

Interactive Tapestry To Raise Marine Noise Pollution Awareness Among Teens

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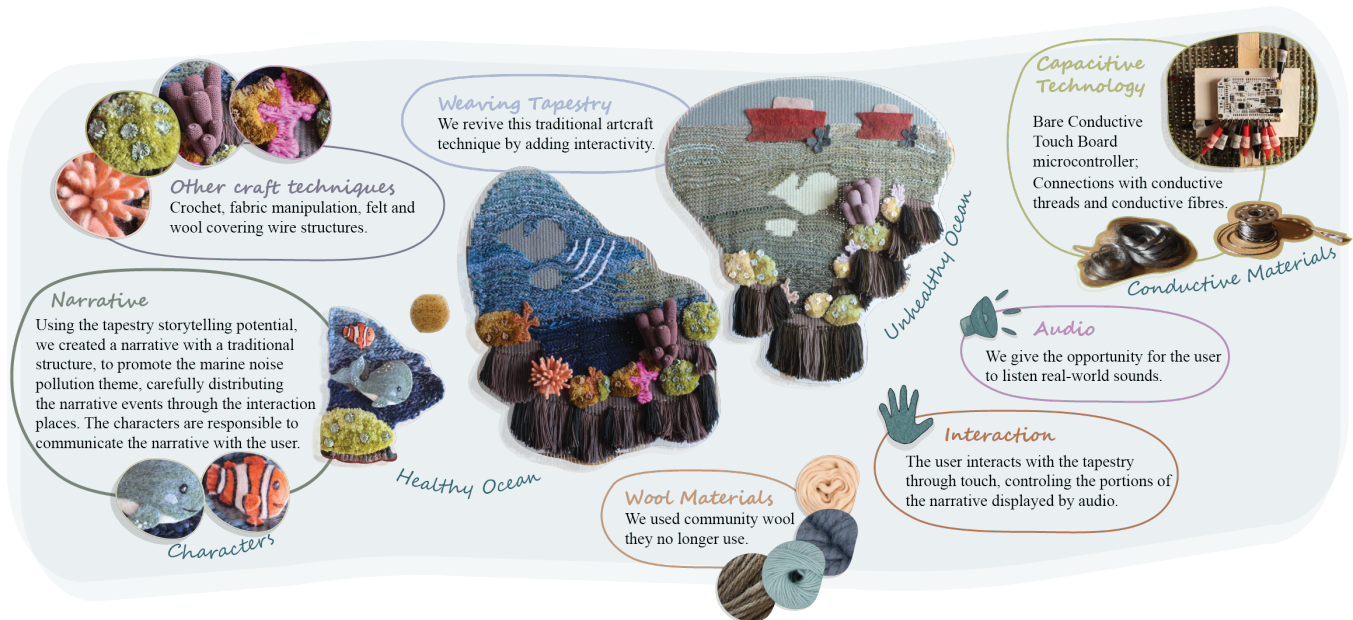


Figure 1: The tapestry employed a user-centred approach in its design and implementation. We developed the visuals and crafted elements to support the narrative plot about marine noise pollution. The experience also incorporates tangible interfaces, audio and sensors to engage the users and sensitise them to this topic.

Abstract

Marine noise pollution is an increasing issue that disrupts marine life communication, causes behaviour displacement of habitats, and threatens marine life ecosystems. Despite adolescents'

general awareness of environmental problems, this issue remains overlooked mainly within the school context. To address this gap, we developed an interactive tapestry that integrates storytelling with capacitive technology, engaging adolescents through touch and auditory features to enhance their understanding of marine noise pollution. An exploratory study showcased promising results, demonstrating the potential of interactive tapestries as effective tools for raising awareness of this issue among adolescents.

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CCS Concepts

• **Human-centered computing** → **Interaction design**; *Empirical studies in interaction design*.

Keywords

Tapestry, Tangible Interfaces, Teens, Marine Noise Pollution

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1 Introduction

Marine noise pollution is a growing problem that harms marine life ecosystems. Human activities in the ocean can disturb, harm, and sometimes even kill many marine animals [1, 4, 6]. However, while environmental issues and pollution are recurring topics at different school levels, marine noise pollution is generally not part of this discourse. By introducing this topic to students, they can better understand how to avoid disrupting marine life. Interactive tangible experiences have proven beneficial for encouraging active learning and allow students to perceive content knowledge through multiple sensory layers [9, 17].

