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VISUAL ARTS TEACHING STEAM AND I-TPACK IN TEACHER TRAINING.

Experience with artificial intelligence and educational audiovisual robotics

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KEYWORDS

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ABSTRACT

This qualitative research in Visual Arts Education analyzes the training of 67 trainee teachers enrolled on a Primary Education Degree program using the STEAM/I-TPACK approaches. The students developed 62 visual metaphors and 31 interactive robotic works combining artificial intelligence and creative robotics to reflect on the Sustainable Development Goals, focusing on inclusion and diversity. The findings reveal a predominant concern with stereotypes, racism, and sustainability. It is concluded that the integration of Arts Education with technologies enhances students' critical and cognitive abilities, achieving high-quality narratives with formal and conceptual coherence.

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1. Introduction

Various international plans advocate promoting digital and visual literacy from the earliest stages of education, with the aim of improving the quality of education and inclusion in an increasingly media-driven society. In this context, there is an urgent need for innovative teaching proposals that effectively incorporate visual culture and information and communication technologies (ICT) into teaching-learning processes (Jing S Omar, 2024; Soto-Solier S Villena-Soto, 2024). Contemporary teacher training must meet the demands of a reality permeated by digital media by preparing professionals to function in hybrid and highly visual environments. One of the most robust pedagogical responses to these challenges is the STEAM approach, which includes the "A" for Arts alongside the traditional disciplines of Science, Technology, Engineering, and Mathematics (STEM). Incorporation of the "A" is not limited to a consideration of only artistic content. Instead, it concerns a holistic approach that integrates creative and aesthetic knowledge, developing interdisciplinary skills (Caeiro et al., 2024; Colucci-Gray et al., 2019). Previous research indicates that STEAM projects foster creative thinking, aesthetic sensitivity, values and innovation (Colucci-Gray et al., 2019; Diego-Mantecón et al., 2021), even serving as a motivational

bridge in scientific areas.

However, effective implementation of the STEAM approach in classrooms depends, intrinsically, on teacher training. It is essential that trainee teachers develop skills in both the arts and the educational use of technology (Sevilla S Solano, 2022). In this regard, the TPACK (Technological Pedagogical Content Knowledge) model stands out as a conceptual framework that outlines the intersection of technological, pedagogical and disciplinary knowledge (Mishra S Koehler, 2006; Koehler et al., 2015). This model has recently evolved into I-TPACK (Intelligent-TPACK), which conceptualizes the transition from human-technology interaction to human-AI collaboration, where cognitive tasks are shared between teachers, students and artificial intelligence agents (Aldemir et al., 2025; Chiu, 2026).

The emergence of generative artificial intelligence (AI) and audiovisual educational robotics poses disruptive paradigms for the teaching of visual arts. AI can facilitate collaborative creativity and the exploration of new creational models in an expanded digital culture (Delgado Hernández S Marqués Ibáñez, 2025). However, this integration requires advanced visual literacy to critically interpret new algorithmically generated symbolic languages (Calderón S Hernández, 2019). Unlike traditional methods, "computational creativity" (López-Mántaras, 2016) allows technology to act as an ally in the creative process, although its use must be pedagogically grounded to prevent AI from replacing essential human processes, given its lack of the empathy required for teaching (Flores-Vivar S García-Peñalvo, 2023). At the same time, educational robotics is establishing itself as a powerful tool for the creation of "interactive object poems" that inhabit physical space (Kac, 2021; Sáez-López, 2021), enabling hybrid learning processes where digital images become interactive through programming.

The present research project was born out of a need to address these challenges. It describes an innovative educational experience developed with future teachers in the subject of Visual Arts Education. The main objective is to improve the visual and digital-technological literacy of trainee teachers by exploring teaching strategies that connect education on the arts with the demands of contemporary visual culture and social challenges.

1.1. Objectives

Design and implement a STEAM-based training experience based on the I-TPACK model, integrating artificial intelligence (AI) and educational audiovisual robotics in the area of Art Education.

Determine the topics that are of interest to trainee teachers when they are prompted to reflect on inclusion and diversity.

Assess the ability of trainee teachers to design and create interactive visual metaphors with conceptual and formal coherence using generative AI and robotics.

Apply generative AI and audiovisual robotics to a project to create interactive visual metaphors, assessing the transfer of learning about visual narrative and technology.

Improve critical thinking through the production of texts and images as complementary processes in the construction of metaphorical visual and audiovisual messages.

2. State of the art

2.2. STEAM-TPACK audiovisual project-based learning focused on the "A"

The current educational setting requires adaptations and solid audiovisual and digital literacy to meet the challenges of the Digital Education Action Plan (2021–2027) and the guidelines of Agenda 2030 and UNESCO (2016), which focus on critical thinking and problem solving. In this context, Digital Humanities (DH) becomes relevant by promoting interdisciplinary processes that generate meaningful knowledge (Rodríguez, 2014). According to Rojas (2013), DH is not just a technological "doing," but a different way of "thinking" based on digital media. This evolution gives rise to DH Labs, as hybrid co-creation spaces related to STEAM Audiovisual Project-Based Learning.

This active methodology focuses on social transformation and community engagement (Kou et al., 2021). The integration of technologies into PBL facilitates digitized and immersive scenarios, where the convergence between HD and pedagogy enhances the development of PBL-STEAM (Hawari S Noor, 2020). These principles are embodied in practical experiences such as the analysis of "Identity Trapped in the Network," where AI and robotics are used to report cyberbullying, demonstrating the effectiveness of these new educational paradigms (Soto-Solier S Villena-Soto, 2024).

