



Catrinatas interactivas: development of creative-humanist talent in a STEAM-H environment with **Mixed Reality**

Catrinatas interactivas: desarrollo de talento creativo-humanista en un entorno STEAM+H con Realidad Mixta

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Abstract

This work presents an educational experience based on the STEAM-H approach, through the project *Catrinatas interactivas*, a collaborative initiative where college students from Digital Design undergraduate program developed experiences of Mixed Reality using Apple Vision Pro. Students, through active methodologies, such as Project-Based Learning (PBL) and the SCRUM framework, not only strengthened technical skills in 3D modeling, programming and interaction design, but they also deepened their transversal skills such as a collaborative work, assertive communication, and creativity. The "H" component of this integrative approach was manifested in the critical and sensitive exploration of the Día de Muertos tradition, promoting the cultural appreciation, the historical awareness and the reflective thinking. Students researched the symbolic imaginary of the catrinatas, linking their designs to aspects of identity and Mexican cultural heritage. To evaluate the formative impact of the project, a self-assessment rubric to the participants was applied, whose results reflect significant advances in creative thinking, technological integration and cultural value. This experience proves how emergent technologies can be catalysts for meaningful learning and talent development in the university setting, with a humanist, inclusive and interdisciplinary approach.

Keywords: STEAM-H education, Mixed Reality in Higher education, cultural heritage, Project-Based Learning (PBL), humanistic abilities, educational innovation with emergent technologies

Resumen

Este trabajo presenta una experiencia educativa basada en el enfoque STEAM-H, a través del proyecto Catrinatas interactivas, una iniciativa colaborativa en la que estudiantes universitarios de Diseño Digital desarrollaron experiencias de Realidad Mixta utilizando Apple Vision Pro. A través de metodologías activas, como el Aprendizaje Basado en Proyectos (ABP) y SCRUM, los estudiantes no sólo fortalecieron habilidades técnicas en modelado 3D, programación y diseño de interacción, sino que también profundizaron en competencias transversales como el trabajo colaborativo, la comunicación asertiva y la creatividad. El componente "H" de este enfoque integrador se manifestó en la exploración crítica y sensible de la tradición del Día de Muertos, fomentando la apreciación cultural, la conciencia histórica y el pensamiento reflexivo. Los estudiantes investigaron el imaginario simbólico de las catrinatas, conectando su diseño con aspectos de identidad y patrimonio cultural mexicano. Para evaluar el impacto formativo del proyecto, se aplicó una rúbrica de autoevaluación a los participantes, cuyos resultados reflejan avances significativos en pensamiento creativo, integración tecnológica y valoración cultural. Esta experiencia evidencia cómo las tecnologías emergentes pueden ser catalizadores del aprendizaje significativo y del desarrollo de talento en el ámbito universitario, con un enfoque humanista, inclusivo e interdisciplinario.

Palabras clave: Educación STEAM-H, Realidad Mixta en educación superior, patrimonio cultural, Aprendizaje Basado en Proyectos (ABP), competencias humanísticas, patrimonio cultural, innovación educativa con tecnologías emergentes

◆ Introduction

In the context of the Fourth Industrial Revolution, society demands that Higher education students gain experience in the development of technological interdisciplinary projects. The convergence of technologies such as artificial intelligence (AI), macrodata, robotics, internet of things and other emerging technologies is transforming the way human beings work and live (Leavy *et al.*, 2023). Hence, preparing students for these challenges is not a futurist goal, but a current necessity.

This training should be focused, not only on technical skills, but also on the capacity to innovate and collaborate to address the needs of a society that constantly evolves. Education with an approach to Science, Technology, Engineering, Arts and Mathematics, developed within the disciplinary context of the Humanities (STEAM-H) is a way of learning where students acquire cognitive, communicative and collaborative skills. Sánchez and Martínez (2024) describe the STEAM-H context as a powerful educational strategy capable of strengthen the critical, reflexive, creative and innovative thought. This research aims to document the process through which the STEAM-H approach is integrated into a collaborative project, where students from Digital Design for Interactive Media program participate both in the design and development for the visionOS platform. To carry out the project, it was necessary to recruit students with soft skills such as teamwork, problem-solving and communication for the development of the project.

The current challenge for Higher education Institutions is to effectively integrate arts and humanities into study programs where Science, Technology, Engineering and Maths (STEM) prevail. This implies not only to demonstrate to future scientists and engineers the relevance of these disciplines, but also to highlight how they influence their professional training and human development. At emphasizing the importance of creativity, critical thought and ethics, their role on the development of a comprehensive perspective is notable, which is fundamental to face the challenges of the twenty-first century (Spyropoulou & Kameas, 2024).

Some authors raise the need to transform the STEM approach to integrate arts and humanities, leading to the STEAM-H model. Sánchez and Martínez (2024) examine the impact of this integration on the significant learning. Findings show that students benefit when they strengthen the understanding of natural and technological phenomena, in addition to developing autonomy and improving key skills. The incorporation of digital tools in interdisciplinary projects stimulates creativity and critical thought.

Lewis (2008) states that the STEAM focus on liberal arts environments uniquely integrate research from a humanist perspective with STEM, because arts and humanities are positioned as connectors of the technological knowledge, as well as they prepare students for creative problem-solving, encouraging them to work collaboratively and promote computational thinking, all of which is associated with the digital literacy of the XXI century.

There is an evident need to develop and investigate projects framed within STEAM-H due to the poor adoption of this focus on the educational field. On this way, Domínguez Saldívar and Vázquez Castelán (2025, p. 2) point out that "they are only a small number of students that participated in this type of actions and a small number of teachers and administrators who have been trained on STEAM education in educational institutions", which is why it becomes an opportunity. This lack of experience and training shows the urgency of implementing projects that promote the complement of humanities on scientific and technological education. Although STEAM projects with cultural components exist, only a few explore Mixed Reality technologies. Chrysanthakopoulou *et al.* (2025) recognize the educational value of Mixed Reality systems and their potential to develop simultaneously technical abilities and sensitivity towards the cultural heritage.

