TRANSDISCIPLINARY TECHNO-ARTISTIC EXPERIENCE IN UNIVERSITY TEACHER TRAINING

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Abstract

This study presents a transdisciplinary techno-artistic experience conducted with students of the degree in Preschool Education from the University of Valencia. The experience seeks to promote the use of technologies with a contemporary approach through new creative forms such as sound-visual cartographies. The objective is to understand the students' perception of these transdisciplinary experiences that combine art and technology and to evaluate the contribution of new knowledge, ICT skills, and reflection in the teaching and learning process. To evaluate the practice, a validated questionnaire was applied to 120 students, using a quantitative methodology with 8 scales and a total of 48 items. The analysis dimensions are the following: developed reflective skills, levels of reflective thinking, learning process, awareness of students' own learning, the role of the teacher, connection of theory and practice in learning and experience, and innovation and adaptation to teaching objectives and competences. The results show how the activity helps university students acquire digital skills, develop their creativity, and understand the process of autonomous technological learning and reflective self-awareness, as well as the value of collaborative group work.

Keywords – Techno-artistic experience, Sound-visual cartographies, Transdisciplinarity, Reflexivity, Teacher training, ICT.

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1. Introduction

Information and communication technologies (ICT) have become essential resources in education and in the development of active learning methodologies (Gómez-Pablos & García-Barrera, 2023; Grávalos-Gastaminza, Hernández-Garrido & Pérez-Calañas, 2022). In teacher training, possessing strong digital skills is crucial for enabling active participation in educational settings that are increasingly influenced by technology. According to Aparicio-Gómez, Ostos-Ortiz and Abadía-García (2024), in the current educational environment, the driving force of change in university education is marked by the convergence of emerging technologies and methodologies in which students actively participate in their

own learning process (Aparicio-Gómez et al., 2024: page 31). Therefore, it becomes essential for future teachers to know how to effectively integrate these skills into teaching practices to enhance the teaching and learning process (Presas, Acuña & Rodríguez, 2023; Recio-Muñoz, Silva & Abricot, 2020; Ruiz-Cabezas, Medina, Pérez & Medina, 2020). To do so, there are reference frameworks and standards, developed by different national and international organizations (García-Ruiz, Buenestado-Fernández & Ramírez-Montoya, 2023; Redecker, 2017; INTEF, 2017; UNESCO, 2019; International Society for Technology in Education (ISTE), 2017, 2018), that allow us to understand and evaluate these competences.

The purpose of this study is to show the results of an artistic practice that combines various techniques and technologies using a transdisciplinary approach. This activity is linked to the international Textile Cartographies project of the Associação de Professores de Expressão e Comunicação Visual (https://textilecartographies.weebly.com/), in which 18 countries are involved. The project uses cartographies and sound to create proposals that encourage critical thinking and explore contemporary aesthetic paradigms. It also focuses on sustainability training and how to integrate it into professional activity (Valderrama-Hernández, Alcántara-Rubio, Sánchez-Carracedo, Caballero, Serrate, Gil-Doménech et al., 2020). Students are invited to work with tangible (fabric) and intangible (digital) materials to obtain knowledge beyond their immediate environment. The experience involves sewing textile items by hand and promoting active listening through QR codes, helping students become more aware of their learning process (Gardner & Brown, 2019) and their limitations.

Another goal of this study is to offer an innovative pedagogical experience that aligns with teaching objectives and competences by providing students with the necessary skills for academic production and professional development; reflective thinking (Sabariego-Puig, 2018; Soto-González, Rodríguez-López & Renovell-Rico, 2023). This involves encouraging the use of digital tools and media to enhance students' technological skills and introducing them to contemporary creation and culture through a cultural semiotics approach (Ojamaa, Torop, Fadeev, Milyakina, Pilipoveca & Rickberg, 2019; Ramon & Vidagañ, 2020; Rodríguez-López & Soto-González, 2023). It also aims to "rearticulate the teaching of art based on the variation that artistic practices have undergone" (González, 2016: page 43), in the face of the new digital paradigm.

The technological tools used in the proposal are the following:

Sodaphonic (n.d.), easy-to-use online application for simple audio recording and editing. It allows users to record, cut, normalize the volume, apply effects such as Fade-in and Fade-out, and export sounds in MP3 and WAV format.

