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Arpilleras Parlantes: Designing Educational Material for the Creation of Interactive Textile Art Based on a Traditional Chilean Craft.

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ABSTRACT

Electronic Textiles (eTextiles) and open source material has been entangled with "DIY" movements and hands on work to create new interactive interfaces. Studies have shown the potential these have to bring computational knowledge closer to new audiences. We address how eTextiles can approach a traditional textile art, specifically "Arpilleras" from Chile, to understand how each field contributes from a symbolic, material and technical perspective. Following participatory approach methods and STEAM guidelines to create an educational program, we observed how eTextiles can influence the creation of soft interactive interfaces that enhance the communicative character and cultural heritage of a craft, and the potential of their use in a pedagogical context by using a specially designed kit. Our study suggests that connecting technology with strong cultural identity craft, can help to reach new audiences, revitalize the traditional technique, and create new tools for expression and creativity.

KEYWORDS

Tangible interaction, computational crafts, eTextiles, education, Arpilleras, textile art, interdisciplinary

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1 INTRODUCTION

In the last 20 years, and mainly boosted by the development of the internet, technology has been getting closer and closer to every aspect of our lives. Electronic components are getting smaller and have become part of a wide range of objects in our daily routines, such as cars, musical instruments, passports and even our pets [20]. Particularly in the world of crafts, the concept of Computational Crafts [10] arose to discuss the union of technology with traditional artisan knowledge, trying to understand how each field contributes from a symbolic, material and technical perspective. As Blauvelt, et al. [3] suggest:

> *"The very notion of home crafts carries connotations of a world of "low-tech" materials—paper, clay, wood, fabric, and so forth. But increasingly, the once-distinct worlds of home crafting and computational media have become integrated on a variety of fronts."*

In the field of textiles crafts, this union has opened new paths for exploration due to the development of eTextiles and open source material, which has allowed artists, engineers and designers like Rehmi Post and Maggie Orth from MIT Media Lab [21], to integrate electronics into textiles surfaces by using new materials such as conductive treads and small micro-controllers. Soldering and coding are integrated into the creation process with traditional methods like embroidering or knitting to generate tangible soft interfaces, breaking the boundaries between "low" and "high" tech. This new interdisciplinary approach arose interest from educators who saw a pedagogical potential in using eTextiles as a methodology to bring computer science knowledge to kids in a more creative and hands-on manner [29].

In this paper we explore the question on how new digital technologies can approach a traditional textile art with a strong identity, specially focusing on Arpilleras, a traditional craft from Chile, and how they can enrich each other from a symbolic and technical perspective in an educational context. As part of the maker world, our main motivations are to connect traditional and new knowledge regarding textiles showcasing their creative and communicative value, and bring them to context following culturally responsive computing practices, hoping to generate a positive impact in the community [9]. To explore the issue, we used a participatory action research approach in the project called "PIN: Arpilleras Parlantes" (PIN: Talking Arpilleras), developed by an interdisciplinary group of designers, anthropologists, engineers and educators, following STEAM education guidelines. We designed and implemented a course to allow primary school students to receive knowledge from the crafts and technology fields, enabling them to create their own interactive textile art pieces. A group of 12 kids participated in an 8 week course, using a material kit designed by the team.

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The key findings of this project reveal that eTextiles can influence the creation of soft interactive interfaces that enhance the communicative character and cultural heritage of a craft, and the potential of their use in a pedagogical context by using a specially designed kit. Our study suggests that connecting technology with a strong cultural identity craft, can help to reach new audiences, revitalize the traditional technique, and create new tools for expression and creativity.

2 BACKGROUND

The concept of computational craft has enabled the understanding of how crafting and computational media are merging, and how both cultures are benefiting from each other [10]. On the one hand, computational capabilities for information processing have enhanced the expressive capabilities of traditional techniques and materials [3]. From the perspective of the arts, they are able to get the computational and digital world closer to physical and tactile environments, to create new supports that contribute to reaching new audiences in a more concrete and playful way, enriching the digital experience. According to Blauvelt, et al. [3], it is possible to distinguish three union strategies. First, the use of software as a tool to design objects that will later be created by hand. Second, the creation of objects by hand using smart materials which allow new results, like the use of thermochromic inks for textile printing. Finally, the most ambitious way of union of these two worlds is to generate systems that allow the use of traditional and smart materials, where some of them enable the communication between objects, and all of this accompanied by a software for programming some of the elements.