**◆ STEAM-H, HUMANIST
ABILITIES AND ACTIVE
METHODOLOGIES**

The original STEM approach has seen a notable evolution in recent years, insomuch that nowadays it is understood as a much broader term that could contain multiple disciplines, including arts and humanities. According to Santillán-Aguirre *et al.* (2020), the incorporation of arts on the traditional focus of STEM helps to extend the set of skills that students can develop, besides stimulating creativity, innovation and problem-solving capacity in a contextualized way. On his work, authors point out that when it is implemented as an active methodology, STEAM is favorable to the connection between theory and practice, something that is vital so students could participate in projects that require the integration of technical knowledge with artistic, cultural and social expressions.

In the literature review by Perignat and Katz-Buonincontro (2019), it can be seen how the concept of STEAM is defined and led by different

scholars, highlighting how Arts are addressed. In the study it is noted that the most successful experiences are those that promote as central axis both interdisciplinary collaboration and creativity. However, this contrasts with the lack of a true measurement of creativity and, in general, from the creative process. Authors point out that, even though there is a consensus about the benefits of focusing, challenges continue, such as the lack of specific teacher training, resistance to modifying rigid curricular structures and the necessity of finding ways of evaluating the results of learning in a more systematic way.

Furthermore, Zúñiga-Tinizaray and Marín (2024) conducted a review that includes 36 indexed publications, in the article it is pointed out that these practices strengthen the cognitive, socio-emotional abilities, the teamwork, communication, and adaptability. Also, it is shown that, for successful STEAM implementation, a flexible curricular design and teacher training that allows for the coherent integration the different disciplines are needed.

Prada-Núñez et al. (2024) work provides a quantitative perspective about the scientific production referring to STEAM in Higher education. Results show a sustained growth in the number of publications, with the United States and Spain as leading countries on research. This analysis corroborates an emergent interest in STEAM, which increasingly shapes educational innovation for its capacity of addressing complex problems in an interdisciplinary way and due to the necessity of developing critical and creative skills in students.

Thus, the transition toward a STEAM-H model extends even more the horizon when integrating in an explicit way humanities and social responsibility in academic training. The United Nations Educational, Scientific and Cultural Organization (UNESCO, 2019, 2021) and the Organisation for Economic Co-operation and Development (OECD, 2023) have called for reconsidering the educational systems with a humanist approach capable of balancing technical innovation with critical thinking, ethics and cultural awareness. Montés *et al.* (2024) suggest the STEAM √H notion (steam for All Humanities). while for Zhang *et al.* (2024) the incorporation of humanities encourages cultural belonging, inter-cultural communication and creativity in Higher education projects.

A key aspect in this framework is the use of active methodologies. PBL, in David Jonassen's (1999) perspective, conceives the knowledge as something that students actively build when resolving authentic and complex problems, within contexts that imitate professional practice. This approach is aligned with the STEAM-H model, given that it not only requires technical knowledge application, but also critical thought and collaborative work. On its behalf, Scrum has become consolidated as an agile framework that organizes interdisciplinary teamwork, favoring autonomy, joint responsibility and continuous improvement. The

combination of STEAM-H, PBL, and Scrum allows students to work in large-scale projects with defined roles, work interactions and joint reviews, incorporating both technical and humanistic dimensions of the training.

In this educational setting, evaluation also plays a key role. The self-assessment rubrics constitute an ideal resource to promote critical reflection about their own performance. Andrade (2005) points out that this type of instrument promotes autonomy and self-regulation, while Panadero and Jonsson (2013) highlight their capacity to strengthen the meta-cognition and motivation, when transforming the student into the main character of their learning process. In the case of the project *Catrinatas interactivas*, the organization of STEAM-H with PBL, Scrum and self-assessment in the same formative process aim to generate meaningful learnings with a cultural and professional impact.

❖ Cultural heritage and digital narratives

Digitalization and re-interpretations of cultural heritage constitute a strategic axis for its preservation and spreading in contemporary society. The digitalization of the cultural heritage implies more than just scanning documents or taking photographs, it requires a systematic focus that covers multiple techniques and technologies to grant the authenticity and durability of the digital objects.

Digitalization of analog heritage: Refers to the transformation of physical objects (like manuscripts, art treasures or historical buildings) to digital formats.

- ❖ High-resolution cameras and scanners: For detailed documentation of photographs, two-dimensional objects and documents.
- ❖ Digital photogrammetry and 3D scanning: They create three-dimensional models of monuments, archaeological sites and objects, allowing complete virtual exploration and precise documentation.

The digital preservation is a crucial aspect of the digitalization of the cultural heritage. Using 3D scanning techniques, photogrammetry with the use of drones and other digital tools, experts can create precise digital replicas of objects, buildings and historical places. These digital models not only capture the physical appearance of movable and immovable property, but also can include detailed information about materials, manufacturing techniques and history (Pabón, 2017).

The *Catrinatas interactivas* project is complemented using Mixed Reality (MR) which combines elements of Augmented Reality (AR) and Virtual Reality (VR), allowing virtual and physical elements to interact in real

time. This creates immersive experiences that increase the comprehension of cultural heritage without changing physical objects, facilitating their preservation. Digital technologies preserve and revitalize the heritage, creating immersive and educational experiences for a broader public.

What is the cultural and conceptual background that underpins the representation of the Catrinas?

The Día de Muertos was inscribed in 2008 on UNESCO's List of Intangible Cultural Heritage of Humanity, as it is one of Mexico's most emblematic celebrations, where pre-Hispanic and Catholic roots converge in a complex system of rituals, beliefs, and artistic expressions. Within this tradition, the Catrina has been established as a cultural icon. Originally created by José Guadalupe Posada at the nineteenth century as La Calavera Garbancera, a satirical critique to the Europeanizing aspirations of some social sectors, it was later revisited and popularized by Diego Rivera on his mural *Sueño de una tarde dominical en la Alameda Central* (1947), where it acquired the identity of "Catrina" (Ades, 1989). Since then, the figure has transcended its satirical character to become a symbol of cultural resistance, creativity, and social appropriation in the face of death.

Therefore, in terms of educational fields, the imaginary of the catrinas opens a fertile space to link history, art and popular culture with digital technologies. Recent research shows that immersive environments, when incorporating cultural heritage, allow students to become producers of digital narratives, which promotes active and meaningful learning (Paul *et al.*, 2025). These experiences not only reinforce historical and aesthetic comprehension but also contribute to strengthening identity and cultural appropriation. In this way, the figure of the Catrina in digital environments is redefined as a pedagogical resource and is consolidated as a cultural and humanistic axis of learning in Higher education. With the Catrinas interactivas, the intangible heritage is integrated through emergent technologies, generating a formative model where digital innovation becomes a vehicle for the preservation and reinterpretation of Mexican cultural identity.

