Anywear Academy: A Larp-based Camp to Inspire Computational Interest in Middle School Girls

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ABSTRACT

This paper presents a case study of designing and running a Larp (live action role play)-based summer camp in which middle school-age girls create social wearables, toward building computational and design skills, interest, and self-efficacy. Our design draws upon prior evidence that edu-larps can address the identity gap for underrepresented groups in STEM. The focus on creation of social wearables built using E-textiles builds on existing larp practices that use costuming as a method for establishing identity as well as for providing a platform campers can use to enhance their dramatic spectacles. Our findings will be of interest to those working in the areas of informal learning of computation through Arduino and another small device programming, as well as those interested in the intersection of larp and technology design practices, and edu-larp.

CCS CONCEPTS

• **Human-centered computing → Collaborative and social computing theory, concepts and paradigms**; **Interaction design**.

KEYWORDS

Edu-Larp, computational interest, informal learning, camp, STEAM, STEM, Research through Design, Design-Based Research, Ubicomp, social wearables, wearable technology, computational community, social, co-located, E-textiles

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1 INTRODUCTION

Even with the drive towards increasing representation in the computing industry in recent years, women are still drastically underrepresented as compared to their proportion in the general population [3]. Research has shown that middle school is a key time in which girls form long term opinions on their interest in pursuing careers or higher education in technical fields [19]. Using a Research through Design [21, 40, 41] /design-based research approach [6, 35], we designed, developed, and deployed a summer camp focused on middle school girls that targets this issue with a novel combination of pedagogy and technology–the use of edu-larp (a structured, live action roleplay experience that teaches through social enactment and reflection [7]) as the primary mode of engagement, and a focus on computational interest-building through the creation of social wearable devices (technologies worn on the body that encourage social interaction) aimed at augmenting the campers' interactions during the camp experience. Both of these strategies place the emphasis on social interaction during the learning, and the solving of socially-relevant technical challenges. This approach draws upon research that shows the importance of coding communities [26, 27] and meaningful social problem solving for increasing girls' interest in computational careers [3]. Using live action roleplay was intended to help campers to get past any personal limitations they might feel in relation to learning coding skills. Being able to identify with practitioners in STEM can be difficult for groups of people who are historically underrepresented in the fields [38] and role play has been used in other educational fields to allow students to better personally relate to the material and those who are experts in it [11].

This project builds on work with the Larp design community to create wearables for two different larps [18, 31], designed to enhance interaction between larpers during their experience. Larp designers have a tradition of including technologies into their designs that explicitly support the experience of the group–they will reject potential technologies that become a distraction from the shared experience [37]. Thus we can think of the larp design community as having the design value of creating positive shared experiences through technologies they develop and deploy. There is also a tradition of developing educational larps (edu-larps) that teach

participants a range of subjects, from historical periods to scientific concepts and methods [7].

The core research challenge we set for ourselves was designing a larp-based camp in which campers built social wearables [17] to solve missions together that would help build a sense of computational community among the girls, as well as increased interest in and sense of self efficacy about coding and ubicomp design. We crafted a series of exercises in the camp that shift the campers' identity through larp. Campers create E-textiles for an alternative version of themselves to succeed at missions that are communally relevant to everyone within this story world. Participants are building computational community with fellow campers through crafting things that are embedded in the character driven world that they're playing in. Wearables help to transform identity in performance and costumes are a longstanding tradition in larp used to establish character for both the wearer and those around them[24]. Our primary research questions are linked to outcomes goals for the camp: *Will the proposed camp increase girls' self-reported competence, self-efficacy, and interest in computational skills and careers?* and *Will the proposed camp work to foster a sense of computational community within the target group?*

2 BACKGROUND AND RELATED WORK

Prior research into the obstacles that girls face when entering into STEM fields have identified not just a skill and knowledge gap, but also an "Identity Gap"[38]. This gap refers to the work needed for girls and other underrepresented communities in STEM to visualize themselves taking on STEM roles and participating in STEM Careers. Work in E-textiles has frequently noted that introducing technology education within the context of crafting helps to counteract the traditionally male connotations that accompany STEM education [39]. Additionally, edu-Larp is particularly suited to the exploration of different roles.

2.1 Edu-Larp

For an excellent overview of edu-larp efforts and theory see [7]. Larp has been used in educational contexts to help students learn a range of subject matter (from history [28] to healthcare [8] to scientific method [9]), and works at multiple levels to engage learners (cognitively, emotionally, and behaviorally). Bowman notes that larps afford "community building; tactical and social problem solving; and identity exploration" (p. 112, [7]).

Larp can be the main pedagogical tool as is the case of Østerskov Efterskole, a danish boarding school in which students learn almost entirely within the context of larp [32]. In these settings, players have the opportunity to take on the role or identity of experts in different fields which results in increased feelings of self confidence in those fields [22].

2.2 Larp and Technology

Larp designers have a long tradition of incorporating technology into the experiences that they craft for participants–[37] provides a survey-based overview of larp designers' use of technology in their practice. As the survey shows, incorporating technology into a larp must be done to serve the participants shared experience and not create a financial barrier to participation. Our camp aims to follow that tradition and aims to foster computational community through a larp experience that all campers are able to engage in at an equal level.

Even researchers in the field of human-computer interaction (HCI) have designed technology for use in larps with the purpose of studying the cultivation of community and connection. In particular, researchers have built wearable technology for larps to help support social interaction [16, 31], demonstrating that wearables can be used to help participants to stay immersed in roleplay [31] and to invite larpers to engage in pro-social, even vulnerable, social interaction that helps to build trust and connection [16]. This holds true in areas that are tangentially related to larp. In physical, cooperative games that combine technology and costuming, like Magia Transformo [24] and Hotaru [1], these elements serve to help players identify with the roles and characters the are inhabiting in the context of the game. This work informed our choice to focus the primary activity of this particular camp toward the creation of designing and implementing social wearables. We took this work as inspiration for making the creation of social wearables a focal point for activities in the camp that we were designing.

2.3 E-textiles in Education

Our research project draws upon other initiatives teaching girls computational skills through these accessible components, including efforts that focus on wearables, E-textiles, and other hardware based projects [13]. E-textiles have been shown to provide an effective way to increase interest in STEM to populations not typically targeted by traditional STEM outreach [23, 25, 39]. Typically these initiatives involve each student creating their own projects, and putting together a portfolio of work [29], rather than on team activities. Many of these initiatives use block-based coding to help make computational skill building more accessible [14], and our research project also takes a block-based coding approach.

"A curriculum for teaching computer science through computational textiles" by Qiu et al. is a quintessential example of this workshop deployment style of research. The authors created a maker-style curriculum of sewable electronics hardware using the Lilypad hardware family paired with a block-based coding platform called modkit. They concluded that "the curriculum both draws a diverse population, and increases students' comfort with, enjoyment of, and interest in working with electronics and programming." [33]

The project described in "Deconstruction Kits for Learning: Students Collaborative Debugging of Electronic Textile Designs" by Fields et al. tackles a similar goal of teaching computational concepts, focusing on debugging e-textile designs. The authors note that this collaboration was useful for learning from a peer mentoring perspective across different skill sets. They noted in their results that students were able to help each other solve most of the problems and that students who with less experience with technology found the hands-on nature of the activity more approachable [20].