2.1 eTextiles

In the field of textiles crafts, a wide range of new materials and kits opened new paths for the exploration of embedded electronics into soft surfaces (for an overview, see [10] and [12]). The use of conductive fibers, fiber optics, conductive polymers, flexible sensors and smaller electronics were the base for the development of electronic textiles (eTextiles) and wearables. Now, it is possible to use textile interfaces for the capturing, processing and generation of information from the environment and the human body, which has had a positive impact on the fields of medicine, sports and performance [10]. Artists and designers have been utilising these technologies with traditional textile techniques for a few decades, like Maggie Orth who made textile keyboards and capacitive embroidered keypads already in 1998 [17]. More recently, the emergence of open source platforms like Kobakant [14] and accessible kits like "LilyPad" by Leah Buechley [5], suitable for textile-based prototyping has enabled the widespread use of these technologies among hobbyists, artists and new audiences, with a particular positive impact in girls participation in computer science [6]. In textile art, artists such as Amor Muñoz [2] had been working with artisans in local communities, mixing eTextiles materials with traditional crafts to, for example, integrate solar panels into woven bags and shoes. While working with communities and technology, specifically computation, new challenges also arise on how present it so it has cultural relevance in context. Here, Ethnocomputing [28] as a concept, puts emphasis on the relevance to consider local particularities "ICT[...] should benefit societies by allowing technological development without undermining local cultures or traditions and by supporting local identity rather than undermining it." [28]. Authors like Kafai and Searle [13] have worked with this concept in practice following culturally responsive open design approaches to bring computational knowledge closer to underrepresented groups of American Indian youth by connecting eTextiles with traditional native arts, integrating design agency in their processes. In this case they see the potential of eTextiles as an "opportunity for students to learn crafting physical artifacts, sewing circuits, and programming functionalities and, in the process, developing design fluency that facilitates the translation of their ideas and identities into a technical realization." [13]. Although Ethnocomputing has a focus on situating computational knowledge in context, in this project we would also explore how traditional and new techniques may be transformed and be informed by each other, and how to create new supports for creative expression. Projects like "Making Core Memory" [25] tackle how these two worlds can be interwoven, showcasing the core memory ropes created by women using traditional woven techniques, in a high tech environment such as the development of the Apollo Guidance Computer. This case is also a good example on how information can be coded and embedded into textiles, with technology enhancing the communication aspect.

2.2 Arpilleras: Cultural Heritage and Technique

Born in Chile during the 70's, Arpilleras are a traditional textile art based on colorful pieces of fabric embroidered into potato sacs. Inspired by the tapestry of the artist Violeta Parra, it was first created as a way for women to generate incomes for their families but rapidly became a support to communicate the horrors of the Chilean dictatorship through a visual and tactile language in times where free speech was limited [1], an seen in Figure 1. The artisans used wool yarns, fabric scraps and three dimensional elements to create "scenes" such as the illegal killing of protesters, missing people or houses without their loved ones. Because of these powerful statements, Arpilleras became an relevant art for Chilean history, with cultural value entangled to the collective memory and enabling many women to engage with politics. Original Arpilleras from the dictatorship periods are still exhibited around the world, like in the The Museum of Latin American Art in Long Beach California during 2019-2020 [16] or the small permanent collection at the Tate Modern London [27].

Nowadays, communities of elderly women and some younger ones continue to create Arpilleras, portraying social injustices, the humble country life, or Chilean landscapes. It is still a powerful expression medium as demonstrated in the big format pieces showcased during the 2019 Chilean social outburst, which have been created in collaborative spaces and are visual statements of the actual political crisis [15]. The composition of the pieces is based on blue sky and the land representation, the mountains and people in action, like cooking for others or marching in a protest [4]. Technically, it has remained similar to the first ones using back-stitch, blanket stitch, herringbone stitch and french knots [7]. Nevertheless, besides their contribution to cultural life and social movements, the artisans struggle to generate income, so the formats have evolved

to fit more utilitarian textile products such as bags, aprons, belts, embroidery books or even greetings cards. Due to lack of economic retribution, the artisans of the group "Arpilleristas de Melipilla" see with concern that new generations are not learning the craft, and when it does, it is mainly associated with a feminine activity in very specific groups [11]. From the project's perspective, we see the potential of working with eTextiles and this craft based on its communicative dimension, being a support to portrait local identities and testimonies [28], and as an easy entry technique that allows personal exploration in the creation of the stories and technique transformations. We also approached the artisans concerns about the transmission of their knowledge to a broader audience, in a different context than arts and crafts circles.

2.3 STEAM education

Science, technology, engineering, arts and mathematics are the basis of STEAM education, a relatively new framework for interdisciplinary education. This new approach, which initially didn't consider "arts" (STEM), was developed to "provide realistic dynamics and influences that allow students to learn how to accommodate to the real world"[30]. STEAM gives space to the students to work with their hands, combining knowledge from different areas, empowering them on the decision making, and at the end, integrating the knowledge base on experience rather than from textbooks. By connecting disciplines, students also learn "to better understand people and things rooted in other disciplines, perspectives and cultures so they can communicate and work with one another while still maintaining their own identities"[30]. In relation to eTextiles, the new material available has made it possible for educators to teach electronics and programming with new methodologies that include the expressive and hands on aspect of textile design to students. As Peppler suggests [19], "e-textiles[...]combines the digital and material in authentic, aesthetic ways and can draw diverse groups of youth into identification with disciplines by connecting seemingly abstract computing and concrete, hands-on, do-it-yourself craft". Starting in 2018, the program "Exploring Computer Science" [8] incorporated a new electronic textiles unit, developed in part by Dr. Deborah Fields which already showed that "E-textiles provide not just an opportunity to learn the basic content but also allow students to practice higher-order thinking skills. By harnessing students' interest and enthusiasm, teachers can use e-textiles to better engage students in their science learning"[29].