◆ Mixed Reality in education and heritage

Extended Reality (XR) technologies, that encompass Augmented Reality, Virtual Reality and Mixed Reality, have become established as pedagogical resources with the capacity to transform educational experiences by converting abstract concepts into concrete and multisensory experiences (Barteit *et al.*, 2021; Maas & Hughes, 2020). MR or Mixed Reality merges the physical and the digital worlds, which facilitates its integration into various academic projects, stimulates active participation, and fosters meaningful learning by the interaction with objects and immersive scenarios. Besides the cognitive benefits, these technologies

promote fundamental transversal competences for the XXI century, like collaboration and critical thinking and interdisciplinary communication (Birchfield y Megowan-Romanowicz, 2009).

In the last years, devices such as Apple Vision Pro have opened up new possibilities for using MR in higher education. Its arrival has been received with enthusiasm for its capacity to offer immersive experiences of high fidelity and for the advancement it represents in the field of spatial computing. García *et al.* (2025) highlight its potential to transform the interaction with data, cultural contexts and collaborative contexts, while Apple (2023) promotes it as a platform to redefine digital learning. Nonetheless, this optimism requires nuance: as Wang *et al.* (2024) warn, the access to this technology continues to be uneven, particularly in universities of peripheral contexts, where the cost and lack of educational specialized *software* restrict its implementation. That is why, rather than a tool for mass adoption, the Apple Vision Pro acquires relevance on pilot projects, where it can function as a catalyst for the development of transversal competencies such as creativity, collaboration and critical thought. In this way, it exemplifies a common paradox on educational innovation: it is presented as disruptive technology, but its true contribution lies in bounded spaces of academic experimentation rather than in immediate structural transformations. Thus, the relevance of integrating these innovations is not only measured by the domain of technical abilities such as 3D modeling, programming or interaction design, but also by the opportunity to link them with creativity, cultural sensitivity and the humanist dimension when working with intangible heritage.

◆ Methodological design

This study was developed under a mixed research design of a qualitative-descriptive type with quantitative elements, framed in the case study style. According to Yin (2018), the case study allows for the analysis of contemporary phenomena within its real context, which is pertinent to understand the implementation of an interdisciplinary educational project like the *Catrin*as interactivas. In addition, a transversal design was used, since the data collection was carried out at a single point in time, to describe and analyze the impact of the project in the defined dimensions (Ato *et al.*, 2013).

The sample consisted of nine higher education students of the Universidad Autónoma de Ciudad Juárez (UACJ), enrolled in the Digital Design for Interactive Media program and the Fashion Design and Management program. The selection was intentional, considering their direct participation in the development of the project. According to Hernández-Sampieri y Mendoza (2018), this type of non-probabilistic sampling is appropriate for case studies or exploratory research, where the

goal is to gain a deeper understanding of specific experiences rather than to disseminate results.

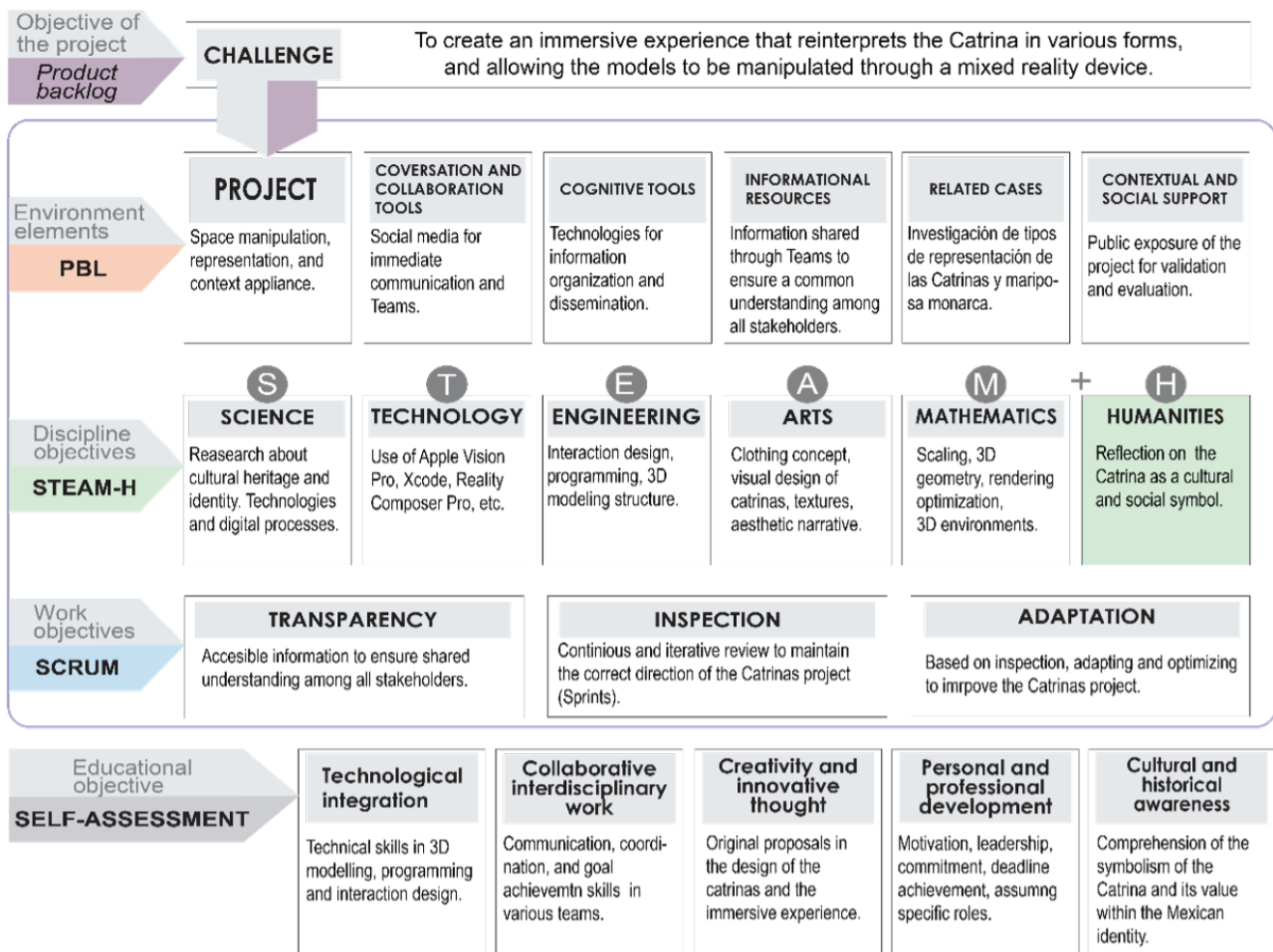
The data collection tool was a self-assessment rubric, designed to assess competencies developed under the framework of the project. Such tool considered five dimensions: technological integration, interdisciplinary collaborative work, creativity and innovation, cultural and historical consciousness and, personal and professional development. The assessment was completed at the end of the project, which allowed for the collection of quantitative data (Likert scale from 1 to 5) and qualitative data through open-ended questions that gathered participants' perceptions and learning experiences. Andrade (2005) and Panadero & Jonsson (2013) point out that the self-assessment rubrics not only facilitate performance evaluation, but also foster metacognition and self-regulation, fundamental aspects in the transversal-abilities development.