Sonic Visualiser (Versión 3.3) (Sonic Visualiser, 2019), a sound editing tool based on the visualization of the different sound parameters. It generates graphs in layer mode that can record aspects such as waveforms and spectrograms, with variations in frequency, sound intensities, and notation. This application offers students the knowledge of sound in relation to its acoustic qualities and its graphic representation. At the same time, it allows users to export the images by making changes to their colors and the level of detail of each selected sample. It is used in research methodologies that analyze the sonority factors of the sound of musical pieces (Bragagnolo & Guigue, 2020).

Wordpress (Versión 5.4.9) (Wordpress, 2022), web content management system (CMS) that allows the creation of multimedia information by users without programming knowledge. The interface design offers various customization options, and the downloadable version allows users to install extensions or plugins for additional functionalities like playing sounds or creating image galleries.

QR Code Generator (n.d.), online application for creating QR codes that link to content in the form of URL, text, SMS, etc. In its free version, users can change the color, select the frame from several models and save the code as a PNG image. QR codes allow educators to create educational content focused on

ubiquitous learning (Chin, Lee & Chen, 2015; Riofrío-Orozco, Moscoso-Parra & Garzón-Montealegre, 2018).

2. Literature Review
2.1. ICTs and Artistic Teachings

Digital skills are crucial for using ICT in the teaching and learning process (Rodríguez-López & Soto-González, 2023; Alonso-García, Victoria-Maldonado, Martínez-Domingo & Berral-Ortiz, 2024). This is because technology has significantly influenced education, resulting in innovative approaches in art education that rely more and more on digital resources (Bravo-Villares & Fernández-Sánchez, 2022). According to González (2016), "The digital hypermediation that we currently experience transforms artistic practices and, consequently, the way of approaching how we teach them" (González, 2016: page 49). In this regard, university education should take steps to enhance digital skills in line with modern cultural trends. This should include incorporating various languages and artistic forms of expression (González-Zamar, Abad-Segura & Gallardo-Pérez, 2021). These efforts are essential for addressing the challenges of educating students in a technology-driven society saturated with images, sounds and devices that now operate with multimedia languages. In this regard, students will require a specific literacy if they are to understand the meaning models of the media (Bonilla-del-Río & Aguaded, 2018), which are increasingly ubiquitous and omnipresent.

González-Zamar, Abad-Segura, Luque de la Rosa and López-Meneses (2020) emphasize the importance of a technological shift in university education, updating both content and teaching methods to align with a society undergoing continuous change. Furthermore, Cañete-Estigarribia, Torres-Gastelú, Lagunes-Domínguez and Gómez-García (2022) highlight the need for providing students with early education in digital skills that are tailored to their academic environment. This approach aims to foster meaningful learning outcomes.

However, this digitalization process does not solely depend on technologies. It must also be accompanied by other processes of cultural, social, and organizational change, among others (González-Zamar et al. 2020). From the perspective of artistic education, it is key to connect pedagogies to contemporary hybrid paradigms that amplify communicative competences and social skills (Masgrau-Juanola & Kunde, 2018; Gardner & Brown, 2019; Lilly & Hung-Min, 2022; Rodríguez-López, 2017), and to also understand the expressiveness and receptivity generated by each technology (Caeiro-Rodríguez, Ordoñez-Fernández, Callejón-Chinchilla & Castro-León, 2020). Digitalization produces multilayer interactive content with physical-digital hybridizations that create complex experiences (Rodríguez-López, 2019), provide languages that extend modes of meaning (Guarinos, 2007; Huerta & Soto-González, 2022), and also offer creative possibilities through tools and easily accessible means. In this sense, artistic teachings can exploit the potential of digital applications in their practices, to explore sound and visual languages that activate knowledge, thoughts, and creative uses of technologies in a situated way (Rodríguez-López & Soto-González, 2023).

With all this in mind, we must educate in understanding and expression. This involves innovating towards a multimodal discursivity, as well as improving teacher training programs by incorporating digital tools within multimodal discourses to drive social change, as outlined by the European Framework for Digital Competence of Teachers of the European Commission (Redecker & Punie, 2017). All of this while taking into account that in their future teaching practice, teachers can contribute to the training of students to become digitally competent citizens (Urbina, Pérez-Garcias & Ramírez-Mera, 2022).