3 METHODOLOGY

For the presented study we used participatory action research approach, and collaborative design methods to integrate knowledge from diverse fields through various stakeholders: designers with eTextiles knowledge, artisans for the textile craft, engineers for physical computing, anthropologists for communication skills and the creation of narratives, and educators for learning goals. Co-design sessions, prototyping, pilot sessions and co-creation workshops were the methods used. Figure 2 shows the timeline and associated steps taken in this project. They were documented through informal notes and video recordings for later analysis.

4 DEVELOPMENT

4.1 Participants: Artisans and Students

As an entrance to the project, the first step was to get in touch with a group of expert artisans and invited them to participate. To find them, we looked for a group with experience, with an interest to work on an innovative project, and that were close to the area of Santiago. "Arpilleristas de Melipilla" is a collective of 10 women, ages going from 50 to 90 years old, that had been developing the craft from its creation in the 70's. They worked together once a week in a communal space at the small city of Melipilla in the central valley of Chile. The main contact was Maria Cartes, head of the group, who showed enthusiasm and curiosity and together with the lead designer organized the sessions to talk with the group and present the ideas. Contrary to what we feared, they were open to try new techniques and to collaborate since they had a positive previous experience working with a designer creating an awarded textile book. For the Course Implementation, we worked together with an educational platform that could provide us with access to students, infrastructure and equipment. The chosen one was "Programa Talentos Peñalolén", an after school free educational program for kids in low-income areas of Peñalolén in Santiago de Chile, that was interested in prototyping new ways of teaching and engaging students with deeper knowledge about arts and technology. The attending students were selected following a process that balances school performance and self-motivation, and aims to get them closer to higher education. From 100 students, we worked with a group of four girls and ten boys, aged 14 years old, who chose our offer from an array of different intensive courses. From the group, nobody had experience with either Arpilleras or eTextiles, one girl and one boy knew embroidery by learning at their houses, two boys had some experience with coding by attending a previous Python course, and everyone managed basic knowledge of physics and electricity. Since this course was optional for the kids, we had the challenge to engage them in a way that they will attend, despite the cold winter, tiredness from school or their already harsh living environments. Motivating them to work to get a final piece and an exhibition in mind was key, and we created a commitment agreement that everyone signed the first day. Halfway, 2 boys had to leave the program due to personal reasons, so the group ended up with 12 kids.

4.2 Co-Design sessions with artisans

To gain contextual understanding of the craft practice of making Arpilleras, and generating ideas for interweaving the cultural heritage and eTextile technologies, co-creation sessions were led between 6 artisans of the group and the main designer to create the first interactive Arpillera. During a period of 2 months, 4 co-design workshops open a space for the artisans to shared their knowledge. Base on generative toolkits for co-design [26], the designer guided the eTextile part using samples and icons of components printed in paper to communicate the basic principles of electronics and working with them in an easier way, to help design and create the piece. The process was documented with video and audio recordings to review the creation steps, register the artisan's impressions and communicate the process to new audiences. The final textile piece was showcased in the museum Violeta Parra during a weekend in

Figure 1: Arpillera "Los estudiantes quemados Carmen Gloria y Rodrigo" (The burned students Carmen Gloria and Rodrigo) [Fondo Dieter Maier], Colección Museo de la Memoria y los Derechos Humanos.

WHEN	February - March 2018	March - April 2019	May 2019	June - July 2019	August 2019
STEP	Co-Design Sessions with Artisans	Design and prototyping of Arpilleras Parlantes Course	Pilot sessions	Implementation of Course	Exhibition and Data Analysis
STAKEHOLDERS	Designer Artisans	Designers Educators Engineer Anthropologist	Designers Anthropologist Students	Designers Educators Engineer Anthropologist Educators Students	Designers Educators Engineer Anthropologist Students

Figure 2: Project Steps. Author's own repository

August 2019. The outcomes of these workshops were positive in terms of achieving to co-create an interactive piece and the interest expressed by the participants to continue exploring. The main motivations shared by the artisans in the sessions were to make the pieces even more "alive", the necessity to reach and share their passion with new public (specially younger ones), the drive to keep transforming the craft and the importance to preserve its value as a collective memory support. Concerning the technique, one key finding was the importance of building the piece by "layers", this means that the electronics would not be in the same level as the embroidery, to facilitate the access to the components and make it easier to fix or change if needed. Also, this allowed us to work as a team in parallel tasks. Secondly, we realize how important it is to have a good "craft" while embroidering the circuits with conductive yarn and to consider the electrical resistance of the material when creating big pieces. One of the main issues we had was that the traces were so long that the components were not working, and if the connections were too lose, the signal was unstable. Regarding the layers, we also realized how the thickness of the textiles affected the light passing through or the values of capacitive sensors, so we had to consider this while designing the Arpillera. We can see then that this process was fundamental to understand how the craft and the electronics techniques could be mutually transformed, what could be the outcomes, and how to teach it to others. Figure 3 shows a detail of the piece created during the workshop.