The data analysis was conducted in two phases. First, the quantitative results were processed using descriptive statistics (averages and general tendencies). Second, a qualitative analysis of the open questions was made, following a thematic categorization procedure that allowed to identify patterns of meaning and emerging learnings (Saldaña, 2021). The integration of both perspectives allowed a broader comprehension of the impact of the project, coherent with the mixed approach of the research (Creswell y Plano Clark, 2018).

Methods for the design

As aforementioned, the *Catrinias interactivas* project was conceived as a university educational experience guided by three complementary frameworks: the STEAM-H approach, the methodology of PBL and the framework of Scrum, which formed the five objectives of the project.

Figure 1
Articulation of the five levels of objectives of the *Catrin* interactivas project



Note: Compiled by authors.

Justification of the objectives of the *Catrin* interactivas project

1. *The main objective of the project:* Was presented as a challenge, which consisted in creating an immersive and interactive experience for the reinterpretation of the Catrina in various forms through Mixed Reality.
2. *Objectives of the PBL learning environment:* This objective was focused on the design of the learning environment, integrating the design and development of the *Catrin* interactivas platform.
3. *The disciplinary objective STEAM-H:* The project was aligned to the disciplinary confluence, through activities that the design

and development process proposes of the Catrinas interactivas platform.

4. *The work objective:* The project was supported by three fundamental pillars of Scrum: transparency, inspection and adaptability, as well as the Scrum guide.
5. *Assessment objective:* Due to its non-school-based nature and characteristics, the project is suitable for self-assessment of competencies and skills.

◆ Proposal development *PBL for the design of the interactive Catrinas learning environment*

The project-based learning, suggested by David Jonassen (1999), allowed to place learning around an authentic challenge that is developed in collaboration (Santillán-Aguirre *et al.*, 2020): to design an immersive experience of Mixed Reality that reinterprets a symbol of the Mexican cultural heritage (Zúñiga-Tinizaray & Marín, 2024), which in this case are the Catrinas. Hence, David Jonassen's (2000, 2011) perspective turned out to be pertinent: students undertook a project where they had to integrate different domains of knowledge and a complex problem that demanded various solutions.

The challenge (which became the main objective of the project) was to create an immersive experience that reinterprets the Catrina in various forms and models could be manipulated through a Mixed Reality device. The project involved the participants on the research of solutions, whereby they had to organize technical (programming and 3D modeling), artistic (clothing and visual aesthetics), and humanist (identity and cultural symbolism) knowledge. This activity stimulated critical thinking and decision-making and collective creativity, which Jonassen describes as the benefits of working with authentic and open problems. PBL identifies six essential components to promote deep and transferable learning. These were structured in the Catrinas interactivas project as follows:

1. Problem/Project: To design an immersive installation of Catrinas in Mixed Reality for Apple Vision Pro, incorporating art, culture and technology.
2. Related cases: Intangible heritage references (Día de Muertos, origin of the Catrina), as well as previous augmented/mixed reality projects in Higher education.
3. Informative resources: Academic texts of cultural heritage, 3D modelling tutorials, Unity and visionOS guides, Mexican popular art documentations.

4. Cognitive tools: Modeling software (Blender, Maya), game engines (Unity), conceptual maps about the symbolism of the Catrina, narrative flow diagrams.
5. Conversation/Collaboration tools: Scrum reunions, interdisciplinary co design sessions. feedback in Reviews and Retrospectives.
6. Social/contextual support: The presentation of the prototype at the event focused in the Día de muertos tradition and its recognition as immaterial heritage by the UNESCO, which gives cultural legitimacy and motivates the community appropriation.

In this way, the PBL of the Jonassen's model not only organized the learning process towards the final product, but also, jointly to Scrum, made possible a learning environment where students became active builders of knowledge, developing critical, creative and collaborative abilities.

Disciplinary frame STEAM-H

The STEAM-H model (Science, Technology, Engineering, Arts, Mathematics + Humanities) was used as the backbone of interdisciplinary learning, incorporating the humanities and cultural reflection in the core of the formative process (Montés et al., 2024; Unesco, 2019). In terms of STEAM-H disciplinary incorporation, the project materialized each component of the model as follows:

- ❖ *Science*: Research of the symbolism of the Catrina and its social role in the Día de Muertos tradition.
- ❖ *Technology*: Use of Apple Vision Pro devices, Xcode setting, Reality Composer Pro and 3D modelling in Blender.
- ❖ *Engineering*: Design of immersive interactions, optimization of models and technical workflow problem-solving, iteration, and quality.
- ❖ *Art*: Conceptualization and visual creation of clothing for the Catrinas and accessories inspired by the monarch butterfly.
- ❖ *Mathematics*: Application of geometric calculations in scaling and proportion to optimize the Catrinas models in 3D modeling and in the interactive prototype environment.
- ❖ *Humanities*: Critical reflection on identity. cultural memory, and heritage preservation of a symbol of the Mexican culture.