Complementing and extending these prior works, the current project focuses explicitly on building computational community [25], doing so by involving the campers in shared missions that engage them in group problem solving through coding and wearable design. In addition the current project is novel because of its use of

edu-larp as a frame for learning. Designers of edu-larp frequently make use of roleplay to help learners' become more comfortable with engaging with material that they might normally be hesitant to explore. [8–10]. We thought this could also lay the groundwork for building connection among campers through shared roleplay-based emotional experiences.

3 CAMP DESIGN TIMELINE, TEAM, AND PARAMETERS

Figure 1: Timeline of major project phases.

The research team began with a set of computational learning objectives taken from age-appropriate CSTA standards [4] that were feasible to aim for within the context of a five-day summer day camp experience, and that emphasized 'core' computing concepts as well as iteration and communication skills. (The topics covered in the camp's programming classes blend both types of skills.) The researchers convened a set of advisors with expertise in informal STEM learning as well as larp and edu-larp design. The core team also included a non-profit summer camp operator with expertise in designing and running role-play-based camps, as well as an external evaluation team with a long history of evaluating informal STEM/computational learning experiences. As part of our co-design process, we also convened a Youth Advisory Committee. We used input from this group and others in the team to develop the narrative, design, and technical components of the Edu-Larp over a one-year period (see Figure 1), toward creating a camp that resonated with our target group's interests.

From previously successful research and with advice from our stakeholders, we ensured that the campers would have some unstructured time for the iterative design processes, and time for integrating their knowledge and skills [15, 34].

Our camp makes use of the Micro:bit hardware platform due to it's previously success in educational settings [5] and the strengths that it offered for wireless communication, which would help support interaction at a distance. The Micro:bit is specifically developed for use in computer education and has a robust ecosystem of with a robust surrounding ecosystem. The ecosystem features a broad array of free online tutorials and projects, as well as a market of both official and 3rd party accessory components. We paired this with the visual coding environment, MakeCode. This block-based coding platform is similar to Scratch, but purpose-built for a variety of maker hardware [30].

4 CAMP DESIGN

Here we describe the overall planned structure and activities for the camp, before diving into more detail about each component. The camp was designed to run for 5 days in succession. Campers would take on the role of agents in training, as part of the Anywear Academy, a secret organization tasked with traveling to different dimensions to establish diplomatic ties and right wrongs. Campers would use wearable electronics they programmed to accomplish a variety of different missions. Their days would be divided between classes and missions that immediately called on the skills learned in the classes (see Figure 2). Over the course of the classes offered, campers would learn how to use the built in sensors and buttons to change the colors and patterns of addressable LED strands, produce monophonic audio, and send and receive radio signals. Campers would be introduced to these concepts in short, 30 minute classes where they would follow along with an instructor that guided them through a structured exercise. These classes were intentionally short to allow the campers more time to explore these concepts independently and in design challenge missions.

Missions would take place in three different sets, representing the different worlds (see the Missions and Plots section below). Each mission was built around a different design challenge that range from structured technical puzzle solving to open-ended performances that the campers design, but each mission requires that campers iterate an existing wearable or create a new one to complete the task.

4.1 Classes

Classes would be short, structured lessons aimed at introducing different concepts (see Figure 4). Initial classes would focus on LEDs, radio communication, sensor based events as well as a class focused on design thinking in the context of creating wearables. These would give the campers a base level of knowledge for creating wearables. From there, the rest of the classes would be optional, though many of the missions would still require the concepts covered, so as to encourage campers who took these optional classes to teach their peers. The advanced classes were: taking analog readings from on-board sensors like the light and magnetic field sensors; playing and sensing simple audio; and controlling servos.

4.2 Missions and Plots

Campers would be able to participate in three different mission chains, referred to as plots, that were separated by theme and setting. Within the framing narrative, Campers were agents of the academy tasked with traveling undercover to different worlds through "portals". Before every mission, an NPC (non-player character–e.g. a camp staff member playing a role) would conduct a short briefing, explaining the mission objectives, hazards, etc. From this, the campers would design wearables that allowed them to blend into to each setting as well as meet specific technical challenges laid out to them.

Plot A took the campers to a fairy themed magical world called Elphame (see Figure 5), where campers must create disguises to

MONDAY

Time	Room A	Room B	Room C	Notes
0900-1000	OOG Briefing (real world stuff)			
1000-1045	Basic Training (IG, fictional stuff)			
1045-1100	Sorting exercise			Wearable activity to get them into 2-3 groups (dependent on number of campers and facilitators)
1100-1130	Get to know unit (meet guide NPC and one another) & short break	Get to know unit (meet guide NPC and one another) & short break	Get to know unit (meet guide NPC and one another) & short break	
1130-1200	Advanced basic training	Advanced basic training	Advanced basic training	
1200-1300	Lunch break			out of character, but can talk about game
1300-1330	Class 1: Light & Colors 1	Class 2: Bodystroming Design	Prep room for mission	
1330-1400	Class 1 (repeat)	Class 2 (repeat)	Prep room for mission	Classes repeat to switch or take again
1400-1430	workshop/independent study	Prep room for mission	Prep room for mission	
1430-1445	Snack break	Prep room for mission	Prep room for mission	
1445-1545	workshop/independent study	Mission B1	Mission A1	Campers choose workshop or mission
1545-1600	IG debrief/next day plot/story	Breakdown mission	IG debrief/next day plot/story	Can slop a little IG into OOG here
1600-1700	Break, OOG debrief (review) and next day plans			Can slop a little IG into OOG if needed

Figure 2: An example day schedule for the camp

blend in as fairies so that they can meet with the Fairy Prince. In-game, campers have magical powers in Fairyland (Elphame) with their wearables, but they have to disguise them so they appear like innate magic and not a tech device, which fairies mistrust.

Plot B had campers travel to Metro City (see Figure 3), a modern world with a superhero theme, where campers create their own super hero personas to investigate a new villain that has started plaguing the city. The explorers have super powers in this world with their wearables, and the people adore them.

Figure 3: Within the Super Hero Plot, campers unravelled the mystery of a new super villain terrorizing metro city and confronted this mystery figure with the help of their sensor reactive costumes.

Figure 4: A. Campers in class; B and C. Independent workshop time: campers are working on an activity of their choice.

Plot C involved a mystery at Earhart station (see Figure 6), a space station that has reported system failures that campers must bring back online. Campers must create wearables that allow them to communicate in the vacuum of the derelict station, as well as create technology that interacts with the malfunctioning systems of the station.

While initial missions were more heavily structured to get campers accustomed to costume creation and the basic technical functions

Figure 5: Images from missions that took place in the fairy themed world. Missions here involved campers trying to make diplomatic ties with the fairy prince while hiding the fact that they are not fairies. They did so by creating costumes that used LED displays to represent their magic and augment their social displays to the NPCs of that world.

available to them, later missions were more free-form design challenges. Mission A4 tasks campers with creating a group performance that integrates gesture-triggered lights and sounds into their act. B4 tasks campers with combining their powers with another camper by having them teach each other how they represent their powers in code. These missions allow campers more leeway to explore the design space that has been presented to them over the previous few days, as well as encouraging campers to collaborate in their designs and share knowledge.

The final mission brings the different plot lines together for a climactic confrontation with the villain of the larp, and brings the story to its narrative conclusion. Campers are tasked with creating a final iteration of their favorite costume and incorporating an action that can be synchronized with others to trigger a display of lights and sound to defeat the villain. As this is the last opportunity to design something for the camp, this is left rather open ended, with the caveat that they need to decide how they will work together. This gives the campers agency over their finale, while still emphasizing collaboration in the design.

