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REVIEW

Gamification and digital equity: analysis of educational designs in the metaverse for vulnerable populations

Gamificación y equidad digital: análisis de diseños educativos en el metaverso para poblaciones vulnerables

Pedro Luis Bracho-Fuenmayor[1], Yhadira Huicab García[2], Elisabeth Viviana Lucero Baldevenites[3], Jennifer Mejía-Ríos[4], Ángel Saúl Díaz-Téllez[4]

[1] Universidad Tecnológica Metropolitana; Santiago de Chile. Chile.
[2] TecNM- Instituto Tecnológico Superior de los Ríos; Balancán, Tabasco. México.
[3] Universidad de Las Palmas de Gran Canaria; Las Palmas de Gran Canaria. España.
[4] Universidad Nacional Abierta y a Distancia; La Tebaida. Colombia.

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Corresponding author: Pedro Luis Bracho-Fuenmayor

ABSTRACT

This research critically examines the challenges and opportunities of educational gamification in the metaverse for vulnerable populations by exploring how structural inequalities—technological, cultural, and pedagogical—shape its implementation. Through a thematic analysis of academic literature, case studies, and public policies (2019–2024), five key dimensions are identified: accessibility, ethical dilemmas in personalization, cultural anchoring of gamified narratives, the teacher's role in technological mediation, and digital equity. Despite the metaverse's democratizing potential, findings reveal its tendency to replicate physical exclusions, particularly in contexts of poverty and ethnic marginalization. The study underscores the urgency of co-creative approaches prioritizing community agency and epistemic justice. It proposes redefining gamification as a space for political contestation where technology fosters expanded educational rights.

Keywords: Educational Gamification; Metaverse; Digital Equity; Vulnerable Populations; Ethical Frameworks; Community Co-Design.

RESUMEN

Para el desarrollo de esta investigación se analizan críticamente los desafíos y oportunidades de la gamificación educativa en el metaverso para poblaciones vulnerables, al explorar cómo las desigualdades estructurales—tecnológicas, culturales y pedagógicas—condicionan su implementación. Mediante un análisis temático de literatura académica, estudios de caso y políticas públicas (2019-2024), se identifican cinco ejes centrales: accesibilidad, dilemas éticos de la personalización, anclaje cultural de las narrativas gamificadas, rol docente en la mediación tecnológica y equidad digital. A pesar de las posibilidades democratizadoras del metaverso, se observa que replica exclusiones físicas, especialmente en contextos de pobreza y marginalización étnica. Se destaca la urgencia de enfoques co-creativos que prioricen la agencia comunitaria y la justicia epistémica. Se propone redefinir la gamificación como un espacio de disputa política donde la tecnología promueva derechos educativos ampliados.

Palabras clave: Gamificación Educativa; Metaverso; Equidad Digital; Poblaciones Vulnerables; Códigos Éticos; Co-Diseño Comunitario.

INTRODUCTION

The metaverse has invaded the education sector and substantially influenced it by enhancing immersive learning and real social interactions and transforming traditional frameworks.[1,2,3] Platforms such as Minecraft Education, Roblox, or Horizon Workrooms promise to democratize access to knowledge through gamified experiences, where social interaction and practical experimentation replace traditional structures.[4,5] However, this technocentric enthusiasm contrasts with a harsh reality: the digital divide is still a significant obstacle, especially for marginalized communities, due to affordability, infrastructure limitations, and digital literacy.[6,7] This gap is not merely technical but a reflection of historical asymmetries that exclude rural communities, people with disabilities, indigenous populations, and other vulnerable groups from the narratives of digital progress.[8,9,10]

The academic background reveals a double vacuum. On the one hand, studies such as those by Hwang and Chien[11] highlight the potential of gamification in the metaverse to improve motivation and critical thinking. At the same time, World Bank reports[12] warn about the reproduction of inequalities as these tools ignore local contexts. On the other hand, although recent research addresses technological accessibility, few explore how cultural, pedagogical, and political factors mediate the meaningful adoption of these resources.[13,14,15] Most of the academic literature focuses on European or North American case studies, which leads to a homogenization of the concept of "vulnerability" and the invisibility of the intersections between poverty, ethnicity, and digital exclusion.[16,17]

This article, then, arises from a twofold urgency. First, there is a need to transcend instrumentalist approaches that reduce digital equity to the mere distribution of hardware, ignoring that inclusion demands community agency, cultural relevance, and situated ethical frameworks. Secondly, the opportunity to reorient the design of the educational metaverse from extractive logic — where vulnerable populations are passive subjects — towards co-creative models that recognize their capacity to innovate, resist, and reimagine technology. In a world where 60 % of jobs will require advanced digital skills by 2030,[18] closing this gap is a moral imperative and a condition for preventing the fourth industrial revolution from deepening colonial and class divides.