Figure 3: Showcasing wool making, the fire lights up when touching the wool in the pot. Author's own repository

4.3 Design "Arpilleras Parlantes" Course

Next, we interpreted the insights of the workshops with the artisans, and studied the educational requirements to structure the "Arpilleras Parlantes" course, which would be accompanied by an uniquely designed material kit to support the creation of interactive Arpilleras. For the course structure, we frame it according to the external demands of the educational institution where we implemented it. These were 2 hours sessions, once a week during an 8 weeks time frame. The contents of the course were defined first by our co-design experience which informed us about the skills and knowledge needed to create the Arpilleras. Then we align them with the government educational goals regarding artistic, technical and communication skills to really contribute to the school program. Finally, we discuss with the interdisciplinary team on how to present them in an easy to follow and compelling way. We decided to "build up" the knowledge, first presenting the new techniques in context, having some hands-on exercises, and later jump into the design and creation integrating what they learn. One key guideline was that every session will end with a final "product" of the daily exercise to keep the kids motivated and have a concrete example of their learnings that they could then share at home, helping communicate what they were working with and bust their confidence regarding the topic [13].

Finally, we took into consideration 8 guiding principles for STEAM powered computing education established by Peppler [19]:

- Choose open-ended, personal, and aesthetic tools and materials.
- Make design thinking central
- Create authentic combinations of STEM and the arts
- Facilitate easy-entry, but challenging, designs
- Purposefully contrast multiple media,tools, and materials.
- Involve a range of disciplinary experts
- Devise new assessments, pedagogy, and learning environments
- Document and showcase the work

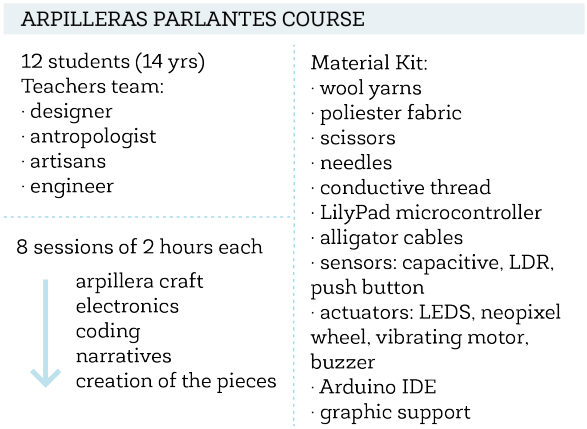

Figure 4: Course Structure. Author's own repository

The course was designed to lead the student towards creating their own Arpilleras Parlantes, integrating different skills and knowledge step by step. Figure 4 shows the final structure and contents of the course.

4.4 Design and prototyping material kit

To achieve the goals of the course, the team created a specially designed material kit considering the requirements of the mention above and the insights obtained from the co-creation workshops. We support our experience with guidelines from Resnik and Silverman [23], on how to create construction kits, having and emphasis on "learning through design" and developing features "that are specific enough so that kids can quickly understand how to use them (low floor), but general enough so that kids can continue to find new ways to use them (wide walls)." We also reviewed previous kits such as Lilypad [5] and Chibitronics [22]. The kit was composed of three main categories: Textiles, Electronics and Visual support, and

was developed through prototyping with low cost equipment from Fab Lab Universidad de Chile, tested by the team and then sent to production, as displayed in Figure 5. The final kit is put together on a canvas bag, to enable a group of people to work together on the same piece.

Textile materials: The co-design sessions with artisans showed us the possibility to continue using traditional textiles materials such as wool yarns and polyester fabric, chosen in bright and contrasting colors to maintain the aesthetic of Arpilleras. Wool yarns are also suitable for kids that are starting to embroidery since they are thick and can cover a bid area faster than thinner yarns, and polyester fabric are stable and maintain the shape during the hand manipulation.

Electronics: The co-creation sessions and previous knowledge of the team helped to define which kind of microcontroller, sensors, actuators and connectors were more suitable to guarantee an interesting range of options but limiting the possibilities to not overwhelm the students and give them some frame of exploration [13]. The chosen ones were a mix between ready made and created by the team to reduce costs and personalize them, as can be seen in Figure 5.

Visual support: Due to previous knowledge, the team was aware that having some visual aids during the process of creation is useful, such as having OHM'S law, the polarity of a led or a stitch instruction written nearby to avoid mistakes. We created a small book with straightforward visual information regarding textiles, electronics and circuits,

The main challenges during the kit design were to create a common language between such different materials, and present them in an approachable manner for the kids. Aesthetically we wanted to communicate the expressive character of the Arpilleras and eTextiles, with soft materials and bright colors, and avoid stereotypes of feminine or masculine associate with crafts and tech kits [24]. Secondly, the cost of the kit was relevant since we were interested in making it affordable to a wider audience in the context of Santiago de Chile. This led us to make half of the electronics by ourselves since the components available in the market for eTextiles mainly provided from the US have high prices (one LilyPad Vibe board costs 7 dollars in comparison with 1 dollar if we made it).