Researchers and creators are developing Tangible User Interfaces (TUIs) with narrative storytelling as a medium for novel interaction. Traditional art craft [8, 16] as TUIs are being explored, giving new life to different techniques. Artists and artisans frequently express their messages through their artworks, sometimes focusing on critical environmental issues, as in the artworks of Vanessa Barragão [3] and Alexandra Kehayoglou [12]. Since the tapestry technique has served to tell stories through its colours and forms [13, 21], we were inspired to revive this technique to provide an essential environmental message to our audience and seamlessly integrate capacitive technology, allowing touch and exploration.

As the world tends to use technology, adolescents spend much time on screens. This work offers a break from the digital world, allowing for more analogue, hands-on creativity. In a time when screen fatigue is becoming a real issue, engaging with tactile, sensory art could help. In this context, we designed and developed a tapestry that integrates capacitive technology within the weaving tapestry technique, allowing users to explore a narrative about marine noise pollution through touch, using the textures and colours to evoke a sense of connection to nature, encouraging teens to consider sustainability, environmental consciousness, and the natural world, while using an artefact that joins a traditional art craft, storytelling and technology.

2 Literature Review

Due to anthropogenic activities, marine noise pollution significantly disrupts whales and other cetaceans, which rely on high-frequency sounds to communicate across vast distances [1]. They use sound for their daily life survival [15]. The noise generated by human intervention is louder and more intrusive, deeply affecting marine ecosystems [4, 6]. Whales play a vital role in these ecosystems by

storing substantial amounts of carbon dioxide, contributing to climate change mitigation [11]. The school curriculum of our region does warn our children and adolescents about environmental problems. However, they do not discuss marine noise pollution in their school curriculum, which reflects the urge for us to develop tools that enrich their education. For that, tangible experiences proved to be a beneficial medium by encouraging active learning and allowing students to explore and perceive the content knowledge through multiple sensory layers [9, 17].

TUIs represent a novel interaction based on the physical manipulation of everyday objects. TUIs focus on using interfaces that do not need the traditional mouse and keyboard to interact with but with direct touch and manipulation of physical objects, taking advantage of their physical attributes and exploring embodiment and human behaviour [10, 14]. We perceive our world through haptic interaction, making it crucial to interact with our surrounding objects with our hands [2]. Researchers and creators are developing TUIs for storytelling, using different techniques [5], traditional art crafts [8, 16], and physical touch through capacitive technology, unveiling hidden narratives, and promoting engagement and other interest and curiosity in exploring these types of interfaces. This way, we used our tangible interface allied with narrative storytelling to raise awareness of a critical environmental issue.

3 Interactive Tapestry Design

Tapest[o]ry is an interactive weaving tapestry seamlessly integrating electronic components to allow user interaction while exploring a narrative about marine noise pollution (see Figure 1). This project's concept and design process has already been published [19]. To support the understanding of the user experience and design decisions, Figure 2 summarises the interaction flow. We carefully designed each of the 11 interaction points, considering the use of sensors and audio elements. We planned these interactions to deliver information on marine noise pollution in manageable portions closely aligned with the narrative structure. In addition, the figure illustrates how users receive contextual feedback based on the state of the ocean environment (healthy or polluted), determined by the placement of removable items within the tapestry.

4 Methodology

We had the opportunity to exhibit the interactive tapestry for four days at a small gallery, with other pieces dedicated to this art craft, including temporary workshops close to our work's display. The piece was placed at the end of a corridor, allowing the visitors to appreciate and interact with it. Our participants were students in an art course at a public urban school. The teenagers, aged 15 to 17, were gathered through their school director, who was responsible for obtaining guardians' approval. The visit and interaction with the interactive tapestry was part of a school field trip activity.

The study design included a short demographic survey, interaction with the art piece, and answering online questionnaires. The questionnaires were to assess the participant's thoughts about the experience interface (Short version of the User Experience Questionnaire) [20], their sense of immersion and engagement with an adapted version of the EGameFlow (see Table 1), narrative affects with an adapted version of the Transportation Scale (see Table 1).