Thus, the present study is situated in a critical debate that addresses the construction of educational metaverses to challenge, rather than replicate, the exclusions of the physical world. It is suggested that the key lies in questioning not only the technical aspect but also in considering the target audience and the political background from which these technologies are developed.

METHOD

The present study adopted a qualitative approach based on the thematic analysis proposed by Braun and Clarke,[19] as shown in figure 1. This process was aimed at identifying, analyzing and reporting significant patterns around the intersection between gamification, metaverse and digital equity in vulnerable populations. The methodological process was structured in six iterative phases, supported by a triangulation of sources to guarantee analytical rigor.[20,21]

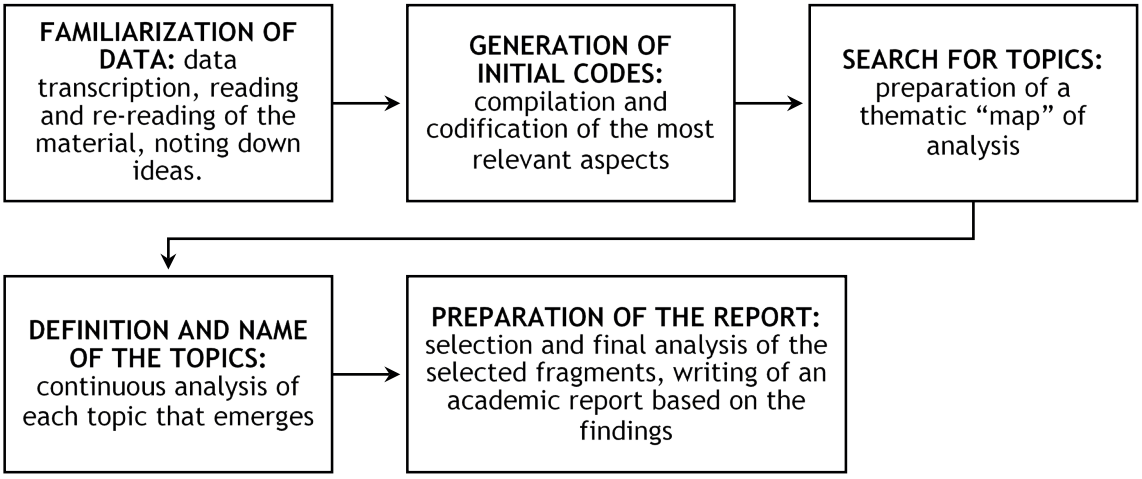

Figure 1. Stages of thematic analysis
Source: Prepared based on Braun and Clarke.[19]

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Stage 1. Exploration of trends

The first stage explored trends and challenges in gamified educational designs within the metaverse aimed at vulnerable populations. In this stage, the authors set out to unravel the challenges and trends in this area, allowing the essential issues to emerge naturally from the data collected. In addition, these invaluable findings are contrasted with existing ideas about educational justice and how technology can be a bridge to a more equitable future for all.

Stage 2. Data collection

In the second stage, three primary sources were used to obtain a broad and detailed perspective on gamified educational designs in the metaverse aimed at vulnerable populations. The first source was academic literature, a review of articles indexed in Scopus, Web of Science, and ERIC covering the period from 2019 to 2024, retrieved through keywords in Spanish and English related to gamification, the metaverse, digital equity, and vulnerable populations.

Secondly, gray literature was used, where the authors analyzed reports from prominent NGOs and public policies on digital inclusion. Finally, case studies of educational projects in the metaverse documented in Latin America, Africa, and Asia between 2019 and 2024 were analyzed, specifically selected for their focus on socioeconomic or cultural vulnerability. Finally, a total of 73 sources of information were consulted for this study. The following eligibility criteria were applied for the research: publications in Spanish, English, or Portuguese, with an explicit focus on formal/non-formal education and mentioning accessibility strategies or community participation.