Figure 6: Missions on Earhart Station had the campers investigating a mysterious abandoned academy space station and, because this station's life support was shut down which prohibited verbal communication, they using their wearables to provide another avenue of nonverbal communication to coordinate cooperative puzzle solving

Figure 7: Between missions, campers had access to tables arrayed with crafting supplies to iterate or create new costumes and wearable elements to prepare for the next challenges.

5 RUNNING THE CAMP

Recruitment was managed by the non-profit camp operator, using digital fliers on social media as well as emails that were circulated to area organizations, schools, and parents. Roughly 100 families expressed interest in the camp, submitting a form that asked for contact information, camper grade level (we were recruiting rising 6th through 9th graders), school, gender identity (as the camp was girl-focused), and optional field for ethnicity. From this pool, 16 candidates were selected. The research team was committed to offering the opportunity to girls with less means, and so we selected prospective campers from the pool using their school's percentage of free lunch users as a proxy for lower family income. Of those selected, 10 completed registration. We had 10 campers on the first day with 9 returning to finish the rest of the camp. All campers assented, and their families consented, to their participation in the research (as per the guidance of our IRB board).

The camp was run in a community center in a US city in July of 2021. The event was organized and facilitated by the non-profit, and ran for five days from 9am to 4pm. The camp was staffed with 4 facilitators hired based on their experience in education, larp and theatre, in addition to an onsite coordinator from the non-profit, who also served as the primary instructor of the class material. The other 4 facilitators shifted roles based on the need at the time, acting as non-player characters during missions, supervising crafting activities, and providing design feedback, as well as handling set design and construction.

Electronics Materials: There were Micro:bits for each student which they were able to take with them at the end of the camp. Researchers had prefabricated a bolt-on connector to the Micro:bit that would allow campers to connect the different types of LED strands, along with the Servos that would be presented later in the week. Adafruit Neopixel Dot Strands were chosen due to their greater robustness and flexibility for use in wearables, versus the more readily available strips. Continuous rotation micro servos

Figure 8: Image from mission B-3: Campers are playing audio to 'calm' an out of control robot.

were used in pre-built robotic props, and were made available for the campers' use after the robots were introduced.

We wanted the campers to have a long growth path offered by the hardware we provided, to allow them to continue to develop their skills based on their interests after the camp concluded. The micro:bit platform was chosen due to its connections to other commercial maker platforms and hardware. It has a low barrier of entry with MakeCode's block-based interface, but it can just as effectively be programmed in python, javascript or the arduino version of C++. The additional hardware components chosen were based on providing the most amount of flexible utility at a relatively low cost. Neopixels and continuous servos have extension packages that work with MakeCode and expand the outputs available to the campers. While micro:bit features a relatively unique cartridge style pin out, we chose not to include any of the bespoke "daughterboard" style accessories, as they are generally not well designed for wearables, relatively restrictive in their use cases, and more expensive than more generic compatible electronics.

Puzzles were also constructed using micro:bits by the camp designers and facilitators, which were integrated into props for the different environments. These included a combination lock puzzle made with five micro:bits which required campers to trigger different micro:bits either in sequence or synchronously using different sensor inputs. The purpose of this was to provide a challenge that brought in the concept of sensor input lessons offered in an earlier class in a familiar form factor.

Crafting materials: Available crafting supplies included sticky tack, popsicle sticks, coffee stirrers, ribbon, temporary tattoos, butterfly wings, pre-made superhero costumes (capes and base-masks), glitter glues, hot glue guns, batting/poly fill, Velcro circle stickers, fabric scraps (various print patterns), organza fabric in various colors, packing perforated paper, foam sheets and packing foam pieces for construction, and tin foil pieces. Crafting tools available included scissors, a variety of types of glues, Sharpies, and tape.

Due to the skill sets of the available facilitators and the designers focusing more on roleplay, electronics, and UX design, we didn't focus on imparting crafting specific skills in the classes. Instead, we focused on imparting design thinking skills early on through a workshop where campers worked in small groups to design a single costume inspired by randomly drawn theme words. Through a series of iterations, they were prompted to think about concepts such as wearability, the secondary user experience, and creating a cohesive design. This manifested in their later designs such as when campers, unprompted, started constructing small shoulder bags to wear under their costumes to hold the bulky battery pack, or when campers incorporated music into their superhero costumes to signal that they are doing a heroic act.

Run of Day: The first activity of the day was a briefing going over the activities that were available that day, as well as a recap of the events of the day before. A block of activities ranging from classes, missions, and independent crafting would occur until lunch, which was an hour and began between 12 pm and 1 pm, depending on when the last morning activity ended. In the afternoon, a second block of activities would occur until 3pm, when the campers would be gathered for the end of day debrief and discussion, where they were prompted to reflect on the events of the day. Once this discussion was complete, campers were free to continue crafting or socializing until they were picked up by their parents or guardians. During the blocks of activities, campers were grouped based on their chosen activity, and these groups took breaks when appropriate. The briefings, lunch, and end of day discussions were done with the entire group of campers together.

Documentation Process: Within the narrative context of the camp, researchers took on the role of members of "Quality assurance" and "auditors" of the Anywear Academy, tasked with documenting the equipment made by the explorers in training and how it was used during missions. We conducted brief interviews after missions asking whether each was an original design or an iteration of a previous one. We asked how they made use of their equipment and whether it worked as intended. Authorship was primarily attributed to the wearer of the costume, but campers were quick to say when another camper assisted in the design or inspired their current iteration.

6 RESULTS

In this section, we present results of evaluating the campers' experience of this first deployment of the camp. We report results concerning the camp's design: Was it enjoyable? How can we link this to design decisions made? Did it in fact seem to foster computational community? We also report results related to the research question: Does the proposed camp increase girls' self-reported competence, self-efficacy, and interest in computational skills and careers?

We created a number of measures that would collect data on the experience of the campers. Before the camp began, each girl filled out a pre-survey online that gauged their interest in coding, design, and teamwork. Campers filled out a post-survey asking similar questions so we could observe shifts in their attitudes (see all survey results in the appendix). We also conducted individual semi-structured interviews with each camper on the last day of the camp, taking about 15 minutes with each of the 9 participants (referred to here as P1-9). The external evaluators followed up with 6 of the 9 campers a few days after camp with a few additional questions aimed at gaining concrete camp design feedback. In addition to these direct questions of campers, we also asked the camp facilitators (F1-5) to complete a daily log with their observations about the camp. Three of the research team were also on site to observe and document (taking photos and videos).

To analyze the data, we transcribed all the interviews and used top-down thematic analysis [12] to evaluate the objectives we had

Figure 9: Examples of artifacts created in the camp. In addition to wearables and costume pieces, some campers chose to create props and tools that they felt would suit their characters in the larp.

for the camp, working from the campers' perspectives, as well as those of the facilitators and the research observers.

6.1 Vignettes

First, we will consider design-related questions we had about how the camp was received by participants: Was it enjoyable? In what ways? How might this be linked this to design decisions made? Did the camp achieve our design aim of fostering computational community? To address these questions, we will present a series of vignettes of particular moments in the camp that illustrate the interrelationship between design decisions and camper enjoyment and formation of community. Afterward, we will present results from camper surveys and interviews that address camper self-reported competence, self-efficacy, and interest in computational skills and careers.

Vignette 1: Learnings in the service of group performative goals This vignette illustrates how using larp as a context for learning created interesting opportunities for campers to meld tech and design innovation with community formation. In this case, the campers designed a wearable interaction that enhanced the drama and improved the group experience. As part of an activity where pairs of campers were tasked with teaching each other how their superhero costumes worked and incorporating a part of each other's functionality into their design, one pair took this further to create a design that was more interdependent in nature.

