, all references you have used should be in Roman alphabet, even if you have cited an article, book in any of the official languages of the United Nations [English, French, German, Chinese, Russian, Portuguese, Italian, Spanish, Arabic], you should write the reference in Roman alphabet and not in any of the official languages.

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