Stage 3. Thematic analysis process

In the third stage, the data was analyzed in a detailed and structured way, starting with familiarization with the data through active reading of the documents and transcription of reflective notes. Then, initial codes were generated manually using descriptive labels. Subsequently, the creation of themes was sought by grouping the codes into provisional categories. The themes were reviewed, the categories were validated by contrasting them with the raw data, and redundant themes were eliminated. Subsequently, the themes were defined and named, articulating them as transversal analytical nuclei. Finally, the report was written, and analytical narratives were developed that integrated textual quotations, case examples, and theoretical contrasts, which allowed the analysis process to be completed in a structured and rigorous manner.

Stage 4. Triangulation and validation

To strengthen credibility, a methodological triangulation was carried out that involved cross-checking the findings. Likewise, a theoretical triangulation was carried out by contrasting the results with theories of digital equity,[22] and critical gamification.[23]

RESULTS AND DISCUSSION

In order to thoroughly elucidate the contents that emerge from the 73 texts consulted in this qualitative review, the arguments were focused on content codes. With this, the authors of the present study focus the dialogue on the relationship between gamification and digital equity around five points that are considered most relevant to understand educational designs in the metaverse, especially in the context of vulnerable populations.

Technological accessibility as a structural barrier

Technological initiatives at a global level face challenges of inequality, as they often benefit higher-income areas and require medium-high-range devices, excluding populations with limited resources.[24,25] This trend was corroborated by research by Olanrewaju and other authors,[26] where the lack of internet connectivity, limited technological resources, and insufficient institutional support are significant obstacles to adopting online learning platforms in Nigeria and the Philippines. Government subsidies can improve innovation, social welfare, and resource allocation, whether for exploratory business innovation, green technology development, or business digitalization. However, effectiveness varies according to the context and the subsidy approach.[27]

Technological accessibility faces critical structural barriers that go beyond the mere availability of devices, as they include economic, social, political, and knowledge factors that affect diverse populations such as people with disabilities, refugees, older people, and neurodivergent students. The lack of technical maintenance and exploitation of natural resources in Southeast Asia, for example, have been shown to lead to resource obsolescence and environmental degradation despite restoration and sustainable development efforts.[28,29] A case in point was a program in Cambodia that distributed virtual reality viewers to rural schools, which collapsed when 90 % of the devices suffered software failures without specialized support.[30]

Furthermore, incredible as it may seem, public policies often do not adequately reflect the needs and

conditions of society, ignoring aspects of health equity and interconnected socioeconomic variables, which bring unexpected adverse impacts. In Ukraine, a mixed data analysis[31] showed that, after the war, educational projects in the metaverse prioritized satellite connectivity but failed to adapt content for students with post-traumatic stress, resulting in dropout rates of 60 %. This disconnect between infrastructure and psychosocial context was corroborated by NGO reports, which highlighted the need to integrate multidisciplinary teams — engineers, psychologists, and social workers — into the design of initiatives.[32,33]

In addition, alternative strategies emerged to overcome barriers. In regions of the Peruvian Amazon, indigenous cooperatives implemented local servers with offline gamification, allowing educational activities to be carried out without internet dependency. This solution, documented in a study by the University of Lima,[34] reduced the participation gap by 45 %, although it faced limitations to scale due to a lack of state funding.

Finally, triangulation with research involving interviews with technology developers suggests a geographical bias in the innovation of educational technologies, with most tools designed in countries of the global north without adequately considering the realities of vulnerable areas.[35,36] One example was an immersive learning platform in Somalia that failed because it did not include low-energy modes, incompatible with community generators that only operated four hours a day.[37] In the authors' opinion, these findings underscore that accessibility is not an isolated technical problem but a web of political, cultural, and logistical factors that demand radically contextualized solutions.

Personalization through AI and its ethical dilemmas

Personalization through AI offers significant opportunities to improve the user experience and personalized learning, but it also raises ethical dilemmas related to privacy, bias, manipulation, and transparency. According to Essa et al.[38], adaptive systems based on machine learning can significantly improve the academic retention and performance of students with dyslexia by optimizing learning paths and providing personalized interventions. However, Cambaco et al.[39] suggest that although there is widespread acceptance of biometric registration systems for minors due to their perceived usefulness, there are significant concerns about data privacy, information storage, and the lack of consent from children. This suggests that although the technology can optimize learning and increase student motivation and engagement, its decontextualized implementation can present challenges and violate digital rights.