Incorporating what they had learned that day from the classes on using sensors as inputs and sound creation, the campers designed an interaction for their costumes using their duo's theme song, which they created as well, which was played when both campers jumped into action, tying the output to the freefall event built into Makecode. When it came time to confront the villain for the first time, this pair of girls took front and center to challenge the NPC played by camp facilitators. During the end of day reflections, campers noted how this event added more drama and theorized that the villain may be vulnerable to sound which more campers then incorporated into their designs for the final confrontation with the villain.

These paired costumes demonstrate how the social problem-solving nature and the costuming elements of larp created a situation in which two campers organically created a design that used technology to facilitate their desired performative outcome. This aspect, combined with the inherent melodrama of performing as a superhero, and the collaborative structure of the missions, worked to inspire the learners to engage with the technology and expressive potential of social wearables in an interesting way that worked toward the overall group experience.

Vignette 2: Embodied rituals and group affiliation Beyond the structure of missions and the narrative to support collaboration and group learning, the playful and fun aspects of learning through larp also worked to improve engagement and create community. An example of this playful and silly attitude was the camper's organic development of "The Wiggle Wiggle Dance" as a sign of group affiliation and a recurring use of the ritual. This ritual was initially created when campers were asked by a fairy character, "How do you do magic?". When one camper started chanting the word "wiggle" and wiggling with their fingers towards the plant wall, the others began copying this. Once everyone was doing the same action the facilitator in costume encouraged this by saying "Oh my, that is new and exciting magic". After the mission, the campers were quick to share their experience with their peers, both the narrative information they had learned as well as demonstrating a recreation of the wiggling gesture.

This gesture was carried through the rest of the week and incorporated into their wearables used in missions that took place in the Fairy world. Examples of how the campers augmented this gesture includes adding flashing lights or audio effects that they would trigger before using the gesture to add emphasis to the action along with designing subtle interfaces for triggering these effects to minimize the disruption to their role playing and to better disguise their technology as magic within the context of the fairy world. This was gesture worked as a common thread that guided them along their learning experience.

Vignette 3: Community formation from freeform activities Allowing space for peer interactions without a task or goal like the missions or narrative interactions with the NPC facilitators also worked to foster a sense of community. While the missions and narrative components of the camp provided a shared goal and experience for the campers to relate through, facilitators of the camp reported that unstructured times like lunch and free crafting periods were times throughout the week that campers became visibly closer to each other and more comfortable. This bonding wasn't frequently related to the specific learning experience or the larp and instead was more relating to each about things outside the camp: the fact that they were starting at the same school after summer, a shared musical instrument that they both played, even a mutual interest in TikTok dances provided additional points for the campers to relate to each other which would support community formation.

This promise of community formation was best represented on the last day of the camp where campers had the opportunity to showcase their work to each other during an impromptu fashion show. Campers wore their favorite costume from the week, showcasing the work they put into designing it and the way they had incorporated technology into the e-textile. One camper took on the role of the announcer and the group cheered for each of their peers as they walked the 'catwalk'. While the fashion show was originally planned to provide the researchers the opportunity to document the campers designs, it had the added effect of demonstrating how

Figure 10: Campers spend their lunch hour together in a group circle outdoors.

the campers had started to celebrate each others work and share it with their community.

At the end of the camp, the participants exchanged contact info (emails and phone numbers) and declared their interest to keep in touch with the rest of the group. Some even expressed interest in participating in future iterations of this camp: For example, P2 hoped that *"maybe [they] could have an invitation to come back here to help teach."*

6.2 Interviews and daily logs

We asked participants about their learning experience in the camp compared to learning in school settings. Their responses suggest they enjoyed it. For example P8 said: *"[i]t felt different in a good way, because it made it more fun and not kinda just strictly learning"* (P8). P2 also mentioned that learning to code also *"felt different."* Some reasoned this was because of the accessibility of knowledge and insight (from the facilitators, and from others) and how easy it was to get help when needed. They didn't need to wait in line like in school; Instead, they *"could easily access [help] because everyone was doing everything else. And the teachers gave a good explanation on how to do things,"* also they *"took a look at what everyone else was doing and tried to copy off of that,"* and they felt it was *"better that way."*

Campers' designs increased in design and technical complexity as the camp progressed, and so did their reasoning when describing their designs. They moved from explaining they had selected materials "*because it was cool*" when crafting their first costumes, to explaining they had took into account technical requirements such as the placement of a battery pack to not throw off the balance of a garment, or how to subtly trigger different functions of their wearables without directly interfacing with the hardware.

Having these behaviors or shared goals related to the role play worked to foster community among the campers. For example, P6 said: *"We all were in it together. Like we went to see the live action one on one together,"*. Participants also commented on particular social activities that happened during larping (missions), but also in preparation to larping, both formal and part of the camp's program, and informal and emergent. For example, P8 mentioned their favorite part was brainstorming with others in-between missions to strategize about how to solve the larp's mysteries: *"I think my favorite part was brainstorming, how to connect the clues together that we got from the missions. Because it was really interesting to see it from different points of views and have different people thought different things about the clues"* (P8). Other formal camp activities were also mentioned. For example, P9 commented on the impact of many of them: *"How we helped each other during coding, how we did the costumes, did that together, and how we did like missions together. Yeah. Did it as a group, so that kind of bonded us."* Helping and supporting each other during these formal activities was highlighted often. For example, P9 said: *"[w]e basically helped each other like when we were in the coding classes when someone like didn't know what to do,"* and P6 said *"[w]e all help each other. Just talk to each other."*

Campers had an overall positive experience. For example, in the last days' interviews P3 said " *"it was super fun,"* P1 commented ' *'I like that we can talk have more fun together and learn together. And there's nothing I didn't like,"* and P4 felt it was as we hoped it would be: *"it felt like a summer camp. It was fun."* Finally, P7 commented *"the worst part was to go home."*

6.3 Camper Self-Reported Outcomes

We noted increases in complexity of designs over the course of the week and noted a continuously high level over engagement and interest in the camp, and the campers reported this change in interest in the pre- and post-surveys. The data shows a general trend towards more confidence and interest in designing, making, coding, and working with circuits and electronics among the girls (see Figure 12, Figure 11; note that some questions were answered only by 8 out of the 9 camp's participants).

Specifically, this change in the level of confidence was apparent in questions about discussing code (e.g.,"How confident are you in explaining to someone else what you code?"), using circuits and electronics (e.g., "How confident are you in making things using circuits and electronics?"), computer science in general (e.g., "How confident are you in computer science or programming activities?"; "How confident are you in identifying problems in computer science?"), and re-using others' code (e.g., "How confident are you in re-using or modifying someone else's code to solve a problem or add something to your code?") (see Figure 11).