The STEAM approach is directly associated with creative thinking, aesthetics, values and innovation (Caeiro et al., 2024, Colucci-Gray et al., 2019; Diego-Matecon et al., 2021). In STEAM projects, project-based learning (PBL) is fundamental for placing the student at the center of the process, while the teacher acts as a learning facilitator. Despite the availability of proposals based on computational thinking such as "do it yourself" (Prat S Sellas, 2021) or gamification (López et al., 2021), PBL remains the most pedagogically meaningful way of working (Diego-Mantecón, Prodromou et al., 2021; López-Banet et al., 2021).

The TPACK model (Mishra S Koehler, 2006; Koehler et al., 2015; Mishra, 2019) is key for achieving effective technological integration. This model has been updated to conceptualize human-AI collaboration, sharing cognitive tasks between teachers, students and agents (Aldemir et al., 2025), via AI functionalities (Chiu, 2026). An example of this application is the design of critical visual metaphors regarding sexual cyberbullying that integrate generative AI and robotics (Soto-Solier and Villena-Soto, 2024).

Finally, the move towards a digital society requires educational and political involvement. Universities must foster hybrid and cooperative environments that promote digital and audiovisual skills (Cabero S Fernández, 2018; Mascarell-Palau, 2020) and critical thinking (Ewing, 2020). This is essential for interpreting and generating new knowledge.

2.3. Audiovisual education and generative artificial intelligence in teacher training.

In the field of plastic, visual and audiovisual expression, the use of artificial intelligence (AI) is emerging as a highly interesting alternative for working on and reflecting on various educational and creative aspects, such as the generation of images from text (prompts), visual analysis, and didactic mediation in the interpretation of works of art. However, creativity, one of the central pillars of arts education, has historically been questioned in relation to AI, as it is considered a distinctive feature of humans as opposed to machines (López-Mántaras, 2016).

This debate has given rise to the concept of "computational creativity," which aims to analyze the design and creation of computer systems capable of exhibiting behaviors that, in human contexts, would be interpreted as creative (Mántaras, 2016). This perspective allows us to

analyze human creativity in terms of its application in technological tools that act as allies of creative processes, opening up new possibilities for teaching and learning in the field of artistic and visual creation.

This approach is particularly relevant in the educational context, where one of the main challenges is to integrate AI as a resource that enhances visual literacy, critical thinking and creativity, in a way that is not detrimental to teachers and does not replace human creative processes (Vicente-Yagüe-Jara et al., 2023) but, instead, provides an opportunity for the development of collaborative art (Castejón Ibáñez, 2025). In this sense, one of the current challenges in education is to reconfigure AI as a teaching opportunity, incorporating it into teaching methodologies and overcoming its perception as a risk or threat. However, as cautioned by Flores-Vivar and García-Peñalvo (2023), unlike a human teacher, AI cannot be a complete source of inspiration because it lacks empathy, which is essential in teaching-learning processes. The expansion of AI-generated imagery has been driven by the emergence of specialized tools such as Craiyon, DALL·E, Midjourney, Stable Diffusion, Jasper, NightCafe and DeepAI, which are widely used in professional fields such as art and graphic design. However, their use raises important ethical questions related to both the veracity of visual information and the professional

threat they may pose to photographers and visual creators (Franganillo, 2023).

The implementation of new educational methodologies based on the use of AI has begun to yield significant results that allow for the analysis of effective and productive approaches. A relevant example is the visual arts-based research developed by Marín-Viadel et al. (2024), which focuses on learning to draw from Goya's engravings and drawings using the *Stable Diffusion* platform. Findings revealed that the instructions given by teachers enabled the AI to learn stylistic patterns, opening up new educational and creative possibilities.

In relation to the line of research proposed here, recent studies evaluating the performance of AI image generators in terms of quality, diversity and efficiency, as well as their limitations and ethical challenges (Bansal et al., 2024), are particularly relevant. Likewise, Pise et al. (2024) conclude that AI systems enable artists to generate highly interesting visual outputs from textual descriptions, expanding and democratizing access to creative processes and reinforcing human creativity, critical thinking and innovative capacity.

Research by Brisco et al. (2023) and Ranscombe et al. (2024) examines whether AI can replace designers in ideation, highlighting its educational potential from a critical and ethical perspective. In this sense, research focuses on creating knowledge through visual metaphors (AI) and robotized object poems, which act as essential resources for visual literacy and reflection on identity, inclusion and social justice. Visual metaphors allow complex meanings that transcend verbal language to be communicated, facilitating abstract concepts and stimulating creative thinking (Caeiro et al., 2021). In addition, they help to explore teachers' beliefs and the impact of sociocultural contexts on perceptions of the world. They also represent an effective technique for developing critical AI literacy (CAIL) (Roe et al., 2025). Recent works analyze AI use in science fiction as a metaphor for existence (Hermann, 2023) or the ability of models such as GPT-4 to interpret literary metaphors (Ichien et al., 2024), showing that this technological integration enhances students' critical thinking skills, generating narratives of high conceptual quality and formal coherence.

