Designing Technology for Girls

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Abstract

While men and women are equally advanced users of technology, young women do not develop technology fluency to the same extent as young men. One reason is that they are continuously neglected as creators and underrepresented as users, manifested in the design of technological artefacts. The goal of this research project was to investigate how to design technological artefacts to narrow the gender gap in technology, and support women in developing an interest and fluency in technology. Through a participatory design process involving 20 girls aged 13-17 we gained understanding of social aspects, features and qualities needed to create technological artefacts that are fun and accessible to the user, as well as identified early prototypes of such artefacts.

Content

1. Introduction

The gender gap in technology as well as the digital divide are well known phenomenon that have been around for decades now. Digital divide refers to the knowledge and communication gap from which social disintegration in technology stems, while the gender gap refers to issues related to low percentage of women in technical jobs as well as a pay gap. More recently governments, educational institutions as well as corporations have started to tackle the issue and are aiming to improve the gender ratio however, women are still continuously underrepresented as creators and neglected as users [1, 20].

While women are equal users, technology is predominantly developed, designed and produced by men. Boys are encouraged to explore programming, women are thought to fear and dislike technology [7]. The perception and attitude towards computation and technology are influenced by social and structural factors [1]. Design of technological artefacts often embody and thereby uphold these conceptions [5, 6]. This is also true for artefacts aiming to introduce technology to children. All these notions combined play a vital role in that young women do not develop an, or lose their interest in technology early. In extent, men are more likely to develop technology fluency than women and as technology fluency is a necessary component to be able to use technology for creation, this phenomenon has significant consequences.

1.2 Background

Technological fluency is the ability to use the computer and technology to create things, realise ideas, contribute to your community and society. It is also the understanding of technological concepts and their application in different contexts and situations [19]. Early exposure is important for development of fluency and interest in technology and this type of experience is key [1]. Boys are usually subject to earlier exposure and report greater experience with programming and creative use of technology than girls [2]. Further, Barron [2] mentions that among young women and men who report the same experience in technology, boys report greater confidence in their technological abilities. Giacquinta and colleagues [10] found major differences in how girls and boys conceptualise computers. Girls understand the computer as a tool used to accomplish tasks, while boys tend to view it as a toy that is used for things such as playing games and programming [10].

While we see a growing number of technological artefacts targeted at young girls, these are often accused of reinforcing stereotypes [20]. Though such artefacts might attract girls, the lack of depth and prospects for development may counter a continued interest. In comparison, video games targeted at boys more often allow programmatic modifications which contributes to development of actual computing and pro-

gramming skills [2, 10]. Lane [14] argue that goals and motivators for women are social while young men is driven by competition and achievement – a notion that constitutes the foundation of many video and computer game designs. Video games are considered a gateway to a continued interest in technology [2], and tend to feature characteristics that are desired by boys [10, 13]. In one study, Kafai [13] had girls and boys design their own games. The research uncovered clear differences in the games feedback and objectives between genders. The boys' feedback was more violent in character, having the player transformed and be game over when the player failed. The objective of the games was to get something, price money or a princess. Girls games focused on activities and allowed players to start-over or hold-back scores as feedback.

As men are dominating the production and creation of technology, technological artefacts are coded male [7]. To view technological artefacts not only as a product of their sociocultural environment, but also an influential actor means that their design can both maintain and challenge social structures that hinders women as creators of technology [21]. Thus, it is important to both involve women in the design of technology and investigate how technology can be designed to include and encourage women to develop technology fluency. In their design brief, Oosterholt and colleagues [18] described the development of a technological product for children in general and young girls in particular, through multiple participatory workshops. Their findings include that an artefact for girls should stimulate communication and social interaction with other girls, creativity rather than achieving scores, and a sense of intimacy. Miller, Chaika & Groppe [16] found, in an extensive focus group study, that girls prefer a good experience, challenging elements of problem-solving and exploration of virtual environments before task completion. The same was also evident in a more recent study by Flanagan [9] This is in contrast to the paradigm in gaming where one constantly has to complete tasks to continue through different levels. The authors conclude that there is a great need for games designed for a female audience.

1.2.1 Design science research

Design science research is a research strategy that involves the design of an artefact, embodying the research findings [17]. Research is conducted through a design process for the creation of an artefact(s) that solves an observed problem. Essentially, it is a research strategy with the principle of learning through creating [12, 17]. The supposed outcome of a design science research project is design science knowledge in the form of an artefact and, for example, either methods, models or design principles [17]. This project will result in knowledge in the form of nascent design theory, and knowledge as operational principles [12], as we aim to investigate principles of how technological artefacts can be designed for inclusion of girls.

Design science research is a fairly recent way of conducting research, and there are a few different suggestions as to how it can be carried out. Peffers et al. [17], agreed

upon by Gregor & Hevner [12], proposes a methodology of six steps. First is to identify the problem, second to define the solution objective. Third is design and development, four is demonstration, fifth an evaluation and the sixth and final step is communication of the proposed artefact and research findings.

1.2.2 Research goals

Young women do not develop technological fluency in the same pace and extent as boys, because the design of technological artefacts is biased towards males. This phenomenon in extent may contribute to social inequality and have negative societal effects with regards to innovation. Even though many girls and young women are advanced users of different technologies they do not have the right artefacts and motivation around them to develop technological fluency and interest. For this reason, the aim of this research project is to learn what technology can we design and create that will engage girls and help them develop technological fluency?