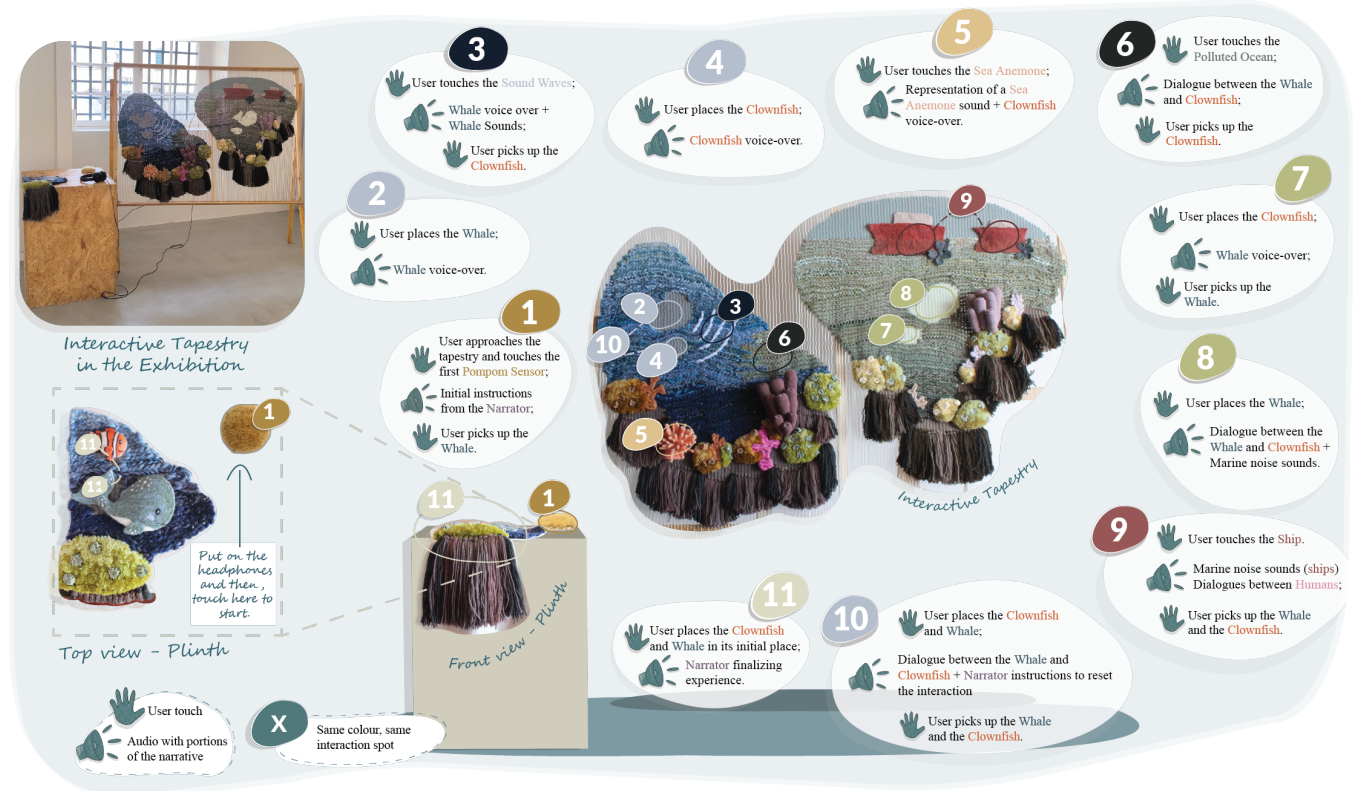


Figure 2: Interactive Tapestry Expected User Interaction. We planned the user experience, starting with the initial phase in the healthy ocean (from interaction spot number 1 to 6); the second phase unfolds in the unhealthy ocean (from interaction spot 7 to 9); and the last phase, back to the healthy ocean (interaction spots numbers 10 and 11).

We also prepared a small questionnaire with five questions to understand the effectiveness of the experience in creating awareness about the issue of marine noise pollution (see Table 2).

We used a five Likert scale, which ranged from 1 = "Strongly Disagree" to 5 = "Strongly Agree" to gather the results from the EGameFlow [7] and reflection questionnaire; A seven Likert scale with a range from 1 = "Not at all" to 7 = "Very Much" for the Transportation Scale [18], and finally the UEQ used a seven Likert scale, between -3 = "Horribly Bad" and 3 = "Extremely Good".