2.4. Audiovisual educational robotics: The image that inhabits space

Educational and creative robotics is another of the most relevant educational technology tools for strengthening the key competencies of students, as well as their digital and audiovisual skills (Relkin, de Ruiter S Bers, 2020; Xia S Zhong, 2018). According to Sáez-López (2021), this modality includes programs, applications, physical robots and so-called digital human environments. As a main example of this, the Makeblock app stands out. This application offers a complete robot control experience, from construction instructions to movement programming using predefined controls. Likewise, mBlock 5 is a comprehensive platform for initial coding education. This platform provides a visual language based on the organization of colored blocks

and has emerged as a benchmark for its simplicity. It is an open-source technology developed by MIT MediaLab based on research by the Lifelong Kindergarten group. Further*, Makeblock-mBlock 5* promotes collaborative work in face-to-face, virtual, or hybrid environments. These qualities make it a key pedagogical tool for the creation of interactive 3D audiovisual metaphors (interactive object poems), employing a methodology that is focused on digital literacy, technological learning and, above all, communication through interactive audiovisual creations.

Integration of robotics into arts education represents a transformative approach to learning that harnesses the potential of technology to enhance students' cognitive development, problem-solving skills and collaboration (Guo and Wang 2024; Mao and Zhang 2021; Wang and Reynolds 2024). As society advances, education is shifting towards more interactive and student-centered methodologies. The role of robotics in the classroom is becoming established as a particularly powerful tool for creating motivating and engaging learning environments (Derakhshan et al., 2025; Pan S Wang, 2025). By articulating constructivist and experiential learning frameworks, teachers can design dynamic arts programs that not only address the fundamentals of art but also promote exploration, experimentation and meaningful interaction among students. From this perspective, constructivist theories emphasize the active participation of students in the construction of their own knowledge, while experiential learning emphasizes the value of direct experience and reflection as drivers of learning (Gao et al., 2024).

The integration of visual educational robotics into arts education facilitates the development of practical projects that connect theoretical knowledge with its real-world application. Activities such as the construction and programming of interactive robotic artistic creations, robotic instruments, or art-generating machines offer students unique opportunities to explore artistic concepts while enhancing critical thinking, creativity and problem-solving skills as they overcome technical and design challenges (Mao S Zhang, 2021). In this way, hybrid analog/digital learning processes are generated through the design and creation of works/prototypes made with physical materials that become interactive through programming.

By broadening the definition of robot, usually associated with the fields of science, engineering, or industry, robotic art refers to devices that are capable of opening spaces for social criticism, the expression of personal concerns, and the unleashing of imagination and fantasy. Robots, understood as objects that operate in time and space, have open and diverse spatiotemporal structures, which allow them to respond specifically to different stimuli (Kac, 2021).

Robotic art ranges from autonomous agents to automatons that perceive and respond to the public through sensors. These manifest mimetic, synthetic, or hybrid behaviors. By simulating physical, temporal and human dimensions, they generate new behaviors that expand the expressive, educational and conceptual boundaries of contemporary art. In this way, the work actively interacts, inhabiting space and transforming the aesthetic experience through technology.

Likewise, the use of robotics in education encourages collaboration and teamwork, as it requires communication and coordination between students with diverse profiles (Mustoip et al., 2024). The contribution of hybrid perspectives and skills to shared projects leads to the creation of inclusive educational environments that value diversity and prepare students to function in an increasingly interconnected and technology-mediated society, both inside and outside the school

context (Ramos et al., 2020). In this sense, educational, social, inclusive, surveillance and sustainable robots, particularly stand out.

Final del formulario

3. Methodology

The project was carried out within the framework of the Bachelor's degree in Primary Education at the Faculty of Education Sciences of the University of Granada, as part of the elective module, Didactics of Visual Arts, taught in the fourth year of the course in the 2024-2025 academic year.

The main aim of this course is to develop specific skills so that trainee teachers can plan and facilitate teaching processes in Art Education using information technology.

The present research pertained to a prospective observational study that was quasi-experimental in nature, with pre- and post-intervention non-controlled comparisons. An educational action research project was carried out based on visual and audiovisual art with AI (Marín-Viadel, 2025) and STEAM-I-TPACK Pproject-Bbased Llearning (Hawari S Noor, 2020; Koehler et al., 2015).

To this end, an educational activity was designed to develop critical and creative skills through the use of generative artificial intelligence and creative robotics. The pedagogical proposal involves participants creating visual and textual narratives through design processes using tools such as ChatGPT-4 and Bing Image Creator, promoting active reflection on the results generated. This didactic intervention not only encourages AI-mediated creative production, but also encourages students to adopt a critical stance based on disciplinary knowledge and critical consideration of the responses, aesthetics and patterns that emerge from generative models.

Based on the initial images generated by AI, students were requested to conceptualize and construct robotized visual metaphors and interactive object poems, integrating visual and textual elements and robotic mechanisms. To do this, they used applications such as Makeblock, mBlock 5 and educational robotics kits, which allow them to link artistic expression with the development of creative computational thinking. This transdisciplinary approach joins advanced digital literacy up with design processes, programming, basic electronics and symbolic aesthetics, thereby promoting meaningful learning through designmaker experiences in innovative and inclusive educational contexts.

3.1. Participants

Sixty-seven student trainee teachers (n=67; women=41, men=26) where organized into groups of 2 to 3 members and produced a total of 31 artistic projects. Each project consists of two visual metaphors (AI-generated images) and a robotized object poem, resulting in 62 visual metaphors and 31 robotic works. The works were created using Generative AI and interactive visual robotics, addressing issues related to inclusion and diversity from a critical and creative perspective. Prior to the initiation of fieldwork, participants were requested to sign an informed consent form specifying the commitments made by both parties—researchers and participants—and expressly guaranteeing the confidentiality of the information provided.