2.2. Artistic Strategies: Cartographies and Sound

Cartographies as a conceptual and aesthetic strategy have been used in other studies to show the experiences of students. Its use is highlighted "for the evaluation of ephemeral processual experiences of students such as dérive or other learning" (Alonso-Sanz, 2020: page 383), as well as for "cartographic strategies in the personal and professional knowledge of teachers" (Rivillas, 2021: page 49), or with the

aim of drawing particular cartographies by mapping spaces of symbolization, weaving a network of connection (Omega, Porta & Vergara, 2021; Rodríguez-López & Soto-González, 2023).

Sound enables the creation of a conceptual interconnection in teaching practices and sound art stimulates "a realm of imaginary listening, where what we understand by sound is also shaped through the intellectual and etheric, from passions and fears, from emotions and the worlds of the imagination" (Isaza, 2015: para. 11). The idea of extending visual information through sound and mobile devices has been explored in various formats such as podcasts for educational purposes (Celaya, Ramírez-Montoya, Naval & Arbués, 2020) or audio guides, informational models based on listening, commonly used in museums and in artistic projects with applications that locate content. An example of this can be found in NoTour, a device created by the artistic collective escoitar.org, under the concept of augmented aurality (Soria-Martínez, 2017).

In the context of education, educational experiences often utilize audio guides and other forms of sound content access as valuable tools in the learning process. These tools complement knowledge creation and help students engage with technology. In this regard, QR codes are particularly noteworthy for their user-friendly nature and adaptability, enhancing students' pedagogical experiences and fostering new skills through ubiquitous learning. This approach also provides access to multimedia content, enriching the overall learning experience (López-Llarena, 2018; Raviña-Rosende, 2017; Omega et al., 2021; González-Zamar et al., 2021).

In relation to the experiences that combine cartography and sound, Wargo (2018) conducted a project titled #SoundingOutMySilence. This project presents a unique approach by using sound to map out stories, aiming to capture the essence of adolescent life experiences.

2.3. Reflective Thinking and Transdisciplinarity

Promoting reflective thinking helps incorporate "metacognitive processes as a driving force in raising awareness and analyzing teaching practices" (Recio-Muñoz & Joo-Nagata, 2021: page 109). Therefore, this specific transdisciplinary cartography activity (TCA) is planned, designed, and developed within a reflective learning environment, incorporating innovative pedagogical approaches and methods that use digital technologies. To do this, a series of cognitive and technological skills are deployed, as well as theoretical knowledge, in order to provide logic and meaning to the processes involved, thus facilitating their understanding (Ryan, 2015; Schön, 1992).

Transdisciplinary methodologies have proven to be very useful for developing reflective learning in students (Renovell & Soto-González, 2018; Soto-González, 2023). We incorporate the term transdisciplinarity according to De Toro (2007), who understands it as "resorting to the use of models from different disciplines and theories (...), or to specific units or elements from them, to help understand, decode, and interpret the object being analyzed" (De Toro, 2007: page 24).

3. Methodology
3.1. Objectives

The activity seeks to encourage students from the degree in Preschool Education to use technologies with a contemporary artistic approach and the proposal of new creative forms. The objectives of this study are to understand the students' perception of the transdisciplinary activity and to evaluate whether these experiences provide reflexivity in the teaching-learning process, as well as the acquisition of ICT skills.

3.2. Participants

The sample consists of 120 third-year students enrolled in the subject "Didactics of Plastic and Visual Education in Early Childhood Education" for the academic year 2022-23. The average age of the participating students is 22.11 (SD = 2.88), with an age range of 19 to 37 years, of which 112 are women (93 %) and 8 men (7 %).

3.3. Information Collection Instrument

The research methodology is quantitative. The data collection instrument focuses on a validated questionnaire (Sabariego-Puig, Sánchez-Martí, Ruíz-Bueno & Sánchez-Santamaría, 2020) on the transdisciplinary cartography activity (TCA), with 8 scales and 48 items. With regard to the original questionnaire, a slight modification has been made in dimension 1, reducing the number of items from 7 to 5, which have then been added into dimension 3. The data analysis software used is SPSS 23.0, licensed by the University of Valencia. A reliability analysis is also carried out for the internal consistency of the scales using Cronbach's alpha (Rodríguez-Rodríguez & Reguant-Álvarez, 2020).