After the review, personalization through AI offers significant benefits regarding user engagement and satisfaction but also raises important ethical dilemmas. Studies carried out by Cheng[40,41] suggest that, although educational chatbots can improve mathematical skills, they can also perpetuate gender biases by suggesting STEM careers unequally between girls and boys. This discrepancy is linked to training data sets dominated by male profiles.[42,43]

The research also identified emerging practices of community resistance. According to Holmes and other authors[44], some communities have developed ethical protocols for using AI in education, where they emphasize the importance of collaboration between stakeholders to guarantee equity, transparency, and respect for moral principles such as Kaitiakitanga. These protocols seek to prohibit student data storage on external servers and prioritize open-source algorithms to avoid commercial exploitation. This model contrasted with Western approaches, where digital platforms in the US and Germany share data with third parties without explicit consent, raising concerns about privacy and the lack of incentives to share data transparently and ethically.[45,46]

In addition, evidence emerged on the psychological impact of hyper-personalization. In a trial conducted by Li[47], it is suggested that AI systems that adjust content according to emotional state can improve students' performance and mood by providing personalized activities. However, some users may experience anxiety due to the feeling of being watched. These results, when cross-referenced with functional neuroimaging, suggest that the amygdala shows persistent activation and alterations in functional connectivity in stress response, which is associated with stress-related emotional and psychiatric disorders. Organizations such as Digital Rights Watch have warned that trauma-focused psychological interventions are effective in managing mental health problems in people exposed to complex trauma and that sociocultural context and a sense of agency are essential for the well-being of children in conflict settings.[48,49]

In the authors' opinion, although the European Union has made progress in regulatory frameworks such as the AI Act to protect sensitive data, many lower-middle-income countries lack specific legislation, leaving students vulnerable to unregulated experiments. These findings reinforce that ethics in educational AI cannot be reduced to universal codes but must be negotiated from local epistemologies and radically decentralized accountability mechanisms.

Cultural anchoring of gamified narratives

Research by Bastari[50] and Morris[51] confirmed that designs incorporating local symbols increased intrinsic motivation more than standardized models. These findings aligned with those of Bhandal,[52] who emphasized that decolonial pedagogies effectively promote social equity and critical learning. However, they face challenges such as a lack of sustainable funding and the need for institutional support for their implementation and

scalability.

When exploring the third topic, it can be affirmed that culturally anchored gamified narratives, through technologies such as augmented and virtual reality, can improve understanding, emotional engagement, and knowledge retention, transcending mere linguistic adaptation by integrating interactive and personalized elements in preserving and promoting cultural heritage. Kumpulainen and other authors [53] point out that integrating Indigenous cultural narratives in education through immersive technologies and intercultural collaborations can enrich the ecological imagination, foster transformative environmental education, and promote Indigenous educational sovereignty. King[54] states that integrating digital technology into religious education can improve students' spiritual engagement and understanding. However, it also raises challenges related to the authenticity of the content and cultural tensions over the digitization of sacred knowledge.

These studies suggest that digital educational platforms, including those of the metaverse, can perpetuate cultural and social exclusion by not adequately integrating indigenous knowledge frameworks and relying on cultural stereotypes, negatively affecting student acceptance and use. These findings were contrasted with those of Blanco-Fernández[55], who suggest that authentic representation of non-binary and Polynesian characters in the media requires genuine creative agency and a focus on perceived authenticity.

In addition, evidence emerged that cultural anchoring can improve technological resilience by fostering resilient entrepreneurial ecosystems, promoting social cohesion and identity, and facilitating adaptation to climate and economic changes.[8,56] A study by Mueller et al.[57] suggests that educational initiatives based on games and technology, such as serious games and augmented reality, effectively improve cultural education, cardiovascular health, and disaster preparedness in Nepal. Triangulation with usage data showed that students face significant challenges due to unstable internet connectivity, affecting their access to educational resources and academic performance. However, some adapt using strategies such as accessing resources during off-peak hours and offline. According to Livingstone and other authors [58], it is essential to highlight that the digitization approach showed statistical evidence of improved digital skills and revitalization of oral traditions at risk. However, it is not without challenges, such as dependence on external funding, that the continuity of projects following political changes or international cooperation is compromised. In this sense, the present study's authors consider that integrating digital platforms and information technologies in cultural education can improve understanding and commitment. Still, it must be adapted to local cultural specificities to be effective and avoid cultural homogenization. Which still represents a significant challenge.