4.5 Pilot Sessions

To evaluate the material and structure of the course, 4 pilot sessions took place with a group of 7 students, revealing improvement opportunities and necessary adjustments. The team was immersed in the workshop as teachers, providing guidance to the kids, taking informal notes from the observations for later discussions. The main observations were the lack of textile and hands on skills the kids had for embroidering wool or conductive materials, so more practice exercises were added, although on the other hand, a positive response towards the creation of textiles circuits with quick understanding of the concepts. Figure 6 displays a hands on pilot session.

4.6 Arpilleras Parlantes Course Implementation

The course was implemented in the framework of "Programa Talentos Peñalolén", an after school free educational program with a group of 12 students, aged 14 years old, participating in a weekly meeting of 2 hours for 2 months. They did not have experience with either Arpilleras or eTextiles, one girl and one boy knew embroidery, two boys had some experience with coding, and everyone managed basic knowledge of physics and electricity. The group was divided, so teams of 4 students would create an unique interactive Arpillera using the design kit. The first step was to introduce the topic to the students, opening a conversation with them about their expectations, previous knowledge and questions. The contents were organized as follows: Arpilleras Craft, Basic electronic concepts, Programming sensors and actuators with Arduino, Narratives, Design, and Creation of the textiles pieces. Following the participatory research approach, different experts got involved in the sessions, imparting knowledge and guiding the creative process and taking feedback directly from the students. A special focus was given to the importance of creating their own stories to transmit with textile art and electronics. Besides the technical knowledge, we open a discussion space about identities, territories and how to communicate their own narratives and how textiles could be a good channel for that. For this purpose it was fundamental to connect the experience of the artisans with the students, sharing how Arpilleras are created and what they are driven to. The main ideas, actions and emotions of the stories were then translated to shapes, colors and interactions such as sound or movement. For example, the representation of a trembling hamster that just survived a fire, using a vibrating motor and touch sensor or the representation of an LGBT flag that had music incorporated. The students experienced every step of the process we designed based on our previous experience with the artisans. Once they had thought about their stories, we asked the teams to make collages with color papers simulating the fabrics to make the first draft of the Arpillera. On top of this collage, they positioned printed icons of the electronic components and wrote these relations on a paper sheet (button – activates light, for example). With this visual guide of the interaction, they use transparent paper on top to draw the connections between the components. Then, they use transfer paper to draw the connections on a base fabric that will go underneath the embroidery. With these guides, the teams divided tasks so some students were embroidering the circuits, others cutting and embroidering the color fabrics, and others writing the code. During the whole process the kids were checking the connections with multimeters, positioning the fabrics embroidery on top on the circuit and uploading the codes as seen in Figure 7. Since the teams were made by 4 students, we encouraged them to rotate the tasks during the sessions so each of them could learn from every step. To complement the work at the school, we also ask them to do one task at home related to embroidery, for them to practice and show their new skills to their families. The process was registered with video and audio, and informal notes were taken by the team after each session, containing impressions from the students and teachers.

In total, 16 hours were spent for the creation of 3 interactive Arpilleras of 60x40 cm using textile, colour yarns, conductive threads,

Figure 5: Material Kit. Author's own repository

Figure 6: Students coding using visual material as guide. Author's own repository

Figure 7: Creation process of Arpilleras: Traditional embroidery with artisans, embroidering soft circuits, and assembling of the layers. Author's own repository

micro-controllers, sensors and actuators. Each group developed a visual narrative inspired by their context which guided the creative process. The final pieces were exhibited during a full day in the museum "Museo Violeta Parra" in Santiago de Chile, inviting the audience to touch and engage with them, as shown in Figure 8.

Arpillera 1 "Sopaipilla food truck": The "sopaipilla", a traditional Chilean street food, is a fundamental part of students daily life. This piece represents "what I do when I arrive or leave the school. More than once my sopaipilla fell to the floor. Is it terrible" (Jürgen, student). By activating the sensor hidden in the sun, the sopaipilla food truck comes to life with its distinctive lights; another sensor is in the figure of a woman seller which triggers the melody that calls for more kids to buy from her. Finally, if we touch the falling sopaipilla, the eyes of the waiting dog become red as a sign of threat.

Arpillera 2 "Peñalolén" Park: This arpillera showcases the social life of Peñalolén Park where, for example, love and heartbreak occurs. Another important element is the LGBT flag, which wants to point out that "we need to have more respect for each other, we are already in the XXI century but we still lack respect for diversity" (Fernanda, student). This textile piece is also a call to enjoy our surroundings and natural life. In this piece, a sensor is hidden behind the sun, which triggers the lights of the shooting target, indicating the path that arrows should follow. The man in the middle of the piece has his heart broken, which lights out when a hand presses his hand. Finally, the tree activates the music that accompanies all the activities from the park (a Mario Bros. tune).