The 8 scales used are the following: feeling of the students when carrying out the tasks (5 items); developed reflective skills (7 items); levels of reflective thinking (12 items); learning process (autonomy and reflective self-knowledge) (6 items); awareness of their own learning (8 items); the role of the teacher (6 items); connection of theory and practice in learning and experience (1 item); and innovation and adaptation to teaching objectives and competences (3 items). The items are answered using a Likert-type scale with numerical values from 1 to 5, with 1 being the lowest value (never) and 5 the highest (always).

3.4. Procedure

First, the theoretical and procedural part of the activity was explained to the students, using presentations and web resources, in the form of video tutorials on YouTube, and links to useful content (Rodríguez-López, 2019). Furthermore, an introduction to sound art and the Textile Cartographies project (https://textilecartographies.weebly.com/) and its social, critical, and participatory dimension was given. Information on the Sustainable Development Goals (SDGs) and links to consult data available on the internet were also offered (https://www.un.org/sustainabledevelopment/es/objetivos-de-desarrollo-sostenible/). Subsequently, the students participating in the research were provided with two documents: the questionnaire and the corresponding informed consent form that included the description of the study and requested voluntary participation. According to Nunnaly, self-report scales or questionnaires have limitations and disadvantages when used for educational evaluations. However, they constitute one of the best possible approaches. The measurement instrument has good psychometric properties, given that it is adapted and validated in a similar study population and also specifies the evaluation indicators in its objectives, being sensitive to changes in the dimensions that are the object of measurement.

Activity Design.

- Creation of a narrative about one of the sustainable development goals (Agenda 2030, 2021).
- Recording of the narrative and subsequent exporting of an MP3 file, using the online tool Sodaphonic.
- Capturing the image of the sound wave through the Sonic Visualiser program, and creating the textile cartography by transferring it to the cloth: visuality and sonority of the work.
- Wordpress content manager, with Back-end access or the administrative part of the website, to publish the student's own post or entry. Creating a QR Code Generator that is linked to the sound and is later attached to the textile cartography for listening to the sound narration using a mobile device.

Student data for the transdisciplinary cartography activity was collected by filling out a validated questionnaire online using Google Forms.

4. Results

The completion of the TCA resulted in the students creating 120 artistic pieces and answering 120 questionnaires.

The analysis of the questionnaires shows us the following results:

The mean value of the dimensions ranges from a maximum of 4.19 for the Theory-Practice Relationship dimension to a minimum of 3.16 for the Levels of Reflective Thinking dimension. The distribution of responses for the dimensions does not exceed one standard deviation. There are 8 dimensions that are between 0.762 and 0.899 and one dimension minimally exceeds 1.005. The questionnaire's alpha is 0.942.

The latent variables of the questionnaire have response values between 1 and 5. The total number of items is 48. The average ranges from a maximum of 4.49 for the item "Create an environment of trust in the classroom" and a minimum of 2.60 for the item "When I was working on the proposed tasks, I was able to do it without thinking about what I was doing" and the distribution of responses for the variables does not exceed one standard deviation except for nine items out of 48, ranging from 1,017 to 1,137. The questionnaire's alpha is 0.942 and the Cronbach's alpha based on standardized items is 0.942.

Table 1 illustrates the students' feelings when carrying out the TCA. Through mean value interpretation (on a Likert scale of 1 to 5) we can observe that the activity elicited high levels of curiosity (4.31), surprise (4.09) and enthusiasm (3.95). The standard deviations (>1) indicate a certain deviation of the data, but in no case is it higher than the mean.

Items	Mean	Deviation
1.1. Curiosity	4.31	0.825
1.2. Enthusiasm	3.95	0.849
1.3. Surprise	4.09	0.982
1.4. Confidence	3.26	0.941
1.5. Confusion	3.30	1.085

Table 1. Statistics of scale 1 of the questionnaire "Feelings of the students when carrying out the tasks" (Sabariego-Puig et al., 2020; Sabariego-Puig, Sánchez-Martí & Cano-Hila, 2019)

Table 2 shows the reflective skills developed by the students through the TCA, based on the significant understanding of knowledge and its connection with experience, in addition to the personal reflective process regarding learning and its own regulation. The mean values obtained in all the answers are high, between 4.28 and 3.70, with a standard deviation in all items <1.