3.2 Research tools

The following tools were selected and developed in accordance with criteria of pedagogical, technological and aesthetic validity:

Protocol for the design and creation of AI-generated artistic images or visual metaphors and robotized 3D artistic pieces, namely, interactive object poems. This educational material was specifically developed and adapted by the teaching team participating in the project. This protocol was integrated into the course syllabus and structured according to sequential phases, providing conceptual, technical and procedural guidelines for students' audiovisual and digital-

technological literacy. Its purpose was to guide the creation of AI-generated visual images and interactive 3D robotic works by combining principles of visual and narrative language with elements of basic programming.

Visual metaphors (created with generative AI) and interactive visual poems (robotized artistic creations made in 3D) were created in line with design and creation processes using digital tools and resources. For instance, the Bing Image Creator (DALL·E 3) application was used to create images using AI, whilst robotics kits were programmed using Makeblock-mBlock 5 based on block programming language to create interactive works. The 2D images and 3D works were created by trainee teachers in groups comprising 2-3 students. Each group generated two images or reflective visual metaphors using AI and a robotic object poem (an interactive artistic work applying robotics as the final output), accompanied by a reflective

documentary portfolio. This portfolio included textual, visual and audiovisual evidence of the research process, with notes on the creative, conceptual and technological decisions made, as well as references to the Sustainable Development Goals worked on in the project (Table 1.).

Rubric for evaluating visual metaphors (images created with AI) and robotized object poems (Table 3.) was developed and administered through a specific protocol with adaptations from validated published studies. Evaluation of the creation of artistic images with AI (Arias et al., 2024; Sáez-López et al., 2016; Sáez-López et al., 2020; Verdú et al., 2025) and creations with audiovisual educational robotics (Sáez-López et al., 2016; Sáez-López et al., 2020) was based on the Educational robotics in Tteaching test (REE). Twenty items were evaluated, which were distributed between two dimensions (D1, D2) and four sub-dimensions: D1: knowledge and conceptualization, quality of prompts and indicators, and design; and D2: creation of the interactive robotic metaphor or poem, and visual aesthetic quality. Responses were given along a five-point Likert scale where 1 means "poor," 2 "pass," 3 "acceptable," 4 "good," and 5 "excellent." The pre- and post-training TPACK perception and knowledge questionnaire developed was based on research conducted by Hawari and Noor (2020) and Koehler et al. (2015), which focuses on the knowledge assessment protocol based on the I-TPACK (table 4.) model. Five knowledge items were evaluated with responses being given along a five-point Likert scale where 1 is "not

adequate," 2 "somewhat inadequate," 3 "adequate," 4 "quite adequate," and 5 "very adequate".

These instruments made it possible to triangulate the information collected, evaluate the formal and conceptual coherence of outputs, and assess the pedagogical impact of the experience from a STEAM and TPACK perspective.

4. Fieldwork

Fieldwork for the present research was structured systematically over twelve sessions, which were divided into five main phases: problem definition, exploratory research, formulation and design, creation, and presentation and evaluation. This process allowed the 67 trainee teachers not only to acquire technical skills in the process of creating visual metaphors, AI-generated images and metaphors or object poems using audiovisual robotics, but also to deepen their reflection on the sustainable development goals, focusing on inclusion and diversity (Table 1.).

Table 1. Phases of the intervention program (P) and sessions (S).

Phases (Ph.)	*Sessions (Theory/Practice)*	*Material*	*Time*
1	**Ph.** Definition of social challenge or problem, inclusion, or diversity. Knowledge, critical reflection, (SDGs). Completion of pre-training I-TPACK knowledge questionnaire.		1h.
2	**Ph. Research-exploration: student training** 2.S. Conceptualization of visual metaphor: analysis of visual and plastic language elements in visual/digital metaphors (Chema Amador). Development of the idea.	- Computer/Tab let Internet	2h.
	3.S. Conceptualization of metaphor or object poem with robotics: Analysis of visual, plastic, and interactive language elements in object poems/3D works (Joan Brossa). Knowledge of art and inclusive creative robotics. Development of the idea.		2h.

3 Ph. Formulation/experimentation:

Design and creation of two visual metaphors (2 images using AI): 1. Original visual metaphorical image and 2. Original visual metaphorical image with creative robotics application.

4.S. Conceptualization and design of metaphorical image using AI: Writing prompts: experimentation—writing a brief synopsis (paragraph) that describes with maximum precision in a literal or figurative way. Development of narrative synthesis. Use of text AI (ChatGPT) to expand the synopsis, defining symbolic objects and contexts through a cycle of review and rectification.

5.S. Generation of metaphorical images with AI: Introduction of indicators (descriptive prompts) in Bing Image C. (DALL·E 3): 1. Image of original visual metaphor.

6.S. Generation of the image of the original visual metaphor through the application of robotics (2. Original visual metaphor with robotics integration). Use generative AI to visualize how the physical elements (symbolic objects, materials, sensors, cables, etc.) will be integrated with the robotic basis, finalizing the design by creating prompts.

Critical evaluation: Error detection (unacceptable compositions or elements that are inconsistent with the initial narrative).