Arpillera 3 Burning House: This Arpillera mixes a real event with the imagination of the students, creating a fictional story that comes alive when interacting with the people. "This was my neighbor's house. I saw it when it started to burn (...) We wanted to create something scary" (Emiliano, student). In this scene, the hamster is the only survivor and the family member are going to haven as seen in Figure 9 By interacting with the piece, the sensor hidden behind the sun lights up all the flame burning the house. By touching the ring bell, the sounds of the firefighters siren starts. Finally, by touching the hamster we can feel his trembling caused by the fear.

5 FINDINGS

Thematic analysis was conducted to identify the emerging themes from the data collected through informal notes and video/audio recordings, the final textiles pieces and the impression received from the public during the exhibition.

5.1 Mutual transformations

One of our main motivations was to explore how the craft of Arpilleras and eTextiles technologies will merge and how booth techniques could gain from each other. Regarding the electronics, the conductive thread caused curiosity to the students who were using the multimeter to understand it but then, assimilated like

Figure 8: Final exhibition of interactive Arpilleras. People touching the "sopaipilla" and watching the dog's eyes getting red. Author's own repository

Figure 9: The burning house Arpillera. Author's own repository

any other yarn and they tried to use the same stitches they learned from the artisans. For its use, the practice using wool yarns was fundamental, because as students quickly understood, the stitches needed to be carefully made and use strong knots in the connections to problems of high resistance or unstable signals. Two boys that had never experienced embroidery described it as "relaxing" and were really committed to making the circuits perfect. We could also observe that having the interactions in mind helped as a guideline to explore with coding, to for example get the exact tune they wanted to play on the buzzer or the rhythm of lights from the

neopixels wheel. Regarding the Arpillera, we could see how the designs were a clear mix between their stories and the possibilities of the electronics. Instead of forcing how to integrate sensors and actuators, students understood them as interaction enablers and integrated them fast to the design. This changed the size of the shapes that were supposed to be touched for example, or what was the amount of layers of fabrics they could use if they wanted the light to pass through. Since the final pieces were big (50x60 cm) the idea behind the layers methodology was to avoid mixing too many materials in the same space, so the kids could easily change, repair and see the parts, and also distribute the tasks. The final pieces did not show electronics on the fronts, so as the students said, there were "surprises" and "hidden messages", but on the back of the pieces was possible to see the embroidery traces, which we show at the exhibition as a hint of the "secrets". This made the aesthetics of the Arpilleras similar to traditional ones at first sight, but it will be interesting to see in the future what would happen if we didn't set the formula and leave the students add the electronics whatever they want. Finally, the pieces were still flexible, maintaining the tactile properties of the original ones, but for the display we had to put them on top of a rigid surface so the push buttons could work.

5.2 Craft, eTextiles and communication

This project showcases that eTextiles can support the creation of new interactive interfaces, enhancing the communicative character of a craft. The Arpilleras, in this case, showed to be a suitable technique to join with electronics due to the visual information and tactility main characteristics, enabling to add more layers of information to the narrations. Now, the stories told with colors and shapes, can respond to the touch of the viewer, and reveal secret information such as the voice of a character or the light of the sun. According to the artisans, the textiles pieces now are "even more alive", and the public is able to see, touch, feel and react to the art. During the process, we encouraged the kids to create their stories considering their backgrounds and neighborhoods and that was clearly the starting point of the Arpilleras, but later when translating the stories to a visual and tactile medium, they made connections with the possibilities of electronics immediately. We believe that having the previous part of learning the technique and coding without a specific project, helped them to first understand how to use them so the creation part run smoothly.

5.3 Knowledge transfer through cultural context

We could observe that the union of these two worlds of knowledge (crafts and eTextiles) have an interesting potential of use in an educational environment, engaging a new generation of students with both traditional techniques and new technologies through a creative process that puts the knowledge in context. Selecting a culturally strong craft not only enabled us to approach technology with new soft materials, but also added a layer of cultural heritage, collective memory and motivations behind the creation that gave the students a frame to develop their work. Creating the visual narratives from their own experiences helped them to have clearer paths for designing the pieces, where the interactions between the public and the textile guide them to define which actions they wanted to achieve so the integration of sensors and actuators made more sense than just being a technical task, and encourage them to explore with coding to achieve their purposes. In a context where the students didn't have knowledge about the contents of the course, we were concerned they would perceive Arpilleras as an old school, old dated technique and programming with coding more exhibiting but challenging. Nevertheless, the Arpillera class was a success, with calm students, showing respect to the artisans, and commenting how this crafts had "so much heart on it". It was emotive to see how they worked together with the artisans, which also were teaching kids for the first time. At the end, all the students knew how to do the basic 3 types of stitches and even made embroidery name tags experimenting with them. On the other hand, they follow the coding and electronics classes easily, proposing new codes and by the time they had to make the circuits, and understood the logic behind short-cuts, resistances and signals so they checked the connections with the multimeter by themselves. Finally, one of the main challenges for us as an interdisciplinary team of professionals but not high school teachers, was to deal with the proper distractions of a group of teenagers. We were concerned about maintaining the motivation, and had to also deal with personal struggles of the students. In that sense, creating the stories and giving them visual tools to express their thoughts was an interesting medium for them to communicate. The most particular case was a girl with anxiety disorder, that shared with us her concerns about gender, sexuality and tolerance at school, so she transferred this to her Arpillera love story and the LGBT flag.