❖ **SCRUM, A WORK GUIDE
FOR THE CATRINAS
INTERACTIVAS PROJECT**

The incorporation of Scrum allowed to manage the complexity of the project by dividing the work into sprints, with clear roles and periodical review and retrospective meetings. As well as PBL provided the pedagogic frame for the knowledge-building from an interdisciplinary challenge, Scrum facilitated the agile organization of tasks and the collective decision-making, and structured the collaborative work in sprints corresponding to the development phases, with roles distributed as follows:

- ❖ *Coordinating professor (scaffolding)*: A full professor oversaw prioritizing cultural and technical objectives.
- ❖ *Project management professor (guide)* A professor was responsible for facilitating agile dynamics and tracking the development.
- ❖ *Development team*: A group of nine students assumed specific roles as follows:
 - 1) Design and concept: Students from Fashion Design and Management (FDM)
 - 2) 3D Modelling: Students from Digital Interactive Media Design (DIMD)
 - 3) Programming: Graduate student specializing in programming and teachers (*scaffolding* and guidance)

Review and Retrospective regular meetings (Scrum) allowed to identify and solve technical problems, adjust design and processes, and take joint decisions. ensuring a coherent workflow with the agile philosophy, through iterative phrases and differentiated roles, favoring continuous feedback and autonomy (Velarde-Camaqui, 2024). This is because this framework is grounded in empiricism, understanding how the idea that knowledge emerges from the experience and the decision-making based on what was observed (Schwaber & Sutherland, 2020). According to their creators, work should be grounded in these three fundamental pillars: transparency, inspection and adaptability.

1. *Transparency*: It assured that the processes and results were visible for every member of the team.
2. *Inspection*: It allowed to periodically review both the product and the advance towards the objectives.
3. *Adaptation*: It enabled immediate adjustments to be made when deviations or problems were detected.

As mentioned by Schwaber and Sutherland (2020), these three elements hold any implementations of Scrum and grant their iterative and incremental character, optimizing predictability and reducing risks. The

work process (which had a duration of four weeks) was defined with the Scrum guide provided by its creators, which was applied as indicated in Table 1 (also see Figures 2, 3 and 4):

Table 1
Work process in Scrum of the Catrinas interactivas

Work process in Scrum of the Catrinas interactivas		
<i>Product backlog</i> (Product list)	It is like a big "menu" of everything the product could have. <i>The product owner</i> puts it in order and prioritizes it, according to the value it brings.	In this stage the interdisciplinary challenges were defined: Identification of technical needs (ITN) (<i>software, hardware, modelling and programming</i>) and aesthetics through co-creation sessions.
<i>Sprint planning</i>	The team decides which elements of the product backlog they can complete within the next sprint. With that it forms the <i>sprint backlog</i> .	Lead times were assigned for each activity, prioritizing collaborative problem-solving, articulating fashion design skills for the conceptualization of the Catrinas environment scheduling in Unity and 3D modelling of the Catrinas with Blender.
<i>Sprint</i> (Iteration of 1 to 4 weeks)	Here is where the real work takes place: design, development, test, integration... everything that is necessary to generate a functional increase of the product.	Fashion Design students delivered the Catrinas models. It started with the 3D modelling of the Catrinas, as well as with the fast-prototyping tasks: Developing of MVP (<i>Minimum Viable Product</i>) on XR using Apple Vision Pro, with feedback cycles each 24 hours to improve the interaction environment.
<i>Daily scrum</i> (Daily reunion)	The team synchronizes its work: what they did the previous day, what they did today, what they will do today, what obstacles exist.	Daily reunions were carried out to review the advance of the 3D models, and the already done models were integrated to the prototype they were refined to test them in a more efficient way on the prototype.
INCREASE	When finishing <i>Sprint</i> , there should be a potentially deliverable product even if it is small (at least viable and usable).	The incorporation of the Catrinas in 3D modelling was completed and the stage of reviews to polish the functionality of the prototype started. At this stage, all the parts are involved in reviewing the design in an integrated manner an to amend if necessary.
<i>Sprint review</i> (<i>Sprint review</i>)	The team presents what they built to the those interested (<i>stakeholders</i>) and receives feedback.	When completing the functional prototype, the professors that guided the project (<i>coach and scaffolding</i>) joined to provide feedback on the functioning prototype.

<i>Sprint retrospective</i>	The team thinks about how the work and seek improvements in their process for the next cycle.	At this stage, work has been reduced to programming. The retrospective is done to correct functional aspects with the Apple Vision Pro and improve the interaction with the physical space and the manipulation of the Catrinas modeled in 3D.
ITERATION	Later, the cycle repeats: it gets planned again in a new sprint based on the backlog and the identified improvements.	Finally, the cycle is repeated to correct programming details, which affects the manipulation of the Catrinas on the physical space, to improve interaction in general. This is made in continuous testing cycles until achieving the final product accepted by all the work team including the coach and scaffolding.
<i>Sprint retrospective</i>	The team thinks about how they work and seek improvements in their process for the next cycle.	At this stage, work has been reduced to programming. The retrospective is done to correct functional aspects with the Apple Vision Pro and improve the interaction with the physical space and the manipulation of the Catrinas modeled in 3D.
Heuristic evaluation	Technical and educational validation through usability tests and <i>focus groups</i> with experts.	The prototype was presented at the Evento Altares y Tumbas of the Universidad Autónoma de Ciudad Juárez (UAJC) at its 2024 version, where a usability test was conducted by those who attended to interact with the Catrinas. The audience consisted of students, professors and the event visitors.
SELF-ASSESSMENT	Self-assessment of the learnings.	A self-assessment tool to know which skills and abilities they acquire through the STEAM-H project was implemented.

Note: Compiled by authors.

Figure 2

Example of the models of the Catrinas made by students of Fashion Design and Management delivered during the first sprint



Note: Compiled by authors. Eight models were made that were passed in the shaper team for its reproduction in 3D

Figure 3

3D modeling made by students of Digital Interactive Media Design delivered during the INCREMENT stage



Note: Compiled by authors. Models were adapted to be presented on a virtual set, the original models were arranged as gallery on the wall to locate the 3D models.