4 Ph. Design and creation of a 3D output: from a digital image to an interactive robotic metaphor "Inclusive robotic object poem" (Integration of audiovisual robotics)

7. S. Conceptualization of an interactive 3D output: Interactive robotic object poem based on the initially created images.
8. S Design and composition of robotic metaphor, integration of physical elements (symbolic objects, materials, sensors, cables, etc.) with a robotic basis, finalization of the visual narrative design. Linking the robotic "work" with the visual "discourse."
9. S. Configuration and application of hardware and prototyping (motion, sound and light sensors)
10. S. Interactive programming with Makeblock-mBlock 5. Block language is used to give the robotic output "behavior."

5 Ph. Exhibition/Assessment

11. S Exhibition.
12. S. AI-generated image assessment (Rubric). Assessment of robotic artistic creations (Rubric).

Post-training I-TPACK knowledge questionnaire

Source(s): Soto-Solier P. M. (2026).

-Computer/ Tablet
-Bing Image C. (DALL· AND 3)
-Internet
- Portfolio
- Computer/Tab let
- Robotics Kit (Sensors: Motion, Sound, Light)
- Makeblock-mBlock
- C a m e r a .
- Portfolio
- Computer/Tabl et
- Camera.
- Portfolio
2h
1h.2h.
2h.
2h. 1h.2h
2h 2h.1h.2h
2h.2h. 2.h

Continuous assessment is carried out through observation and rubrics, allowing for the adaptation of analogical digital-technological methodological strategies during the process (Soto-Solier and Villena-Soto, 2023). Students engage in self-assessment and group co-assessment processes, rigorously questioning the strengths and weaknesses of their visual metaphors and the effectiveness of the technology used (Soto-Solier and Villena-Soto, 2024).

Thirty-one projects or outputs completed by students were analyzed. This section is vital, as it allows observation of the real application of the I-TPACK-STEAM model and the way in which AI and robotics are intertwined with visual narrative in two of the outputs (Table 2).

Table 2. Analysis of two I-TPACK-STEAM case studies. Artistic projects with AI and robotics

Case 1 analyzes I-TPACK-STEAM integration using the metaphor	***Commodification of childhood.***







Generative image/AI Robotics / Interaction

Images 1. right. 2. left: Participating students +AI (2025). Social visual metaphor created with AI: Commercialization of childhood and rampant consumption. Two photographs: left. Original metaphorical concept with AI; right. Metaphorical concept with 3D integration of visual robotics. Digital images.

Final prompt image 2. left: "As an expert in visual arts, create a critical visual metaphor for the commodification of childhood and rampant consumption, create an image that functions as a critical visual metaphor of the commodification of childhood and excessive consumerism. The image shows a childlike doll placed inside a shopping cart, surrounded by receipts and barcodes, constructing a critical metaphor about the commercialization of childhood. The frontal composition and neutral background isolate the subject, reinforcing its vulnerability. The uniform, clinical lighting removes any emotional warmth, emphasizing the artificial character of the scene. The receipts symbolize compulsive consumption and economic logic, while the cart transforms the child into a product, denouncing the reduction of childhood to a market object".

Image-frame video 3: Authors (2025). 3D audiovisual metaphor, robotic social object poem: Commodification of childhood and rampant consumption. Video of the interactive audiovisual metaphor (robotic object poem) https://shre.ink/Metafora-visual-robotica

mBlock v.5.4.0 Prototype+Robotics kit: Arduino+ sensors (light, movement, and sound)+AI vision

I-TPACK Dimension

1. **Artistic content (I-CK) / Visual literacy.** Artistic references: Chema Madoz and Joan Brossa. The metaphor "Commodification of childhood" stands out for its originality in decontextualizing a shopping cart to symbolize consumption that dehumanizes the subject (the doll). The aesthetics, achieved through technical prompts with desaturated tones and cold lighting, reinforce the artificial nature of the concept.

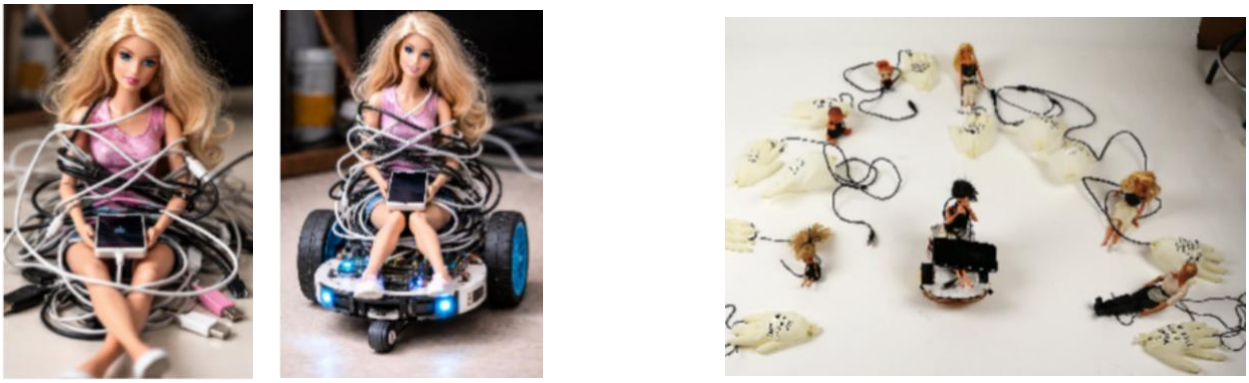
2. **Technological knowledge (I-TK) / Digital literacy:** Competence is demonstrated through the use of generative AI as a conceptual basis and mBlock with Arduino for the physical prototype. Integration includes the management of motors, sensors and AI Vision, achieving transposition from the digital to the interactive plane.
3. **Pedagogical knowledge (I-PK):** The project encourages critical thinking and autonomy in interdisciplinary problem solving, forcing the student to effectively connect the visual narrative with programming.
4. **HAIC-K (Human-AI collaboration):** Students assume the role of "creative designer-producer" through strategic prompt engineering, controlling technical and compositional aspects so that AI can materialize their exact vision.
5. **ETHICs-K (Ethical knowledge):** The work reflects an ethical commitment to using technology to audit social problems, such as the dehumanization of children for the benefit of market values.