5.4 Material kit design

We saw the value of having a specially designed material kit, which guided the process in a fluent way avoiding technical difficulties related to hardware or tools, reducing the confusion in the classroom to reach the materials, and contributing to a tidier workplace. From a communicative point of view, having the textile and electronics in the same package transmitted that these tools could work together and there was not uneven emphasis on the different knowledge. In this matter, the previous co-creation workshops with the artisans and the pilot sessions were fundamental to understand the creation process and the support material needed, showcasing how relevant it is to get involved in hands-on work and getting in place feedback from the experts and learners.

6 DISCUSSION

If we consider how the concept of computational crafts arise to approach the link between crafts and new digital technologies, this project has shown to be an example on how both fields interact and influence themselves generating new creative processes and supports for interactive art using design methodologies. From a technical perspective, the eTextile technology added new layers of complexity to the craft with new steps such as circuitry and coding, but maintained the same codes based on the contact with the soft materials and hand-on work. From a symbolic point of view, it enriched the communicative aspect, proving to be a flexible support that enables new creators to share personalized stories and engage the viewers in a new interactive way. By reaching new audiences and showing the technique from a new perspective, this

exercise also proved to help in the transmission of a craft that is mainly kept alive by elderly women, contributing to maintaining its cultural heritage going. For this goal, the presence of the artisans was highly relevant to express the value and spirit of the art, and the young students showed a really respectful and curious attitude towards them. By giving the space for exploration to new creators, with the help of the specially designed kit, we could observe how the technique could evolve and adapt, not following strict rules or formal restrictions, and become a new tool for creative expression. On the other hand, we observe the impact it can have to choose a culturally strong craft, where the content is not based just on the technique but on identity, history and collective memory. We believe that this contributes to providing more meaningful learning experiences, where the context and the connection with people from other backgrounds adds value to the knowledge and places it in a social context, as discussed in ethnocomputing and culturally responsive practices. For further development, it would be interesting to open more spaces to explore with the material, enabling both kids and adults to create new pieces. Considering that our goals were to bring both worlds of knowledge as equally valuable, we think this project was successful because of the maintain enthusiasm of the students during the course and the integration of the new knowledge on the final pieces. This project then differentiates from computer focus projects that use textiles as means to connect with students, but where it doesn't have a relevant position in terms of craft, history and technique. Including crafts in a deeper way, inviting expert artisans to participate can present an opportunity to generate a bigger impact regarding the transmission of knowledge and new tools for creation in a specific cultural context. On the other hand, it also presents new technologies to the artisans, opening doors for future collaborations and eventually, new transformations on the craft. In that sense, this project is unique in the region of implementation and we expect to continue its development.

Secondly, literature showcases how eTextiles kits have been used to decrease gender gaps in computer science [6], and even if this was not our goal, we see potential of this project to explore it in the future. Our group of kids was not equal, 4 girls and 8 boys, but we could observe equal enthusiasm from them when approaching either the Arpilleras or electronics. The value of the project is that since the knowledge was put together in one final piece, there were no separations that could intensify gender associations and on the teams, and the tasks were distributed in a way that everyone had to experience every step. We also took care of presenting professionals from the different areas with a variety of ages, genders and professions as role models. Interwoven techniques from different fields that historically have had gender bias like embroidering being feminine [18], and computer science being masculine [25], could affect the way students perceive their own identities based on skills.

Finally, it would be relevant to develop this project further, training teachers so they can integrate this program into their curriculum, making low-cost material accessible and decreasing the entry barriers, opening new paths for exploration and sharing of different voices and perspectives. Nowadays, access to eTextiles material is very restrictive due to its cost, usually coming from US or China, and materials for Arpilleras, even though not expensive, are not gathered in one place or kit, so we hope to make a real contribution with our kit.