We divided the participants, nine in total, into two groups because of the space limitation. They gathered around the piece, and the main researcher, the author, provided a brief introduction to the interactive tapestry and the activity. At this point, the researcher also asked the participants about their previous knowledge of marine noise pollution, to which they nodded, looked to other colleagues, and said no. Each group selected a volunteer to interact with the piece. The group directed the different interactions to be performed by the volunteer/participant in the experience, and the researcher took observation notes. At the end of the interaction, we asked the participants to answer the questionnaires.

5 Results

The overall quantitative results were positive and supported by the qualitative results.

User Experience Questionnaire - short version: The UEQ allow us to reflect on the use of the tapestry as an interface for its pragmatic (efficiency, perspicuity and dependability) and hedonic qualities (pleasure and novelty) (see Figure 3).

The *conventional/inventive* parameter had the highest mean score ($M=2.89$, $SD=0.333$), indicating that participants perceived the tapestry as a novel artefact, going beyond its more traditional use. Conversely, the *complicated/easy* parameter presented the lowest results ($M=1.89$, $SD=1.537$), meaning that some participants found the tapestry was not completely easy to interact with, but it was also not difficult. The rest of the parameters demonstrated positive results, indicating that the interactive tapestry has the potential to serve as a good medium interface for its purpose, representing an efficient ($M=2.78$, $SD=0.441$) and supportive ($M=2.44$, $SD=0.726$) medium, clear to understand ($M=2.78$, $SD=0.44$), which is original and leading edge ($M=2.56$, $SD=0.882$). The participants results also showcased interest ($M=2.78$, $SD=0.667$) and excitement ($M=2.23$, $SD=0.707$) about interacting with the piece.

EGameFlow: According to the EgameFlow results, the participants were engaged and immersed in the experience (see Table

1). The participants lost track of time, demonstrating a sense of immersion in the experience. The high scores in the involvement of the participants, the learnability value and a clear understanding of how to interact with the piece increased the participants' affects and motivation to interact with the piece, reflected by the participants' physical, facial, and body expressions during the interaction, where they concentrated, listened carefully, and provided feedback to one another on how to interact next.

Transportation Scale: The results showcased high levels of curiosity, cognitive, and emotional involvement with the narrative (see Table 1). Moreover, these results and the participants' behaviour showed that the narrative maintained the participants' curiosity and involved them emotionally with the events, leading to the exploration of the different areas of the tapestry to reach the end of the narrative.

Participants Reflection on the Marine Noise Pollution Concept: The participants' responses indicate that the experience effectively raised awareness of marine noise pollution and its consequences (see Table 2). As we had established, before interacting with the tapestry, the participants' understanding of marine noise pollution was low, and engaging with the content would increase their knowledge. Most participants strongly agreed with the statements

in all five questions, showing high awareness that their behaviour can impact marine noise pollution, the marine environment and its ecosystems. The question that gathered the lowest score was how to reduce and avoid this situation. We also left an open space for the participants to give us their opinion about the project, to which some commented *"I loved it, excellent work"*, another answered *"Loved it, it's great"*, and finally one replied, *"I liked it"*.

Observation Notes: We observed that our audience quickly understood how to interact with the tapestry and were cooperative with each other. In general, the participants smile when the clownfish calls the user *"human"* and laugh when the clownfish acts like a rebel by proposing to quickly explore the other side of the ocean, even after their parents warn them about that dangerous part of the ocean. The participants also acted shocked when the whale hit the ship and ended up hurt, and in the story, a man on the ship suggests killing the whale.

6 Discussion

This paper presents a tangible interactive tapestry that combines ancestral craft techniques with capacitive technology to raise awareness of marine noise pollution. Given our region's proximity to the ocean, promoting environmental consciousness among adolescents is crucial. The tapestry effectively communicated its message, aligning with Vanessa Barragão [3] and Alexandra Kehayoglou [12], who use traditional crafts for environmental awareness.

As seen in works like Arpilleras [8] and Crafting Stories [16], capacitive technology enhances craft techniques by adding interactivity. Our approach introduced storytelling elements that emotionally connected users to the narrative. This interaction fostered empathy, curiosity, and a desire to help the characters, similar to the strategy in Letters to José [5].