The camp's facilitators observed that the activities (plots, missions, and classes) were engaging to campers. For example, F2 stated in their daily log (day 4): *"The campers seemed very engaged with the plot and trying to figure out all the clues and what was really going ."* F5 stated in their log (day 3) they *"noticed that while some seemed to form their own smaller groups, they all were still comfortable engaging with each other - everyone was respectful and helpful with each other."* On day 4 F5 noticed that *"[t]he campers seemed more engaged today, many of them eager to start working to advance the plot from the moment they walked into the building in the morning. Throughout the day the engagement seemed to remain high, especially as they worked together to uncover clues to drive the story forward."* F4 noted in their log (day 3) that the campers *"are very excited by how the plot is progressing," and that the "[c]ampers who are not so interested in away missions are still very excited about all of the tech that they have to work on back at HQ."*

We asked participants about their learning experience in the camp compared to learning in school settings. Their responses suggest they enjoyed it. For example P8 said: *"[i]t felt different in a good way, because it made it more fun and not kinda just strictly learning"* (P8), and P1 said: *"[n]ow I feel more like coding instead of before, because I didn't like code a lot. Now. I want to code more."* Participants appreciated working together with others, and felt they advanced their knowledge, for example, P5 said: *"[i]t was really fun when we worked as a group [...]. Before I didn't know as much, but now I know more."*

The live action roleplay aspect of the camp sparked interest in the learning by making it *"a bit more open to do whatever you want"* (P2). P2 also mentioned that learning to code also *"felt different."* For example when they were seeking help with coding, they didn't need to wait in line, they *"could easily access it because everyone was doing everything else. And the teachers gave a good explanation on how to do things,"* also they *"took a look at what everyone else was*

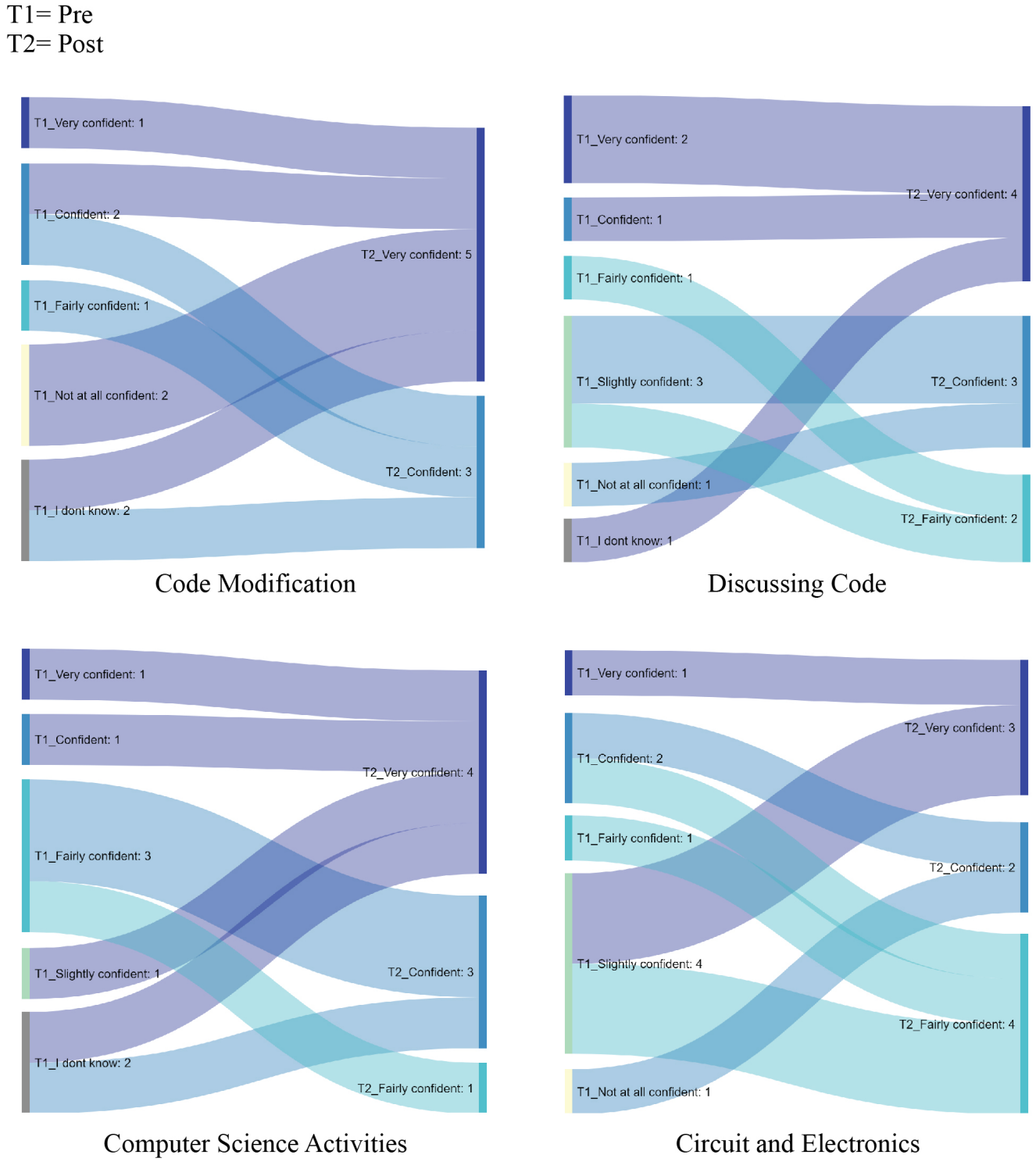

Figure 11: Sankey diagrams depicting the changes in campers responses between the pre- and post-survey. On the left side of each graph we visualize the answers of each participant's confidence when they took the pre-survey. On the right side of each graph are participants' post-survey self-reported confidence level. The lines follow each participant selection showing the individual changes in their self-reported confidence levels.

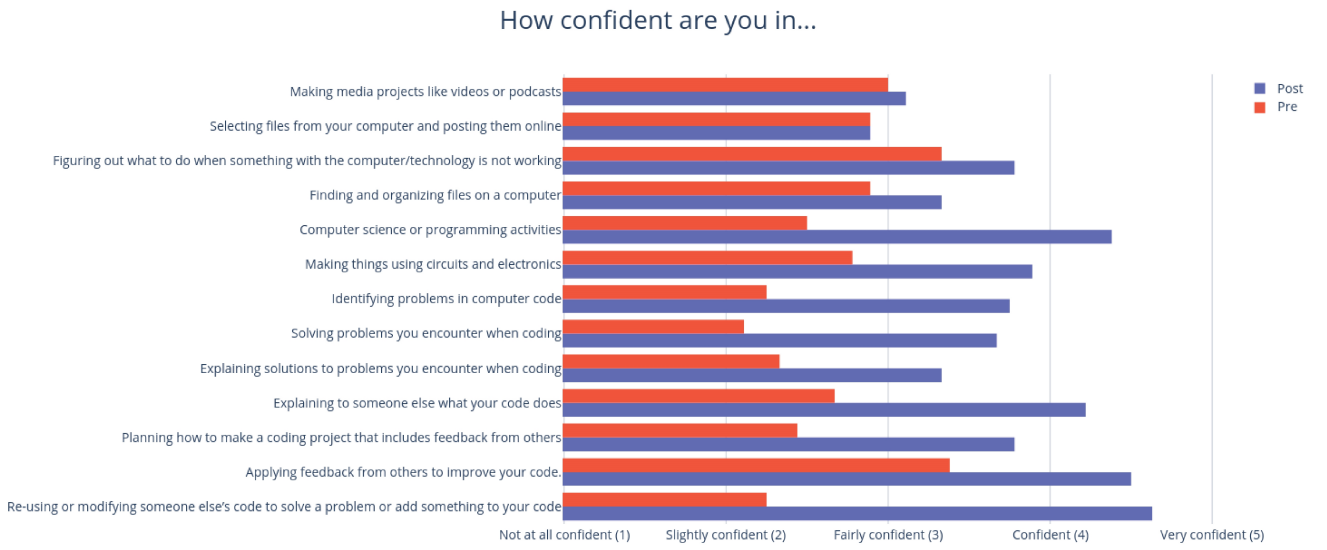

Figure 12: the pre- and post-survey to questions about their confidence levels.