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REFERENCES

[1] Marjorie Agosín. 1985. Agujas que hablan: Las arpilleristas chilenas. *Revista Iberoamericana* 51, 132 (1985), 523–529.
[2] Amor Muñoz 2017. *Yuca Tech:Energy by hand.* Retrieved August 4, 2020 from https://amormunoz.net/2017/02/02/yuca_tech/
[3] Glenn Blauvelt, Thomas Wrensch, and Michael Eisenberg. 2000. Integrating craft materials and computation. *Knowledge-Based Systems* 13, 7-8 (2000), 471–478.
[4] Kelley Boldt and Timothy White. 2011. Chilean women and democratization: Entering politics through resistance as Arpilleristas. *Asian Journal of Latin American Studies* 24, 2 (2011), 27–44.
[5] Leah Buechley and Michael Eisenberg. 2008. The LilyPad Arduino: Toward wearable engineering for everyone. *IEEE Pervasive Computing* 7, 2 (2008), 12–15.
[6] Leah Buechley and Benjamin Mako Hill. 2010. LilyPad in the wild: how hardware's long tail is supporting new engineering and design communities. In *Proceedings of the 8th ACM conference on designing interactive systems*. 199–207.
[7] Museo de la Memoria y de los Derechos Humanos. 2019. *Arpilleras* (2nd ed.). Ocho Libros Editores, Santiago, Chile.
[8] Deborah Fields 2018. *Stitching the Loop.* Retrieved August 4, 2020 from http://www.exploringcs.org/e-textiles
[9] Ron Eglash, Juan E Gilbert, and Ellen Foster. 2013. Toward culturally responsive computing education. *Commun. ACM* 56, 7 (2013), 33–36.
[10] Sibel Deren Guler, Madeline Gannon, and Kate Sicchio. 2016. *Crafting wearables: Blending technology with fashion.* Apress.
[11] Sofía Guridi. 2019. Técnicas dialogantes: arpillera y las nuevas tecnologías de e-textiles. *RChD: creación y pensamiento* 4, 7 (2019).
[12] Kate Hartman. 2014. *Make: Wearable Electronics: Design, prototype, and wear your own interactive garments.* Maker Media, Inc.
[13] Yasmin Kafai, Kristin Searle, Crîstobal Martinez, and Bryan Brayboy. 2014. Ethnocomputing with electronic textiles: Culturally responsive open design to broaden participation in computing in American Indian youth and communities. In *Proceedings of the 45th ACM technical symposium on Computer science education*. 241–246.
[14] KOBAKANT 2020. *How to get what you want.* Retrieved August 4, 2020 from https://www.kobakant.at/DIY/
[15] latercera 2019. *Durante la dictadura las arpilleras eran perseguidas por tener contenido subversivo.* Retrieved October 29, 2020 from https://www.latercera.com/paula/durante-la-dictadura-las-arpilleras-eran-perseguidas-por-tener-contenido-subversivo-catalina-larrere/
[16] MoLa 2020. *Arte, Mujer y Memoria: Arpilleras from Chile.* Retrieved August 4, 2020 from https://molaa.org/arpilleras-online
[17] Maggie Orth, Rehmi Post, and Emily Cooper. 1998. Fabric computing interfaces. In *CHI 98 conference summary on Human factors in computing systems*. 331–332.
[18] Rozsika Parker, Rosika Parker, and Rozsika Parker. 1984. *The subversive stitch: Embroidery and the making of the feminine.* Women's Press London.
[19] Kylie Peppler. 2013. STEAM-powered computing education: Using e-textiles to integrate the arts and STEM. *Computer* 9 (2013), 38–43.
[20] Anna Persson. 2013. *Exploring textiles as materials for interaction design.* Ph.D. Dissertation. University of Borås.
[21] Ernest Rehmatulla Post, Maggie Orth, Peter R Russo, and Neil Gershenfeld. 2000. E-broidery: Design and fabrication of textile-based computing. *IBM Systems journal* 39, 3.4 (2000), 840–860.
[22] Jie Qi, Leah Buechley, Andrew" bunnie" Huang, Patricia Ng, Sean Cross, and Joseph A Paradiso. 2018. Chibitronics in the Wild: Engaging New Communities in Creating Technology with Paper Electronics. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. 1–11.
[23] Mitchel Resnick and Brian Silverman. 2005. Some reflections on designing construction kits for kids. In *Proceedings of the 2005 conference on Interaction design and children*. 117–122.
[24] Els Rommes, Maartje Bos, and Josine Oude Geerdink. 2011. Design and Use of Gender Specific and Gender Stereotypical Toys. *International Journal of Gender, Science & Technology* 3, 1 (2011).
[25] Daniela K Rosner, Samantha Shorey, Brock R Craft, and Helen Remick. 2018. Making core memory: design inquiry into gendered legacies of engineering and craftwork. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. 1–13.
[26] Elizabeth B-N Sanders and Pieter Jan Stappers. 2014. Probes, toolkits and prototypes: three approaches to making in codesigning. *CoDesign* 10, 1 (2014), 5–14.
[27] Tate 2020. *Arpilleras: group of 20 patchwork pictures from Chile.* Retrieved August 4, 2020 from https://www.tate.org.uk/art/artworks/unknown-female-artist-arpilleras-group-of-20-patchwork-pictures-from-chile-256314

[28] Matti Tedre, Erkki Sutinen, Esko Kähkönen, and Piet Kommers. 2006. Ethnocomputing: ICT in cultural and social context. *Commun. ACM* 49, 1 (2006), 126–130.

[29] Colby Tofel-Grehl and Deborah Fields. 2015. SEWING UP SCIENCE. *The Science Teacher* 82, 8 (2015), 45.

[30] Georgette Yakman and Hyonyong Lee. 2012. Exploring the exemplary STEAM education in the US as a practical educational framework for Korea. *Journal of the korean Association for Science Education* 32, 6 (2012), 1072–1086.