Figure 4

The prototype was presented at the *Altares y Tumbas* event of the UACJ in its 2024 version



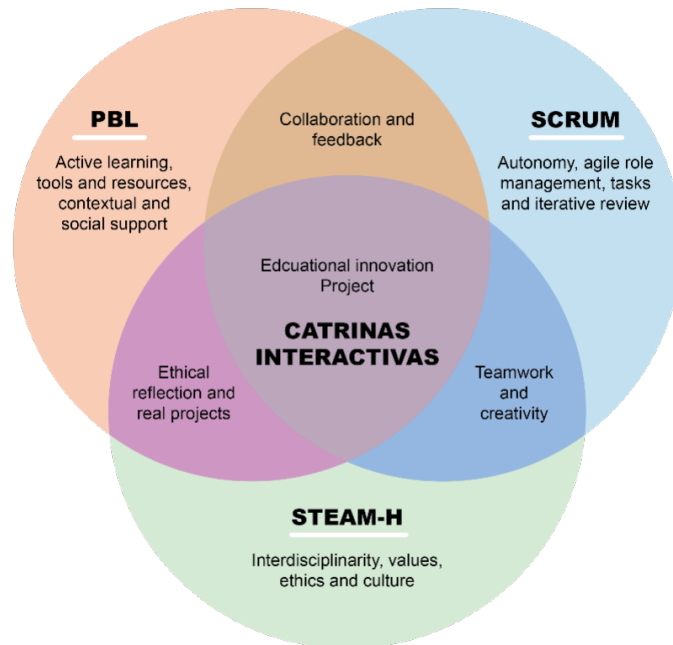
Note: Compiled by authors. Visitors could choose which they wanted to see and when selecting it, it appeared in front of them in life size, so they could get close, surround it, make it bigger or smaller.

The self-assessment of abilities as a part of the objectives of the *Catrinas interactivas* project.

The last objective of the project was self-assessment, for this the three models were aligned and the skills and abilities that are cultivated through each one of them were verified, which contributed to the making of the self-assessment rubric.

Figure 5

Joint of the STEAM-H with the PBL and Scrum, with focus in skills and abilities.



Note: Compiled by authors.

A rubric that was applied to participants was designed, with the aim of assessing the competencies, which were evidenced in three dimensions:

- ❖ **Technical abilities:** To reinforce design abilities, 3D modeling, programming and interaction design.
- ❖ **Transversal abilities:** Strengthening collaborative work, assertive communication and creativity, transfer of learning outcomes.
- ❖ **Humanistic abilities:** Development of cultural appreciation, critical thought and historical awareness.

These quantitative results were complemented with a qualitative question derived from students' participation during the public exhibition. The results of the self-assessment rubric constitute the focus of this research.

- ❖ **Results** The formative impact assessment of the Catrinas interactivas project was conducted using the application of a self-assessment rubric that included five aligned to the STEAM-H model: 1) technological integration, 2) collaborative interdisciplinary work, 3) creativity and innovative thought,

4) cultural and historical awareness and 5) personal and professional development. Each category was evaluated on a Likert scale from 1 (very low) to 5 (very high) and was complemented with an open question to collect qualitative perceptions. The results of the self-assessment rubric applied to the participants (n = X) demonstrated a positive impact of the *Catrin* project in the five categories or dimensions (see Tables 2, 3, 4, 5 and 6).

Table 2
Technological integration

INDICATOR	P.1	P.2	P.3	P.4	P.5	P.6	P.7	P.8	P.9	Prom.
1. Technological integration										
I applied technical knowledge in 3D modeling, programming and/or interaction design for the development of the project.	5	4	4	5	5	4	5	5	5	4.67
I understood and properly used Mixed Reality technology and its difference with AR and VR.	5	4	5	5	4	5	5	5	5	4.78
I could solve technical problems related to the implementation of Mixed Reality.	4	5	5	5	4	4	5	5	5	4.67

Note: Compiled by authors. In the technological integration category, the achieved average was **4.70/5**, reflecting a high level of mastery of competencies in 3D modeling, programming and interaction design, as well as the differentiated use of Mixed Reality compared to Augmented Reality and Virtual Reality.

Table 3
Interdisciplinary collaborative work

INDICATOR	P.1	P.2	P.3	P.4	P.5	P.6	P.7	P.8	P.9	Prom.
2. Collaborative interdisciplinary work										
I actively participated in a multidisciplinary team respecting and valuing my partners' contributions.	5	3	5	5	4	5	4	5	5	4.56
I contributed to meeting the defined group goals and deadlines.	5	4	5	5	4	5	3	5	5	4.56
I learned how to effectively communicate with peers from other areas to achieve common targets.	5	4	5	5	4	5	5	4	5	4.67

Note: Compiled by authors. The collaborative interdisciplinary work had an average of 4.59/5, which indicates that students valued the interaction with partners of different areas (digital and fashion design) and the ability to coordinate effectively to accomplish objectives and lead times.

Table 4
Creativity and innovative thought

INDICATOR	P.1	P.2	P.3	P.4	P.5	P.6	P.7	P.8	P.9	Prom.
3. Creativity and innovative thought										
I suggested creative and innovative solutions in the design or conceptualization of the Catrinas interactivas.	2	4	5	5	4	3	5	3	5	4.00
I participated in the generation of ideas that transformed the way cultural traditions are experienced in digital environments.	1	4	5	3	4	3	5	1	5	3.44
I succeeded in combining artistic, cultural and technological elements in an original way.	2	5	4	4	5	3	5	5	5	4.22

Note: Compiled by authors. In the creativity and innovation category, the average was 3.92/5, which suggests that, even though original proposals were generated, this was the most challenging area. Students pointed out on the open questions that time and technical limitations made it difficult to further experiment with innovative proposals.

Table 5
Cultural and historical consciousness

INDICATOR	P.1	P.2	P.3	P.4	P.5	P.6	P.7	P.8	P.9	Prom.
4. Cultural and historical awareness										
I researched the meaning and symbolism of the Catrinas as elements of Mexican cultural heritage.	1	3	4	5	5	3	2	5	4	3.56
I understood the importance of binding technology with cultural expressions to communicate identity and memory.	4	5	5	5	4	4	5	5	5	4.67
I thought about the symbolic value of the Catrinas in the present Mexican identity.	5	5	5	5	4	4	5	5	5	4.78

Note: Compiled by authors. The dimension of cultural and historical awareness achieved an average of 4.14/5, demonstrating that participants were able to connect the symbolism of the Catrina with the Mexican identity and to reflect on the role of technology in cultural preservation.