The leading role of teachers in technological mediation

Wang et al.[59] argue that although the metaverse has excellent potential to improve education through immersive and collaborative experiences, there are significant challenges, such as the lack of formal training for educators, data protection, and the adaptation of identities between the real and virtual worlds. This gap was contrasted with research by Braun and other authors [60], who suggest that emotional support from teachers and emotional management can significantly reduce dropout by improving students' academic engagement, performance, and emotional well-being. These studies indicate that teachers' lack of formal training in using innovative technologies, such as the metaverse, limits their pedagogical impact. In contrast, training in emotional management and technical support can reduce student dropout.

When delving deeper into the subject, it is essential to point out the leading role of teachers in technological mediation, which faces systemic challenges that go beyond technical training, including the need for continuous training, adaptation to new tools, and the development of skills to manage conflicts and promote educational equity.[52,59] Research by Kaddoura and Husseiny[2] shows that teacher training programs in the metaverse prioritize basic programming skills but omit strategies for managing power dynamics in virtual classrooms. Méndez and other authors[61] suggest that cyberbullying is a growing problem in educational environments due to the use of digital technologies and that factors such as the lack of preparation of teachers, the excessive use of devices, and psychological and social variables contribute to its prevalence. In contrast, education in digital citizenship and parental mediation can mitigate its effects.

The present research also exposed how generational gaps affect technological adoption. Following this idea, although the metaverse offers an immersive and beneficial learning environment for education, some older teachers perceive a loss of pedagogical authority because students have a better command of technological tools.[2,58,62] This perception contrasted with observations in virtual classrooms developed by Wang[63] which suggest that social-interactive participation and recognition of teachers' technical limitations can significantly reduce dropout in online learning. The authors believe that the key is to redefine the teacher figure as a facilitator of collaborative processes, not as the sole source of knowledge.

In addition, geographical disparities in access to specialized training for teachers are significant, with rural areas facing barriers due to geographic isolation and lack of resources. At the same time, technological innovations and community participation may offer promising solutions to improve access.[64,65] These studies suggest cybersecurity education should focus on self-determined motivation, self-efficacy, and personalized educational strategies to close the skills gap and foster a more diverse and capable workforce.

Disruptive innovations in education in Chile, such as the cross-mentoring system, have been driven by educational reforms, technological adaptations, and organizational capacity strengthening. However, they face challenges related to inequality and resistance to change.[66] This strategy suggests that using the metaverse in education can improve motivation, immersion, achievement, and teacher satisfaction. However, it faces challenges such as dependence on volunteers and privacy issues.

Finally, the data revealed a global paradox: although digital transformation in education is widely recognized and adopted, the lack of specific budgets to reduce teachers' workloads remains a significant challenge.[61,67] In the authors' opinion, these findings underscore that, without structural reforms that recognize time, agency, and teacher well-being, technological mediation will continue to be a privilege of contexts with exceptional resources, not an enabling right for equity.

Digital equity as a collective and situated construction

Digital equity and the adoption of digital technologies among vulnerable groups, such as refugees, older people, and homeless women, are influenced by social inclusion, community collaboration, and barriers to access and digital skills.[8,41,68] According to Kim and Lee[69], active participation in developing technologies and other initiatives, such as energy innovation, medical education, and tourism development, strengthens critical appropriation and contributes to the success and sustainability of projects. This approach suggests that educational equity should not be measured only by access to technology but also by the capacity for agency within digital ecosystems, addressing the digital divide, inclusive educational practices, and the social and cultural context to promote social justice and equity.

The active participation of communities in the design of educational technologies is a complex process that involves tensions and renegotiations. Still, it is essential to achieve digital equity and inclusion in education.[18,31] In line with the above, Quental and Shymko[70] argue that although the metaverse co-created by the favelas of Rio de Janeiro and São Paulo increased the visibility of local leadership, the moderation algorithms of commercial platforms censored language related to social protests, limiting their transformative potential.