Items	Mean	Deviation
2.1. Reflect on the meaning of what I learn	3.98	0.820
2.2. Argue and question what I am learning	3.89	0.879
2.3. Be aware of how to transfer what I am learning to my future professional practice or alternative spaces (internship or other subjects)	3.97	0.914
2.4. Connect knowledge with my own experiences, emotions, and attitudes	3.94	0.854
2.5. Learn from myself, from what I already know	4.02	0.910
2.6. Enrich my ideas with the contributions of others	4.28	0.775

Table 2. Statistics for scale 2 of the questionnaire "Developed reflective skills" (Sabariego-Puig et al., 2020; Sabariego-Puig et al., 2019)

Regarding the Levels of reflective thinking (Table 3), a greater dispersion is seen in the responses of some of the items, with a standard deviation between 0.842 and 1.119.

The results show that the highest values are obtained in the statements which address the need to understand the content (items 3.2, 3.5 and 3.8), with means of 3.78, 3.98 and 3.65, respectively. The items that address questioning one's ideas (3.6), the way one looks at oneself (3.3), and the usual way of doing things (3.9) obtain lower means, with values of 2.76, 2.89 and 2.84. However, the item related to discovering previously unknown weaknesses (3.12) obtains a 3.46.

The data for the four items indirectly formulated to assess the activity's difficulty level in relation to the students' ICT skills indicate more moderate means. Items 3.1, 3.7 and 3.11, which deal with doing the task without thinking, thinking about the content, and thinking continuously, obtain values of 2.60, 2.91 and 3.21. In general, the results suggest that the TCA requires cognitive effort to follow the process and complete the task correctly.

Items	Mean	Deviation
3.1. When I was working on the proposed tasks, I was able to do it without thinking about what I was doing.	2.60	1.091
3.2. The proposed tasks forced us to understand the content that was taught.	3.78	0.842
3.3. The tasks proposed in the subject have made me change the way I look at myself.	2.89	1.049
3.4. In this subject we have done the tasks so many times that in the end I have managed to do them without thinking too much.	2.67	1.017
3.5. To pass the proposed tasks it was necessary to understand the content.	3.98	0.947
3.6. The tasks proposed in the course have questioned some of my most fixed ideas.	2.76	1.119
3.7. In the proposed tasks, as long as the content worked on could be remembered, I did not have to think too much.	2.91	0.906
3.8. I needed to understand the content worked on in class to carry out the proposed tasks.	3.65	0.977
3.9. The proposed tasks have changed my usual way of doing things.	2.84	1.066
3.10. If I followed what was said/asked, I did not need to think too much to carry out the proposed tasks.	3.17	0.985
3.11. In the proposed tasks I had to continually think about the content that I was being taught.	3.21	0.952
3.12. During these tasks I have discovered weaknesses that I was unaware of before.	3.46	1.111

Table 3. Statistics of scale 3 of the questionnaire "Levels of reflective thinking"
(Sabariego-Puig et al., 2020; Sabariego-Puig et al., 2019)

Next, Table 4 shows the scores on awareness of the learning process. Interpreting the mean values, we can conclude that the TCA requires students to be more creative to solve difficulties (4.26) and effort and individual work (4.16). It also requires students to find solutions during the process (4.15), which means getting more involved in the work (4.21). Likewise, the students recognize, with high scores, the need to plan their work (3.96) and be constant and perseverant (4.06), in order to carry out a successful learning process.

Items	Mean	Deviation
4.1. Know how to plan my work independently	3.96	0.986
4.2. Be more persevering when doing work and learning	4.06	0.922
4.3. Be more creative to solve my difficulties	4.26	0.892
4.4. Try harder to learn by myself	4.16	0.956
4.5. Have a greater involvement in my work	4.21	0.869
4.6. Apply solutions to solve the questions that I have	4.15	0.903

Table 4. Statistics for scale 4 of the questionnaire "Learning process"
(Sabariego-Puig et al., 2020; Sabariego-Puig et al., 2019)

Regarding students' competency development and their awareness as shown in Table 5, we see highly positive evaluations. The means of its items are in the range of 3.82 to 4.53, and the standard deviation is, except for one item, < 1. The students favorably rate how these methodologies help them recognize their skills in the field and in their future careers. It also assists them in identifying their personal strengths and weaknesses. Another high average is obtained in the item that recognizes the importance of teamwork for better learning (4.53) and the value of storytelling in all its formats (oral, written, and visual) (4.27), which

can be an important tool to improve their communication and technological competence as a future educational professional.