Conclusion of case 1: Overall integration (I-TPACK) is achieved with the perfect balance: AI "thinks" (symbolic design), robotics "acts" (physical interaction) and art "communicates" (critical message).

Case 2 analyzes I-TPACK-STEAM integration using the metaphor:

Identity trapped in the network: sexual cyberbullying

Generative image/AI Robotics / Interaction



Images 1. right. 2. left: Participating students. +AI (2025). Social visual metaphor created by AI: Identity trapped in the network: sexual cyberbullying. Two photographs: left. Original metaphorical concept with AI; right. Metaphorical concept with 3D integration of visual robotics. Digital images.

Final prompt image 2. left: "As an expert in visual arts, create a critical visual metaphor: Identity trapped in the network: Non-Identity. The Barbie doll holds a cell phone on her lap, connected to cables. Her expression is neutral and serene. The scene is lit with soft natural light, with shallow depth of field and a slightly blurred background. The color palette is neutral and slightly desaturated, creating a minimalist and contemplative atmosphere. The composition is centered, with the cables forming soft lines around the body, suggesting a metaphor for digital cyberbullying".

I-TPACK Dimension

Image-frame 3: Author (2025).

3D audiovisual metaphor, object poem, social critique, robotized: Identity trapped in the network: sexual cyberbullying. Video of the interactive audiovisual metaphor (robotized object poem) https://shre.ink/Metafora-visual-robotica-2

mBlock v.5.4.0 Prototype+Arduino board+sensors (light, movement, and sound)+AI vision

1. **Artistic content (I-CK) / Visual literacy.** Artistic references: Chema Madoz and Joan Brossa. Presents a metaphorical reinterpretation of original work using a Barbie doll to symbolize vulnerability to sexual cyberbullying. The aesthetic, defined by desaturated colors and soft lighting, visually reinforces the subject's emotional paralysis in the face of digital oppression.
2. **Technological knowledge (I-TK) / Digital literacy:** Demonstrates proficiency in generative AI and hardware through the use of Arduino, sensors (light, sound, movement) and AI vision programmed in mBlock, enabling the transition from digital concept to physical interactivity.
3. **Pedagogical knowledge (I-PK):** The design of this "rooted object poem" encourages critical thinking and interdisciplinary problem solving, forcing the student to connect artistic narrative with engineering autonomously.
4. **HAIC-K (human-AI collaboration):** Students take on the role of creative designer-creator, using strategic prompt engineering to ensure that AI accurately materializes their conceptual vision, controlling composition and symbolism.
5. **ETHICs-K (ethical knowledge):** The work constitutes an ethical denouncement of the risks of the digital environment and dehumanization, using technology to audit and reflect on online violence.

Conclusion of case 2: Total integration is achieved, where AI generates the symbolic basis, robotics provides interactive action, and art communicates an urgent social message based on gender violence.

Source(s): Soto-Solier P. M. (2026).

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5. Results

Results obtained from the rubric corresponding to the protocol for evaluating the design and creation of AI-generated images and interactive 3D visual creations made using audiovisual robotics (Table 3).

Dimension 1. Visual metaphors using AI. In the sub-dimension of knowledge or conceptualization, outcomes reveal that participants based their work on a solid theoretical and creative foundation.

Seventy-five percent of students achieved superior performance levels ("good" or "excellent") for the knowledge and conceptualization of visual metaphors and the analysis of plastic language (Item 1), with a remarkable 30% achieving excellence. Outcomes pertaining to knowledge of art and inclusive robotics applied to object poems are even more noteworthy, with an impressive 85% of the sample ranked at level 4 or 5 and 43% being rated as "excellent" (item 2). These data suggest that the integration of artistic references such as Joan Brossa and Chema Amador facilitates a deep understanding of visual narrative.

In terms of the quality of prompts and indicators, there is a transition from the narrative idea to successful technical execution. Outcomes regarding redaction of the idea and brief synopsis were also positive and balanced, with 37% achieving "good" and 25% "excellent" (item 3).

However, 14% achieved only a passing grade, indicating that written synthesis remains a challenge for some. The ability to extract meaningful ideas (narrative synthesis) to guide visual creation also yields positive data, with 65% of participants being good or excellent (item 4).

Consistent outcomes were also found for technical competence in crafting accurate descriptive prompts (Item 5) and defining technical parameters such as color, visual compositions and balance (Item 6). Specifically, 70% were rated as "good" or "excellent" at handling technical parameters (item 6). Particularly noteworthy is the introduction of indicators into tools such as Bing Image Creator (DALL-E 3), where 41% of students also demonstrated "excellent" performance (item 7). Critical evaluation and detection of errors or inconsistencies in AI-generated compositions represents the area with the greatest room for improvement, with the highest percentage of "acceptable" ratings (32%) of the entire sub-dimension (item 8). This indicates the need to reinforce critical thinking in relation to algorithmic results.