doing and tried to copy off of that," and they felt it was *"better that way."* P2 continued to reflect on her own experience: *"I wasn't really good with coding before, like actual putting it into real things. I never really done that before. I've only like made kind of animations and projects on the computer, not putting into real life. And this boosted my confidence on helping turn my projects into actual [physical things using the micro:bit]... And it helped me see what was going on."*

Participating in the larp increased their interest to learn about how to make things. For example P8 said: *"when we have to take the clues from the roleplay, and then, make something that was connected to it, it was really like interesting"* (P8). Another participant found the value in coding when she was introduced to its practical applications during the larp, she said: *"first, I thought coding was like very boring. But after I figured out all the, all the different, like, stuff that you can do on it. I guess it was, it was fun"* (P9). P5 was proud of one of her coding projects for the mystery at Earhart station, a space station in Plot C: *"[m]y favorite thing I made was a code, a piece of code that could make the micr:bit send messages to other micro:bits [...]. It was challenging at first, but then after I got the idea, I could do it. No problem."* P4's favorite moment was one of the missions on the last day of the camp, when they applied all that they learned during the week. She said: *"I think that was my favorite one because we got to put together all that we learned and everything that we coded and we got to put together a pretty costume for the Fairy ball."*

6.4 Observed Camper Challenges and Difficulties

While the campers had plenty of successful interactions with the technology, there were some technical difficulties that researchers observed that campers needed to overcome. The most frequent programming difficulty that campers encountered was with connecting the micro:bit to MakeCode so that they could upload code. Campers

Figure 13: Campers went straight to the crafting tables as they arrived in the morning.

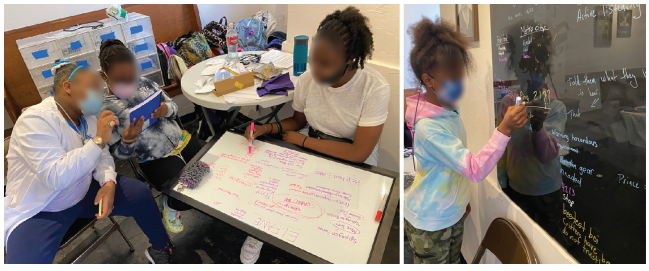

Figure 14: Campers created shared boards to document and map out all the clues they received in their missions.

were able to troubleshoot most of their code using the built-in simulator, but when trying to load their code onto the actual hardware, MakeCode would occasionally not recognize the device. This was

Figure 15: On the final day of the camp, an impromptu "fashion show" provided the campers the opportunity to show off their favorite costumes to each other.

a known bug to the instructors, and campers were shown a work around that allowed the code to be downloaded to the computer first before being uploaded to the hardware that had a much higher success rate. As the week progressed, this knowledge spread from camper to camper whenever someone encountered this issue for the first time. The most frequent hardware challenge observed was malfunctions with the LED strands due to the wires connecting the micro:bit to the LEDs failing from strain on the connection point. Campers would approach a facilitator when their lights would stop turning on, and the camper was prompted to check the connection for breaks or fraying first, and then shown how to trim, restrip, and attach the wires to the micro:bit. Campers that got this lesson from the facilitators acted as technicians for their peers whenever possible, allowing this skill to be shared organically. While this was an unintentional teaching opportunity, it became a valuable one and in future iterations we will more formally incorporate it.

7 DISCUSSION

Here we discuss a few key themes that emerged from the results in more detail:

Larp context: Campers cited the larp context as one of the factors that made their camp experience worth it, that helped them form a cohesive community, and supported an increased interest in learning computational skills. The context that they were playing and learning in gave a shared set of experiences and goals. Adding in this social drive provided momentum to their learning, and participating in the larp served as a positive feedback loop to continue engaging with the overall experience. The use of larp in this way resulted in an environment that promoted campers to engage with the instructional material and each other in a way that was perceived positively different from formal learning in the school. Previous work in edu-larp has shown that taking on the role of a skilled and knowledgeable person can improve a learners interest and comfort in the field they are role-playing [22] but this doesn't necessarily correspond to addressing the identity gap described in STEM educational research [38, 39].

A narrative frame of an academy and trainees– in our case the Anywear Academy, and the "Explorers-in-Training" – facilitated an enjoyable engaging learning experience. We think that there is something unique about playing this type of characters, and learning for the sake of solving missions in the larp. This type of learning may lift the anxiety that is sometimes associated with learning technical skills or the expectation of being able to perform a role that requires expertise. The learning in this case is done for the sake of the characters, and has a social goal– to participate in the drama, and solve mysteries. The story of the Anywear Academy also knitted in, in its overarching narrative, the need to fix things in other worlds, which expanded the fantasy and made the story richer. It also facilitated different genre interests (for example, fairies vs. superheroes).

Based on our observations, we found this type of framing story very powerful in fostering a vibrant, positive, and low stress learning environment. Because of the variety of activities that go into participating in a larp, many campers had a variety of avenues into engagement, some of which they had zero previous experience with. For example, one of the campers reported in the post-interview that she never participated in any acting or drama activities, but she loved it. The mix of it all– crafting, larping (acting and being improvisational), coding, and socializing – was exciting and fun.

Speaking to those who would seek to create a camp that follows a similar structure, we had difficulties navigating the line between overly structured challenges that limited creativity, and challenges that were so open that campers found solutions that bypassed the type of social interactions that we intended as part of a particular challenge. Based on the experience this camp provided, a narrative frame that makes sense within the context of the larp being played out helps to provide and maintain structure in situations where campers find solutions that bypass an activity's intent. While creative problem solving is far from an undesired outcome, these solutions should fit the spirit of the exercise, and communicating that spirit to campers, ideally in a way that makes narrative sense to preserve immersion, is key.

Hardware and how it was used: While campers didn't always make use of the electronics to create wearables that augmented their social experiences in the ways we expected, the devices were a constant feature of their costumes, and the campers did make use of them in interesting ways. Addressable LEDs were used for social and performative purposes such as to show affiliation by syncing their colors prior to entering a mission space, communicate state by showing when a camper's superhero or magic ability was active, as well as for problem-solving purposes. Campers would use the light provided by them to see in darkened areas or to trigger light-reactive puzzle components.

Due to a limited amount of hardware available, campers had to reuse their electronic components across their different costumes for each world. In most cases, campers chose to iterate their existing costumes to fit the mission at hand and integrate lessons learned through the classes, previous missions, and observing their peers. Constantly needing to reuse their electronics provided the campers with plenty of opportunities to experiment with different methods of affixing them to their bodies and iterate, but it also meant that every time they went to a different world for a mission they needed to spend a significant amount of time recycling the components rather than iterating on the design they had just used in a mission. While different worlds offer campers a variety of themes and characters to interact with, structuring the day to allow for campers to reflect on the designs they just used, rather than having them alternate between designs made with a shared

set of electronic components, could potentially result in campers creating more nuanced costumes over time.

More on community building: While it isn't possible to say at this stage that the participants of the camp now have created a computational community that will endure, we can report that the experiences of this camp provided a framework for campers to socially engage with the subject of computation and crafting. Outside of the in-game social experiences and the unstructured social time described in vignette 3, the end of day debrief was another key opportunity for community to develop. It worked for our data collection purposes to prompt the campers to reflect on their experiences daily but this also worked to reinforce their shared group experience. Group reflection and debriefing is a key component in the overall larp experience has been cited as a ritual that leads to the formation of communities of practice [22].