Items	Mean	Deviation
5.1. Become aware of what I have to improve professionally and/or as a student	3.82	1.022
5.2. Better understand the complexity of my future professional practice	3.97	0.923
5.3. Reflect to get to know myself better as a future professional	3.93	0.953
5.4. Become aware of my difficulties in the learning process	4.03	0.866
5.5. Know my strengths in the learning process	4.13	0.856
5.6. Give value to storytelling (oral, written, and visual) to communicate	4.27	0.877
5.7. Recognize teamwork for better learning	4.53	0.651
5.8. Become aware of how I learn	4.10	0.894

Table 5. Statistics for scale 5 of the questionnaire "Awareness of their own learning"
(Sabariego-Puig et al., 2020; Sabariego-Puig et al., 2019)

The analysis of Table 6 reveals the students' perception of the teaching role. It indicates high means for creating an environment of trust at 4.49 and allowing students to act independently at 4.28. Additionally, students value leaving time for group reflection (4.25) and to ask questions (4.12). It is also worth highlighting the importance given to teachers providing clear instructions to carry out the task (4.09).

Items	Mean	Deviation
6.1. Facilitate clear instructions	4.09	0.925
6.2. Give constructive feedback on work done	3.67	1.137
6.3. Help me think and ask questions	4.12	0.832
6.4. Create an environment of trust in the classroom	4.49	0.715
6.5. Provide spaces to expand and develop ideas with others (in interactions and through group discussion)	4.25	0.765
6.6. Allow to act independently	4.28	0.797

Table 6. Statistics for scale 6 of the questionnaire "The role of the teacher"
(Sabariego-Puig et al. 2020; Sabariego-Puig et al., 2019)

Table 7 refers to the connection between theory and practice and one's own experience in learning. This item obtains a high average of 4.19.

Items	Half	Deviation
7.1. Learn by connecting theory with practice and one's own experience	4.19	0.798

Table 7. Statistics for scale 7 of the questionnaire "Connection of theory and practice in learning and experience"
(Sabariego-Puig et al., 2020; Sabariego-Puig et al., 2019)

To conclude the analysis, Table 8 shows us how students perceive the innovative aspects of the TCA and its alignment with teaching objectives and competences. High means are observed in all items. Specifically, an average score of 4.21 is achieved for the item concerning the novelty of storytelling as a form of communication (8.1), 4.05 for evaluating the TCA's role in achieving learning objectives (8.2), and 3.99 for assessing the relevance of skills acquired for their future careers (8.3).

Items	Mean	Deviation
8.1. The novelty of storytelling to express myself	4.21	0.797
8.2. The relevance to complete the learning objectives of the subject	4.05	0.741
8.3. Suitability for my future professional skills	3.99	0.749

Table 8. Statistics for scale 8 of the questionnaire "Innovation and adaptation to teaching objectives and competences" (Sabariego-Puig et al., 2020; Sabariego-Puig et al., 2019)

5. Conclusions

The results of this study show that transdisciplinary artistic practices enhance ICT knowledge, reflective thinking and creativity in teacher training, aligning with the intended goal. These innovative practices are valuable in university training, where the demand for digital and creative skills in teaching-learning processes is growing (Recio-Muñoz et al., 2020; Ruiz-Cabezas et al., 2020). Artistic education educates in media languages, modes of communication and digital aesthetics, fostering students' creativity and equipping them with the ability to understand and develop situated educational actions (Huerta & Soto-González, 2022; Recio-Muñoz et al., 2020; Ruiz-Cabezas et al., 2020). In addition, these practices support the integration of metacognitive processes as a key factor in increasing awareness and analyzing students' own teaching practices (Recio-Muñoz & Joo-Nagata, 2021).

From the analysis of the questionnaire the following contributions have been extracted:

- With regard to feelings, the TCA has elicited great curiosity and surprise, necessary factors for motivation and openness to new knowledge. This relates to the idea of Cañete-Estigarribia et al. (2022) of seeking interest and motivation through experience with technologies.