Table 6
Personal and professional development

INDICATOR	P.1	P.2	P.3	P.4	P.5	P.6	P.7	P.8	P.9	Prom.
5. Personal and professional development										
This project strengthened skills that I consider useful for my academic or working future.	5	5	4	5	5	5	5	2	5	4.56
I felt motivated and challenged to learn new things within and outside the traditional classroom.	5	5	4	5	4	5	5	5	5	4.78
I recognized the value of this type of project to strengthen my professional profile both in design and technology.	5	5	5	5	4	5	5	5	5	4.89

Note: Compiled by authors. The personal and professional development area obtained the highest average, with 4.70/5, highlighting the motivation of students to learn within and outside the classroom and their recognition of the value of interdisciplinary projects to strengthen their academic and working profile.

The qualitative responses to the open question reinforced these findings. Among the most frequently mentioned lessons learned were:

- ❖ "The experience of participating in a large-scale project."
- ❖ "Understanding the possibilities and limitations of Mixed Reality."
- ❖ "The importance of collaborative work".
- ❖ "The satisfaction of linking cultural tradition with the use of emerging technologies".

Overall, the results confirm that the STEAM-H model, articulated with PBL and Scrum, favored not only the development of technical competencies, but also the strengthening of cultural identity and professional motivation, validating its relevance as a meaningful learning strategy in Higher education.

Preliminary findings

In the technological integration category (technical abilities), students reported meaningful progress in the use of 3D modeling, programming and interaction tools. Also, they pointed out that they had acquired a differentiated understanding of Mixed Reality compared to Augmented Reality and Virtual Reality, which allowed them to recognise the particularities of this type of immersive experience.

Regarding collaborative and interdisciplinary work, most participants highlighted the importance of integrating multidisciplinary teams in one project (digital and fashion design). Results show that they were able to coordinate effectively to accomplish goals and deadlines, in addition to improving their communication skills with partners from different areas.

At the creativity and innovative thought area, participants valued the opportunity to generate original proposals that combine cultural, artistic and technological elements. Some mentioned that this project allowed them to experiment with new ways to reinterpret Mexican traditions in digital environments.

In the cultural and historical awareness category, students stated that they had deepened their understanding of symbolism of the Catrina and its role as heritage figure of the Día de Muertos. This reflection allowed them to recognize the relevance when integrating technology to maintain and redefine cultural expressions.

Finally, in the personal and professional development category, students pointed out that the project strengthen useful skills for their academic and working future. They reported feeling motivated and challenged to

learn within and outside the traditional classroom, in addition to recognizing the value of interdisciplinary experiences to build a solid professional profile in the design and technological field.

Qualitative responses to the open question demonstrated that participants valued the project as a space for innovation and of integral formation. Among the learnings mentioned were the following: the capacity to confront technical challenges, the development of cultural sensitivity and the importance of teamwork to give a meaning to a technological product with social and human value.

Overall, the results show that the *Catrinias interactivas* project strengthened transversal and technical abilities, as well as fostering cultural reflection and critical thinking, confirming the pertinence of the STEAM-H project as a strategy to promote humanist and meaningful learning in Higher education.

Conclusions

The *Catrinias interactivas* project demonstrated the potential of the STEAM-H approach, which goes beyond technical instruction and promotes learning experiences that add creativity, cultural identity and humanist awareness, aligning itself with the recommendations of international organizations of integrating humanism into education (Unesco, 2021). Thus, STEAM-H, together with active methodologies such as Project-Based Learning and the Scrum framework, constituted an effective strategy to link the technical formation with cultural and humanist reflection that fosters meaningful learning, in which students not only reinforced their abilities in conceptual design, 3D modeling, programming and interaction design, but also developed transversal skills, such as teamwork, communication, creativity and the application of knowledge in an integrated manner across differentiated contexts.

In general, the educational experience confirmed the importance of addressing poorly structured problems, such as David Jonassen (2011) proposes in PBL, as the creation of an immersive experience towards the *Catrina* demanded the incorporation of different knowledge and the collective decision-making in the face of ambiguity and the lack of unique solutions. This process promoted critical thought and the students' capacity for innovation. The results obtained through the self-assessment rubric reflected a positive impact on the five evaluated dimensions. Although creativity was identified as the most challenging area, the other categories achieved high values, especially highlighting the strengthening of the academic and professional profile of the participants.

Regarding the project, it confirmed that the immersive technologies, when integrated from a humanist and interdisciplinary focus, can become

catalysts for learning, cultural preservation, and creative talent development in Higher education.

Nevertheless, it is necessary to recognise that devices like Apple Vision Pro, that represent an advance in spatial computing and offer experiences of high fidelity, are not generally accessible in most universities due to their high cost and the lack of an extended educational ecosystem. Its true educational value lies in their strategic use within pilot projects that, as in *Catrinas interactivas*, take advantage of the experimental resource to strengthen transversal abilities and reflect on the relationship between technology, culture and society. In this sense, rather than an end, technology becomes a means of linking educational innovation with cultural identity, creating a replicable model for university initiatives that seek to combine heritage, technological innovation, and comprehensive education. 🍎

🍎 References

- Ades, D. (1989). *Art in Latin America: The modern era, 1820-1980*. Yale University Press.
- Andrade, H. (2005). Teaching with rubrics: The good, the bad, and the ugly. *College Teaching*, 53(1), 27-31. <https://doi.org/10.3200/CTCH.53.1.27-31>
- Apple. (2023). Introducing Apple Vision Pro. Apple Inc. <https://www.apple.com/newsroom>
- Ato, M., López-García, J.J. y Benavente, A. (2013). Un sistema de clasificación de los diseños de investigación en psicología. *Anales de Psicología*, 29(3), 1038-1059. <https://doi.org/10.6018/analesps.29.3.178511>
- Barteit, S., Guzek, D., Jahn, A., Bärnighausen, T., Jorge, M.M. y Neuhann, F. (2021). Evaluation of e-learning for medical education in low- and middle-income countries: A systematic review. *Computers & Education*, 145, 103726. <https://doi.org/10.1016/j.compedu.2019.103726>
- Birchfield, D. y Megowan-Romanowicz, M. (2009). Earth science learning in small groups with a mixed reality environment. *Computers & Education*, 52(2), 210-220. <https://doi.org/10.1007/s11412-009-9074-8>
- Chrysanthakopoulou, A., Chrysikopoulos, T., Arvanitis, G. y Moustakas, K. (2025). Reimagining Historical Exploration: Multi-User Mixed Reality Systems for Cultural Heritage Sites. *Applied Sciences*, 15(5), 2854. <https://doi.org/10.3390/app15052854>
- Creswell, J.W. y Plano Clark, V.L. (2018). *Designing and conducting mixed methods research* (3ra. ed.). SAGE.