In camper interviews and also in the last informal group discussion at the camp, campers repeatedly asked when the next iteration of the camp would occur. Even if they couldn't participate in the same way, they pushed to be considered as potential mentors or peer councilors, as they wished to come back and continue to support future campers. This, and the fact that they exchanged contact information provided strong support for the camp providing a valuable communal experience.

Grand Finale: A finale is a very common and important component in larps [2, 36]. It serves to close the narrative arch, it is the culmination of the work the larpers have been building towards, and it resolves in a sense of completion. Adına Schreiber explained at NELCO 2018 factors that make for a satisfying climax, which includes success at in-game goals, relevance to one's character, reflection on one's actions and efforts during the larp, achieved transformation, accomplishment of something significant, giving a sense of choreography, and proper focus and spotlight [36]. An event like this is important at the level of individual character development as well as the different relationships between characters.

Ours is peculiar: It is both an event of narrative significance as well as the end of a journey of scaffolded learning. It is the proverbial final exam where they put together what they had learned, but at the same time, with our edu-larp learning approach, it should feel completely different than an exam. The campers commented that having a larp-related event to bring their educational growth to a conclusion was important both from a learning and experiential perspective. By design, our finale was designed to support a good climatic experience: it was relevant for the characters; it would reflect the campers' actions and efforts during the larp, and reflect success at in/game goals and accomplishment of something significant [36]; it was also highly social, and celebratory. While the original design of the finale was set around a party to allow for campers to showcase their work in a social setting, the impromptu fashion show gave each camper an actual structure and platform from which to share their work with each other in a way that was not present in party. The success of an impromptu fashion show that allowed campers to showcase their work to their peers in a supportive and celebratory setting should be further explored and formally integrated into the camp design. Hence this ad hoc improvisation from the facilitators made this final larp event ever more expressive and performative; it emphasized even more a sense of choreography and proper focus and spotlight, which are very important aspects of climatic events in larps [36].

7.1 Future work

As stated earlier, it is difficult to measure the longer term effects of our camp on the formation of computational community without a study that examines what happens afterward. In further sessions of the camp we hope to include a longitudinal follow-up with campers that can help to explore whether a computational community actually forms and how sustainable it is.

We plan to iterate the camp's design in preparation for future instances of the camp, building on the learnings from this first deployment. In the long run, our intent is to build a 'camp in a box' version that allows others to run the camp in diverse contexts. To that end, we are also applying what we learned from this first instance to thinking well about how to package and transfer best practices to others who may deploy the camp in future.

One key goal is to lower the skill threshold required to hold a camp of this complexity, so as to not rely as heavily on highly skilled facilitators improvising extensively on the fly. While we will adapt camp materials to explicitly allow for and include flexible elements, we also plan to develop materials to on-board and skill-up potential facilitators. For example, staff design workshops, improv acting exercises, and a full table read of the camp narrative as a group would go a long way towards making sure that all facilitators are equipped to help produce the best camp experience possible, knowing when and where to adapt what they are doing to provide the best end experience.

8 CONCLUSION

This research project was begun with the hypothesis that a larp-based, social wearables focused camp could build computational interest, competence, and self-efficacy in middle school girls by helping to support the formation of computational community among them. In this paper we describe the design for the camp and report results from the first deployment of the camp. Results support the hypothesis, and the promise of camps like this one to positively contribute to sparking and maintaining interest in computation among middle school girls. Camp observations, interviews and pre- and post-surveys showed that campers reported increases in measures of competence, self-efficacy and interest in computation, indicating that we are on the right track in regards to our primary research question. The research findings will be used to further improve the camp's design, toward eventual dissemination of a 'camp in a box' that can be used by many others.

This research project has relevance to HCI researchers and practitioners interested in designing learning experiences and activities for this target group. It introduces edu-larp as a possible approach to framing technology learning experiences, and presents a design case study that showcases the value of wearables as a technology to use in shared informal learning experiences to help build computational community.