Dimension 2: Interactive 3D visual metaphors through audiovisual robotics. This dimension evaluates the transfer of a visual concept to a physical and interactive output. For the design and creation of the interactive robotic metaphor sub-dimension, outcomes in terms of knowledge and conceptualization (item 9), and design of the robotic metaphor (item 10) coincide with those found for the first phase, with 85% of students satisfactorily integrating physical elements, sensors and visual narrative (Item 10).

The link between the robotic "work" and the visual 'discourse' (item 11) was rated as "excellent" by 41% of participants, which highlights the effectiveness of robotics as a means of artistic expression and not just a technical tool. The visual-technical quality under the principles of visual language also received high ratings, with 76% of the sample rating this at 4 or 5 (item 12).

In strictly technological terms, the configuration and application of hardware and prototyping (item 13) and the use of block language to attribute outputs with a behavior-like quality (item 15) were both also rated highly with 41% reporting "good" and 35% "excellent." This means that 76% of students feel competent programming interaction sequences with Makeblock-mBlock. Finally, the level of interactivity of the work (Item 16) achieved an "excellent" rating in 35% of cases, demonstrating effective interaction between the body, space and the generation of events (Item 16).

Subdimension 2.2: Visual aesthetic quality. Analysis of achieved aesthetic quality reveals significant artistic maturity. Formal visual arts concepts (iconicity, connotation) were correctly applied by 66% of students (4 and 5) (item 17). In terms of linguistic and rhetorical concepts (irony, metaphor), 40% were rated as "good" and 20% as "excellent" (item 18). The use of color as an expressive element stands out as one of the best-performing items in the entire study, with 54% of ratings corresponding to "good" and 29% being "excellent" (item 19). Finally, the final quality of the constructive-formal design was good or excellent for 68% of participants (item 20), consolidating the success of the project as a whole.

Table 3. Protocol for evaluating the design and creation of AI-generated images and interactive 3D visual creations made with audiovisual robotics.

1. Dimension	**Design evaluation and creation**					
Subdim.	***Visual metaphors with AI items***	***1***	***2***	***3***	***4***	***5***
1.1 Knowledge and conceptualization	7. Introduction of indicators (descriptive prompts) into the free version of Bing Image Creator (DALL·E 3) (limited to 480 characters).	6%	9%	13%	31%	41%
	8. Critical evaluation and error detection, such as absurd compositions or elements that are incongruous with the narrative.	5%	2%	32%	38%	23%
	9. Knowledge of art and inclusive robotics. Conceptualization of the object poem metaphor and robotics: Analysis of visual, plastic and interactive language elements in object poems/3D works (Joan Brossa). Development of the idea.	2%	3%	10%	42%	43%
1. Knowledge and conceptualization of the visual metaphor: analysis of visual and plastic language elements in visual/digital metaphors (Chema Amador). Development of the idea.						
Dimension 2. Subdim.		4%	4%	17%	45%	30%
1.2. Quality prompts	3. Drafting of the idea and brief synopsis (paragraph) that integrates the selected words literally or figuratively.	5%	14%	19%	37%	25%
	4. Narrative synthesis and extraction of significant ideas from the final narrative to guide visual creation.	6%	4%	25%	35%	30%
	5. Develop precise and technical descriptive phrases,	4%	6%	20%	40%	30%

Design evaluation and creation of interactive 3D visual metaphors - audiovisual robotics	9. Knowledge and conceptualization of an interactive 3D output: Object poem with robotics.	4%	4%	17%	45%	30%
2.1 Design and creation of interactive robotic metaphor. "inclusive robotic object poem"	10. Design and composition of the robotic metaphor, integration of physical elements (symbolic objects, materials, sensors, cables, etc.) with the robotic base, concretization of the visual narrative design.	2%	3%	10%	42%	43%
	11. Linking the robotic "work" with the visual discourse.	6%	9%	13%	31%	41%
	12. Visual-technical quality according to the basic principles of visual language.	3%	3%	18%	41%	35%
	13. Configuration and application of hardware and prototyping (motion, sound, and light sensors).	3%	3%	18%	41%	35%
	14. Interactive programming with Makeblock-mBlock	3%	1%	20%	39%	37%
	15. Use of behavior sequences-interaction.	3%	3%	18%	41%	35%
2.2 Visual aesthetic quality	16. Level of interactivity of the robotic artwork (body-space interaction). Event generation.	3%	7%	22%	36%	35%
	17. Formal concepts of visual arts: iconicity, connotation, complexity, etc.	3%	5%	26%	39%	27%
	18. Linguistic concepts of visual arts rhetoric: irony, metaphor, etc.	7%	8%	25%	40%	20%
	19. Use of color as an expressive element.	5%	3%	9%	54%	29%
	20. Quality in constructive-formal design.	2%	8%	22%	37%	31%

Source(s): Soto-Solier P. M. (2026).

In conclusion, obtained outcomes indicate that the methodology used, which combines artificial intelligence and robotics under the umbrella of visual metaphors, is highly effective. The vast majority of indicators were rated as "good" or "excellent" (above 60%). It is particularly noteworthy that technical skills (programming and AI management) were not only acquired but also successfully integrated into an artistic and communicative proposal. The remaining challenge identified in the data lies in improving the critical evaluation of AI-generated results (item 8), where a considerable number of students still remain at intermediate levels.

Results obtained from the knowledge assessment protocol based on the I-TPACK model (Table 4).

Table 4. Knowledge assessment protocol based on the I-TPACK model. Pre-post training questionnaire.