- Domínguez-Saldívar, A. y Vázquez-Castelán, C. (2025). Potenciando el futuro: STEAM+h en la nueva escuela mexicana, un aprendizaje transformador. *European Public & Social Innovation Review*, 10, 01-25. <https://doi.org/10.31637/epsir-2025-575>
- García J.A., García H.Y. y Martínez, M.D. (2025). Transformando la educación: una comparativa entre apple vision pro y oculus quest 2 en la enseñanza de tecnología educativa. *RIDE. Revista Iberoamericana para la Investigación y el Desarrollo Educativo*, 15(30), e827. <https://doi.org/10.23913/ride.v15i30.2276>
- Hernández-Sampieri, R. y Mendoza, C. (2018). *Metodología de la investigación: Las rutas cuantitativa, cualitativa y mixta*. McGraw-Hill.
- Jonassen, D.H. (1999). Designing constructivist learning environments. En C.M. Reigeluth (ed.), *Instructional-design theories and models: A new paradigm of instructional theory* (pp. 215-239). Lawrence Erlbaum Associates.
- Jonassen, D.H. (2000). Toward a design theory of problem solving. *Educational Technology Research and Development*, 48(4), 63-85. <https://doi.org/10.1007/BF02300500>
- Jonassen, D.H. (2011). *Learning to solve problems: A handbook for designing problem-solving learning environments*. Routledge.
- Leavy, P., Harris, A. y Holman Jones, S. (2023). *Handbook of arts-based research*. Guilford Press.
- Lewis, T. (2008). Creativity in technology education: Providing children with glimpses of their inventive potential. *International Journal of Technology and Design Education*, 19, 255-268. <https://doi.org/10.1007/s10798-008-9051-y>
- Montés, N., Barquero, S., Martínez-Carbonell, A., Aloy, P., Ferrer, T., Romero, P.D., Millan, M. y Salazar, A.d.S. (2024). Redefining steam to steam √H (steam for All Humanity) in Higher Education. *Education Sciences*, 14(8), 888. <https://doi.org/10.3390/educsci14080888>
- Organización para la Cooperación y el Desarrollo Económicos (ocde). (2023). *OECD Skills Outlook 2023: Skills for a Resilient Green and Digital Transition*. oecd Publishing. <https://doi.org/10.1787/27452f29-en>
- Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura (Unesco). (2019). *Futures of education: Learning to become*. Recuperado el 12 de octubre de 2025 de <https://unesdoc.unesco.org/ark:/48223/pf0000370801>

- Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura (Unesco). (2021). *Reimagining our futures together: A new social contract for education*. <https://doi.org/10.54675/ASRB4722>
- Pabón, C.J. (2017). Preservación del Patrimonio Cultural Digital: Retos y Perspectivas para la Escritura de la Historia. *Boletín de Historia y Antigüedades, CIV*, 199-229. Retrieved October 15, 2025 de <https://www.researchgate.net/publication/353677462>
- Panadero, E. y Jonsson, A. (2013). The use of scoring rubrics for formative assessment purposes revisited. *Educational Research Review*, 9, 129-144. <https://doi.org/10.1016/j.edurev.2013.01.002>
- Paul, A., Kunnumpurath, B., Balakrishnan, C., Ramachandran, S. y Suseelan, A. (2025). Enhancing Heritage and Cultural Education through Immersive Audio-Visual Techniques. En B. Sundaravadivazhagan, N. Gnanasankaran, Pethuru Raj, A. Saleem Raja (eds.), *Virtual Reality and Augmented Reality with 6G Communication*. <https://doi.org/10.1002/9781394336081.ch10>
- Perignat, E. y Katz-Buonincontro, J. (2019). steam in practice and research: An integrative literature review. *Thinking Skills and Creativity*, 31, 31-43. <https://doi.org/10.1016/j.tsc.2018.10.002>
- Prada-Núñez, R., Peñaloza-Tarazona, M.E. y Rodríguez-Moreno, F.J. (2024). Análisis de la producción científica en educación steam: Una revisión desde la base de datos web of science. *AiBi Revista de Investigación, Administración e Ingeniería*, 12(3), 214-227. <https://doi.org/10.15649/2346030X.4414>
- Saldaña, J. (2021). *The coding manual for qualitative researchers* (4ª. ed.). SAGE.
- Sánchez, O. y Martínez, G. (2024). Fundamentos del Steam-H, como estrategia del modelo educativo aplicado en la formación de ingenieros. *Tierra Infinita*, 10, 44-58. <https://doi.org/10.32645/26028131.1305>
- Santillán-Aguirre, J., Jaramillo-Moyano, E., Santos-Poveda, R. y Cadena-Vaca, V. (2020). steam como metodología activa de aprendizaje en la educación superior. *Polo del Conocimiento*, 5(8), 467-492.
- Schwaber, K. y Sutherland, J. (2020). *The Scrum Guide: The definitive guide to Scrum, the rules of the game*. Scrum.org.
- Spyropoulou, N. y Kameas, A. (2024). Augmenting the Impact of steam Education by Developing a Competence Framework for steam Educators for Effective Teaching and Learning. *Education Sciences*, 14(1), 25. <https://doi.org/10.3390/educsci14010025>
- Velarde-Camaqui, L. (2024). Realidad Mixta en educación universitaria: Desafíos y oportunidades. *Revista Peruana de Educación Superior*, 8(1), 55-74.

Wang, Y., Zhou, X. y Liu, F. (2024). Barriers to adoption of mixed reality in higher education: A systematic review. *British Journal of Educational Technology*, 55(1), 45-63. <https://doi.org/10.1111/bjet.13345>

Yin, R.K. (2018). *Case study research and applications: Design and methods* (6a. ed.). SAGE.

Zhang, J., Wan Yahaya, W.A.J. y Sanmugam, M. (2024). The Impact of Immersive Technologies on Cultural Heritage: A Bibliometric Study of VR, AR, and MR Applications. *Sustainability*, 16(15), 6446. <https://doi.org/10.3390/su16156446>

Zúñiga-Tinizaray, F.S. y Marín, V.I. (2024). Estrategias Educativas stem-steam en Nivel Superior: Revisión Sistemática de Literatura. *Revista Espacios*, 45(4), 16-30. <https://doi.org/10.48082/espacios-a24v45n04p02>

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