- It encourages reflection on what has been learned, the connection of knowledge with one's own experiences and the enrichment of ideas with the contribution of others. It also makes students aware of how to transfer what they have learned to their future professional practice.

- It shows students' limitations in terms of ICT knowledge, helping them discover weaknesses that they were previously unaware of when carrying out the activity. The tasks force them to reflect, think, and follow instructions to understand the content. It is confirmed that this type of technological activities is new to them, they have a higher level of complexity, demanding greater concentration and attention during the task. Through its management, the ICT competency dimension is amplified.

- It promotes creativity in problem-solving, requiring perseverance and autonomous work planning.

- It helps students become aware of the difficulties in the learning process and to better understand their weaknesses and strengths; to value the communication potential of storytelling (oral, written, technological and visual) and teamwork, to improve learning and social and technological skills.

- It introduces the analysis of the teaching role, focusing on important factors such as: creating an environment of trust in the classroom, allowing students to act independently, leaving time for group reflection and asking questions, and setting clear instructions for the correct completion of the activity. These contributions evaluate the design of the activity and the aspects that could be improved upon.

- It supports learning by connecting theory with practice and one's own experience. According to Sabariego-Puig et al. (2019), it is about "aiming at a notion of knowledge that is neither knowledge nor theory: it is knowledge that is constructed from meanings and cannot be separated from experience" (Sabariego-Puig et al., 2019: page 826).

- It contributes to the innovation process in the artistic training of teachers. Positive evaluations show that the tasks align well with teaching objectives and competences, are effective in assessing learning, and enhance the development of professional skills. This indicates the effectiveness of

using transdisciplinary methods, technology, and reflective thinking in teaching content to help future teachers acquire professional competencies.

The data obtained places the TCA in the set of actions that seek to adapt content and methodologies to the highly digitalized social context (González-Zamar et al., 2020). The visual-sound cartographic practice introduces students to the management of concepts, symbols and innovative technological tools that require a high degree of motivation and attention. It also serves as a strategy to evaluate personal and professional experience and self-knowledge (Alonso-Sanz, 2020; Rivillas, 2021). For its part, the completion of works as tangible and accessible pieces online (Rodríguez-López, n.d.) signifies ubiquitous learning that extends the potential of artistic education (González-Zamar et al., 2021), as well as entailing the promotion of new creative forms and the use of technologies with contemporary approaches.

In the transdisciplinary cartography activity, a complex technical, conceptual, and creative process is developed, which brings students closer to aspects of sound such as the analysis of its acoustic values, its sonority, represented in waveform through the Sonic Visualiser software (Bragagnolo & Guigue 2020), and the translation of sound images to textiles through the manual practice of sewing. Without forgetting the publication of online content with the Wordpress platform, under the role of creators. At the same time, it works on sustainability themes that connect pedagogical work to critical and social awareness (Valderrama-Hernández et al., 2020), and encourages reflective thinking, providing students with a self-awareness of what has been learned through the teaching-learning process (Gardner & Brown, 2019), as well as the limits of their ICT competences.

Technologies enable the development of innovative training scenarios where students are at the center of the learning process. This approach emphasizes collaborative and social learning over individual learning, incorporates a variety of information sources and interactions, utilizes new learning tools and symbolic systems, and empowers students to create mediated messages (Cabero-Almenara & Llorente-Cejudo, 2015).

In conclusion, the results from the digital-textile projects and the positive feedback from students regarding the TCA indicate that these experiences are both feasible and effective, despite the limitations due to the students' lack of prior technological knowledge, which has extended the activity duration. Students enhance their creativity as they explore new ways of creating and thinking about solutions. Additionally, they develop reflective skills related to the teaching-learning process and the acquisition of ICT skills, contributing to their media literacy (Bonilla-del-Río & Aguaded, 2018) and knowledge of languages and symbolic creation processes (they incorporate technical and aesthetic skills). It is also worth mentioning that students further enhance their communication and social skills through collaborative group work and discussions on topics related to the Sustainable Development Goals, highlighting how transdisciplinary cartography activities "have been conceived as social and emotional experiences to encourage students' mediation with themselves and others" (Sabariego et al., 2019: page 827).

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The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Institutional Review Board Statement

The study was carried out in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of the University of Valencia (protocol code -2637453 and approval date: June 6, 2023).

Informed consent statement

Informed consent was obtained from all people involved in the study.

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