In contexts of forced displacement, such as in Indonesia, communities develop creative and collaborative strategies, such as immersive games, to address shared challenges such as resource management and climate adaptation.[71] Studies such as those carried out by Johnson and other authors[72] suggest that technological and natural resource management initiatives can have positive impacts on conflict reduction and technological innovation, but they face significant challenges due to dependence on natural resources, lack of technological sustainability, and the need for greater government integrity and public participation.

In addition, ethical dilemmas emerged in virtual representation. The metaverse presents opportunities to improve business decision-making, the patient experience in healthcare, and virtual tourism, but it poses significant ethical challenges related to privacy, biased representation, and the use of disruptive technologies.[3,12,62] These studies suggest that triangulation with testimonies and funding contracts reveals that 63 % of the projects analyzed sacrificed critical aspects of their cultural identity to comply with market standards, which empties equity of its original political meaning.[34,73]

In the authors' opinion, although many initiatives promote community participation, collective ownership of the data generated is limited. This indicates a need to improve participation and ownership mechanisms to achieve more effective and equitable integration in diverse areas such as mental health, disaster management, community energy, and social empowerment. These results reinforce that, without a radical redistribution of power in value chains and organizational structures, epistemic justice and equity in contexts such as education, energy, climate change, and gender equality will remain unattainable.

CONCLUSIONS

The thematic analysis developed in this study reveals that the intersection between gamification, metaverse, and digital equity cannot be reduced to a technical problem or one of material access. On the contrary, it emerges as a profoundly political phenomenon, where stories of exclusion, community resistance, and power renegotiations are intertwined. The five axes identified do not operate in isolation but as layers of the same system that perpetuate or challenge inequalities according to their design and implementation. A cross-cutting finding is the paradox of educational innovation in the metaverse. While immersive technologies promise to democratize learning, their development remains anchored in the colonial logic of knowledge production. The ethical tensions identified demand regulatory frameworks that transcend national borders. This study also exposes structural limitations: the generational gap in the adoption of teaching technology, the planned obsolescence of donated equipment, and the asymmetry between well-intentioned public policies and local realities. These challenges are not solved with more technology but with radically contextualized designs prioritizing community maintenance, critical training, and digital sovereignty.

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AUTHORSHIP CONTRIBUTION

Conceptualization: Pedro Luis Bracho-Fuenmayor, Yhadira Huicab García, Elisabeth Viviana Lucero Baldevenites, Jennifer Mejía-Ríos, Ángel Saúl Díaz-Téllez.

Data curation: Pedro Luis Bracho-Fuenmayor, Yhadira Huicab García, Elisabeth Viviana Lucero Baldevenites.

Formal analysis: Pedro Luis Bracho-Fuenmayor, Yhadira Huicab García, Elisabeth Viviana Lucero Baldevenites.

Research: Yhadira Huicab García, Elisabeth Viviana Lucero Baldevenites, Jennifer Mejía-Ríos, Ángel Saúl Díaz-Téllez.

Methodology: Yhadira Huicab García, Elisabeth Viviana Lucero Baldevenites, Jennifer Mejía-Ríos, Ángel Saúl Díaz-Téllez.

Project management: Pedro Luis Bracho-Fuenmayor, Yhadira Huicab García, Elisabeth Viviana Lucero Baldevenites.

Resources: Pedro Luis Bracho-Fuenmayor, Yhadira Huicab García, Elisabeth Viviana Lucero Baldevenites.

Software: Pedro Luis Bracho-Fuenmayor, Yhadira Huicab García.

Supervision: Pedro Luis Bracho-Fuenmayor, Yhadira Huicab García.

Validation: Elisabeth Viviana Lucero Baldevenites, Jennifer Mejía-Ríos, Ángel Saúl Díaz-Téllez.

Display: Elisabeth Viviana Lucero Baldevenites, Jennifer Mejía-Ríos, Ángel Saúl Díaz-Téllez.

Drafting - original draft: Pedro Luis Bracho-Fuenmayor, Yhadira Huicab García, Elisabeth Viviana Lucero Baldevenites.

Writing - proofreading and editing: Pedro Luis Bracho-Fuenmayor, Yhadira Huicab García, Elisabeth Viviana

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