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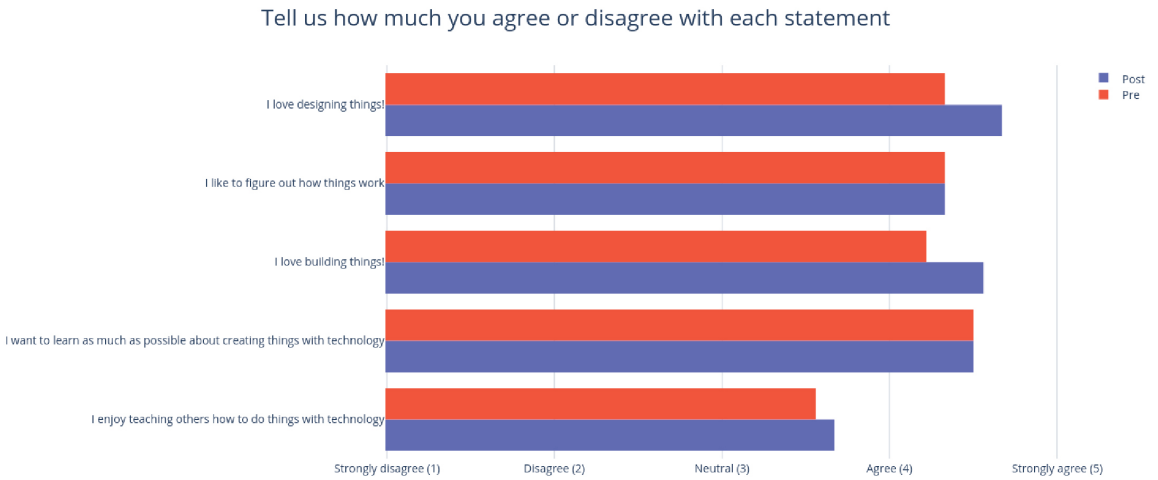
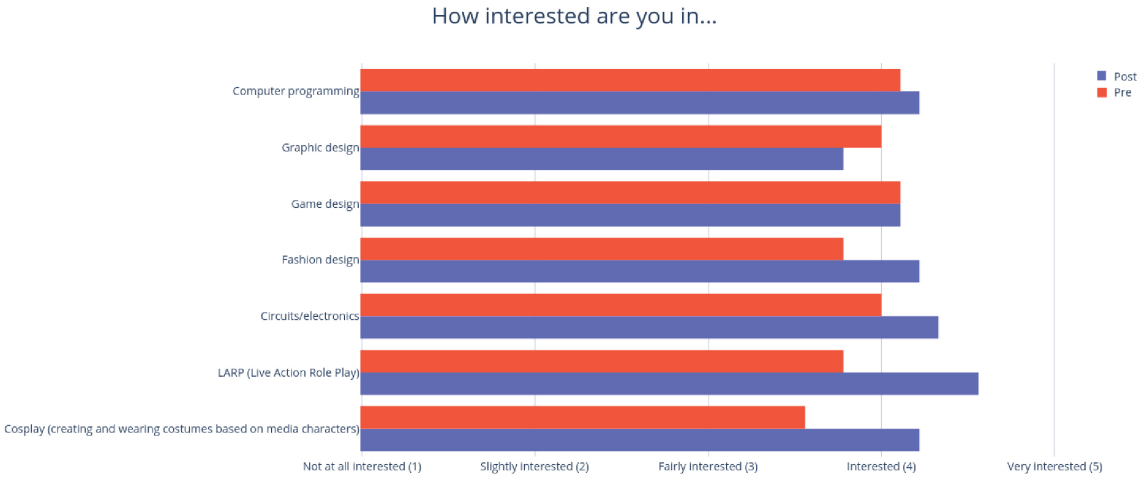
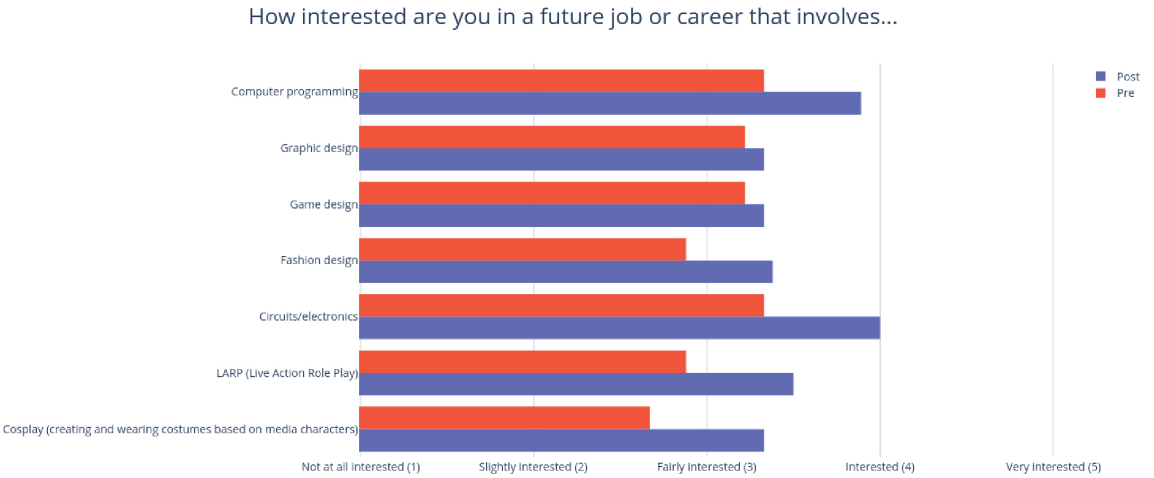
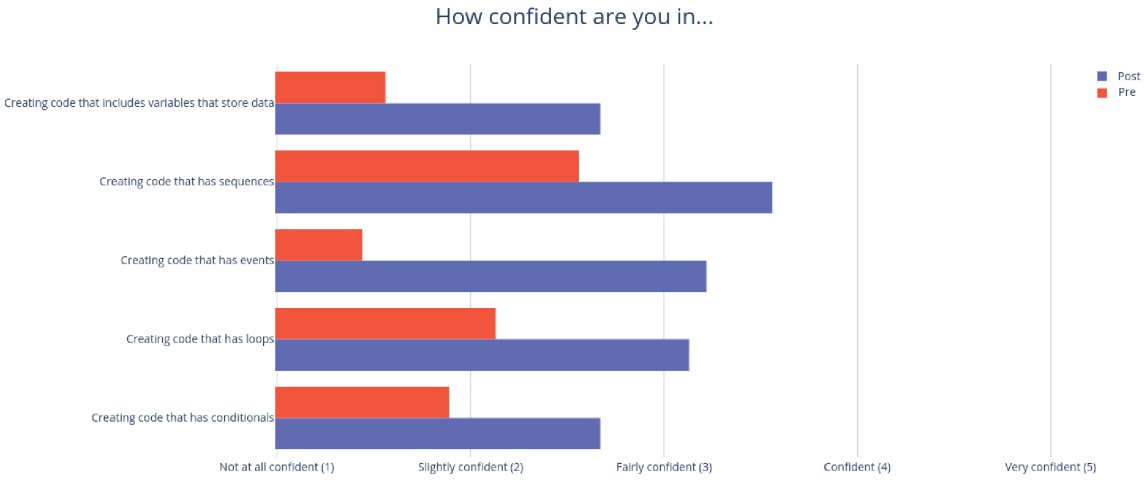
A PRE AND POST SURVEY RESULTS

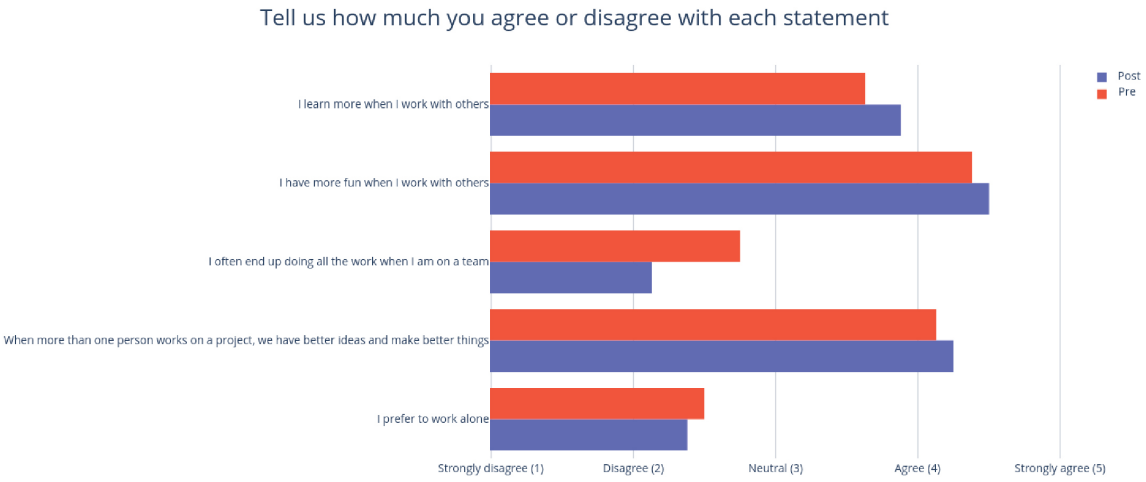





How interested are you in a future job or career that involves...
Post
Pre
Computer programming
Graphic design
Game design
Fashion design
Circuits/electronics
LARP (Live Action Role Play)
Cosplay (creating and wearing costumes based on media characters)
Not at all interested (1)
Slightly interested (2)
Fairly interested (3)
Interested (4)
Very interested (5)


How confident are you in...
Post
Pre
Making media projects like videos or podcasts
Selecting files from your computer and posting them online
Figuring out what to do when something with the computer/technology is not working
Finding and organizing files on a computer
Computer science or programming activities
Making things using circuits and electronics
Identifying problems in computer code
Solving problems you encounter when coding
Explaining solutions to problems you encounter when coding
Explaining to someone else what your code does
Planning how to make a coding project that includes feedback from others
Applying feedback from others to improve your code.
Re-using or modifying someone else's code to solve a problem or add something to your code
Not at all confident (1)
Slightly confident (2)
Fairly confident (3)
Confident (4)
Very confident (5)


How confident are you in...
Post
Pre
Creating code that includes variables that store data
Creating code that has sequences
Creating code that has events
Creating code that has loops
Creating code that has conditionals
Not at all confident (1)
Slightly confident (2)
Fairly confident (3)
Confident (4)
Very confident (5)


Tell us how much you agree or disagree with each statement
Post
Pre
I learn more when I work with others
I have more fun when I work with others
I often end up doing all the work when I am on a team
When more than one person works on a project, we have better ideas and make better things
I prefer to work alone
Strongly disagree (1)
Disagree (2)
Neutral (3)
Agree (4)
Strongly agree (5)