Our quantitative and qualitative results indicate that participants connected with the experience and became more aware of marine noise pollution. We believe this experience enriched their lives, bringing awareness, a sense of care, and a possible seed of change for the future, as supported by Hatira and Sarac [9]. Even though this was a small exploratory study with nine participants, we think these results are promising. In the future, we should do a more significant study to bring more validation to this conclusion.

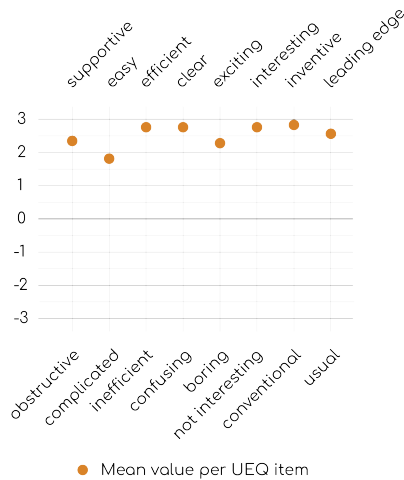


Figure 3: User Experience Questionnaire Results

EGame Flow Question	Mean (M)	Standard Dev. (SD)
EGF_Involvement - I feel viscerally involved during the experience.	4.67	0.500
EGF_TimePassing - I forgot about time passing while interacting with the installation.	4.22	1.093
EGF_Learnability - I imagine that most people would learn to use this type of interface.	4.22	1.093
EGF_Immersion - I become unaware of my surroundings while interacting with the installation.	4.00	1.118
EGF_Complexity - I found the tapestry unnecessarily complex.	1.22	0.441
Transportation Scale Question	Mean (M)	Standard Dev. (SD)
TS_Curiosity - I wanted to learn how the narrative ended.	6.78	0.441
TS_Cognitive - I was mentally involved in the narrative during the interaction.	6.67	0.500
TS_Emotional - The narrative affected me emotionally.	5.56	1.130

Table 1: EGameFlow and Transportation Scale Results

Question	Mean	Standard Dev.	SD	D	N	A	SA
Q3 - After interacting with the tapestry, I understand that humans are the biggest danger to marine noise pollution.	5.00	0	0	0	0	0	9
Q5 - I think marine noise pollution is a significant threat to marine life, as are other pollution threats (e.g., plastic and chemicals).	5.00	0	0	0	0	0	9
Q1 - After interacting with the tapestry, I became more aware of the theme marine noise pollution.	4.89	0.333	0	0	0	1	8
Q2 - I think marine noise pollution damages the normal functions of marine ecosystems.	4.89	0.333	0	0	0	1	8
Q4 - I am aware of how to take action to reduce the marine noise pollution that comes from human intervention in the ocean.	4.44	0.726	0	0	1	3	5

Table 2: Participants' Reflection: Mean (M), Standard Deviation (SD), and Distribution (SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree)

7 Limitations

The specific context of the art gallery where we conducted our exploratory study was a constraint since the tapestry exhibition space was small, and the gallery logistics relative to workshops in the same space limited the number of people visiting and interacting with the piece. Moreover, the tapestry showcased specific structural fragilities, including the sensors' sensitivity and easily moveable wood structure. As a result, we need supervision during the interactions. Over several days on display, visitors disconnected sensors by pulling the conductive threads due to the lack of monitoring.

Finally, the gallery setting may have influenced participants' willingness to engage through touch, as it is uncommon to encourage physical interaction with such artworks. In future studies, we plan to conduct research in a more controlled environment with larger participant groups.

8 Conclusion

In this paper, we presented an exploratory study among teens with an interactive tapestry to raise awareness of marine noise pollution. By blending a traditional tapestry technique with capacitive technology and storytelling, we created an engaging experience that fostered curiosity and empathy among adolescents. Participants showed increased awareness and emotional connection with the narrative and its content, reflected in the positive feedback and evaluation results.

Despite the small sample size, the study showcases the potential of this interactive experience using storytelling for environmental conscience. Future work should focus on expanding the research and refining the tapestry's design to enhance durability and accessibility. This interactive tapestry demonstrates how combining art and technology can inspire action in protecting marine ecosystems.

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