Items	4 Optimal % pre-post	3 Somewhat % pre-post	2 Little % pre-post	1 None % pre-post
2.1. I-TK: Intelligent technological knowledge. Prompts ability to draft and refine strategic instructions that translate abstract concepts into powerful and pedagogically useful visual images.	0-18	3-70	8-10	89-2
2.2. I-CK: Intelligent content knowledge (critical validator). Triangulation of sources: the visual metaphor is conceptually sound and academically valid. Identifies cultural stereotypes or representational gaps in the generated images that may distort the metaphor's message. The AI's statistical approach to creating the image differs from the discipline's own methods of inquiry.	0-30	4-55	8-13	88-2
2.3. I-PK: Intelligent pedagogical knowledge (strategic designer). Values the creation process (prompt refinement, critique of results) not just the final image of the metaphor. Uses AI to create different levels of complexity in visual	0-32	4-63	2-12	93-3

metaphors, adapting to profiles and prior knowledge. Reflects on how interaction with AI influences the creative process and understanding of the concept of audiovisual content accessibility, image textual

description, visual alternatives, and playback and interaction control using educational audiovisual robotics.

2.4. HAIC-K: Human-AI collaborative knowledge. Applies AI as a "co-creator" or "simulation partner" that helps visualize ideas and acts as the creative director. Classroom culture in which ethics take precedence over AI suggestions. Maintains original ideas through an iterative process of co-creation and refinement.

2.5 ETHICs-K: Ethical knowledge. Visual metaphors should not reinforce biases related to gender, race, or socioeconomic status. Usage protocols must include disclosure of AI involvement in the creation process, and adherence to copyright and privacy rights must be respected.

Source(s): Soto-Solier P. M. (2026).

Knowledge assessment outcomes based on the I-TPACK model reveal significant improvement following implementation of the intervention program. Initially, between 88% and 94% of participants were rated as "none" (1). Following the intervention, 88% reached satisfactory levels (3–4) in I-TK (2.1) which pertains to refining strategic prompts for the creation of visual metaphors. Further, 85% demonstrated critical awareness when identifying AI biases (I-CK: 2.2). The highest success rate corresponded to I-PK (2.3), with 95% of students being rated as 3 and 4 for effectively integrating robotics and pedagogy. Further, 94% of participants were able to act competently as creative designers in interactive processes (HAIC-K: 2.4). Lastly, ETHICS-K (2.5) stood out with 37% of participants achieving excellence (4) in ethical commitment and respect for copyright.

6. Discussion and conclusion

Present research findings confirm that visual arts didactics, the STEAM approach, and the I-TPACK model can be effectively combined in teacher training. Findings demonstrate that integrating artificial intelligence (AI) and educational audiovisual robotics not only enhances technical competencies but also transforms the professional identity of future educators—shifting from a merely instrumental use of technology towards an artistic and symbolic one.

In relation to the interdisciplinary approach, findings confirm that incorporating the "A" (Arts) into the STEAM model provides a holistic perspective that blends creative knowledge with technical disciplines. As noted by Colucci-Gray et al. (2019) and Diego-Mantecón et al. (2021), such projects foster aesthetic sensitivity and innovation, overcoming the fragmentation of knowledge. The presented experience shows that teachers must integrate creative thinking into pedagogical strategies mediated by technology, aligning with the TPACK framework by Mishra and Koehler (2006).

A key finding is the progression in intelligent technological knowledge (I-TK) and intelligent content knowledge (I-CK). While most participants initially had minimal knowledge in these areas, the intervention brought about significant improvements in terms of prompt creation. This advancement supports Chiu's (2026) conception of the I-TPACK model, which positions AI literacy as an essential teaching competency in the digital age. However, the present research also reveals critical evaluation of algorithmic outcomes, such as identifying errors, absurd

compositions and elements that are incongruent with the narrative, as the area with the most room for improvement. This aligns with that cautioned by Flores-Vivar and García-Peñalvo (2023), who emphasize that AI, unlike human educators, lacks the empathy and intuition needed to serve as a fully inspirational source.

In the field of creation, the use of generative AI has proven to be a valuable tool for "computational creativity," enabling students to act as creative experts. The quality of the visual metaphors produced reinforces the findings of Marín-Viadel et al. (2024) regarding the didactic potential of platforms such as Stable Diffusion and DALL·E for learning stylistic patterns and generating complex visual narratives. This Human-AI collaboration (HAIC-K), in which students demonstrated reasonable mastery, suggests a profound redefinition of authorship in the context of contemporary digital creation.

On the other hand, transposition from a digital image to a robotized object-poem enabled effective interaction between body and space. Robotics, far from being solely an engineering field, is consolidated as a means of artistic expression—"Art Robot"—that fosters social critique and imaginative exploration, as proposed by Kac (2021). The fact that future educators felt competent when programming with mBlock 5, validates the idea that block-based visual languages facilitate the communication of metaphorical 3D messages.

Finally, the themes chosen by students, such as the commodification of childhood, cyberbullying and sustainability, demonstrate that ABP-STEAM is an effective methodology for fostering social engagement. By placing the student at the center of the process when addressing real-world problems, this approach fulfills UNESCO's (2016/2023) guidelines on the development of critical and reflective thinking. The ethical dimension, in which a significant number of students achieved excellence, confirms that teacher training must prioritize bias mitigation and respect for copyright in the use of emerging technologies. In conclusion, present research shows that the hybridization of art and technology within digital humanities laboratories represents a key pathway towards critical and empowering visual and digital literacy.

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