The purpose of this study is to investigate how the gender divide in technology can be narrowed through design of technological artefacts for inclusion of young women by understanding why young girls don't develop or lose interest and fluency in technology. The final goal of this research is to propose a digital technological artefact designed to encourage young women in developing technology fluency and interest in technology, embodying the knowledge outcome of the research activities.

2. Method

This research used empirical method [5] and design science to guide the research [17]. The research was conducted through an iterative process where the outcome of each activity guided the next. A participatory approach was used to gather data through the development of a design together with the participants. The participants were all representatives of the intended target group. Appendix 1 contains an overview of the project timeline.

2.1 Design and procedure

This research was carried out through the design of a prototype embodying the research findings. The process was carried out through Peffers et al. [17] 6 steps for design based research, with participatory activities as described by Greenbaum & Kyng [11], though somewhat altered to better suit the purpose of this research: 1) identify the problem: literature review and survey, 2) define solution objectives: survey and future workshop, 3) design and development: scenarios, lo-fi prototyping workshop

and hi-fi prototype, 4) demonstration: hi-fi prototype, 5) evaluation: user testing - think aloud/wizard of Oz, semi-structured interviews, 6) communication (this paper). Each design activity was intended to yield specific knowledge as well as a number of prototypes of different levels of fidelity.

2.2.1 Survey

Prior to and in conjunction with the future workshop participants were surveyed about their hobbies, everyday use of technology and interest for technology. The survey [3] consisted of 6 open-ended questions, allowing us to gain better insights about the motivations and interests of the participants such as what technologies they use, as well as how and why. In addition, the survey also provided key information to understand why the participants decided to participate in the workshop and their motivations to learn about the creation of technological artefacts. See appendix 2 for questionnaire.

2.2.2 Future Workshop

Future workshop is a participatory design method in three phases: critique, fantasy and implementation. The goal is for the users to clarify their common problems in the current situation, generate visions about the future and how these visions can be realised [15]. Specifically, for this research, method was used to understand the problem as perceived by the participants and yield possible solutions in the form of tangible lo-fi prototypes. The goal was to generate insights that could guide the design of an initial concept based on the participants own solutions.

The participants were presented with a brief background about the lack of females in the ICT sector and the issue that women do use technology to the same extent as men, but does not use it for creation.

Critique phase

The aim of the critique phase is to identify problems in the user's current situation through a brainstorming session and formulate a common, concise critique [15]. In this phase, the girls were divided into 6 groups of 4. Each group was presented with the challenge, post-its and pens. They were then asked to brainstorm individually writing down their thoughts on the post-its as short statements. The statements were then discussed within the groups to decide on one problem (or a set of problems) to solve in the fantasy phase.

Fantasy phase

The fantasy phase is a second brainstorming session with the aim to yield imaginative solutions to the problem statement defined in the critique phase, without any restrictions [15]. The girls were asked to brainstorm about possible solutions to their defined problem individually and then discuss their results within the group. At this stage, they were also given the opportunity to use other materials such as colouring pens and paper in addition to post-its.

Implementation phase

How solutions can be realised is discussed and assessed in the implementation phase [15]. Each group were asked to decide on a solution or combine their solutions from the fantasy phase into one. The groups were provided additional materials such as clay, glue and cardboard to test and modify their vision into a feasible solution and tangible lo-fi prototype.

2.2.2 Lo-fi prototyping

A lo-fi prototyping workshop was held with the objective to elicit requirements, desired features, look and feel of the product and do early evaluation [14, 15]. 12 girls participated in the workshop, divided into three groups of four. A description of the design concept was given, limited to its core features to not restrict the participants' imagination and limit their ability to create own solutions. Three scenarios (see appendix 3) depicting use cases of the potential artefact were given to the participants to facilitate their prototyping conceptualisation and imagination. The girls sketched using materials paper, pens, coloured pens and mock-ups. After individual brainstorming and sketching, the participants presented their designs to their group. The group members then collaborated to refine their ideas into one prototype.

2.2.3 Evaluation

5 girls between ages 13-16 participated in the evaluation of the hi-fi prototype, tested using Adobe XD on an IPhone 5s. The participants were give tasks (see appendix 4) to complete that would take them through vital features. We used a Wizard-of-Oz [11] like set-up to evaluate the function of creating a design or project through code and change the design of your own case, or send it to a friend. Additionally, this method allowed us to evaluate the preview-function in the text editor. One researcher acted as the computer, updating the screen on one phone to match what the participant said she was coding on the other. Following the evaluation, a semi-structured interview

[3] (see appendix 5) was conducted with the participant to yield further information about new requirements, unnecessary features and feelings towards the design.

2.2.5 Analysis

Two different methods for analysis was used in the project. First, thematic analysis was used to analyse the survey results, identifying patterns within the data that we concretised into themes. For every workshop activity, an affinity diagram was created, also with the goal to formulate themes from the data.

Thematic Analysis

Thematic analysis is a qualitative method for identifying, analysing and reporting patterns (themes) within data and is a suitable method for analysing textual data [6]. After familiarizing ourselves with the collected survey data both members of the group generated initial codes and searched for themes individually. This process included collecting codes into potential themes and gathering all data relevant to these themes. After sharing the identified themes with each other our team produced a thematic map following the idea of "Internal Homogeneity and External Heterogeneity" meaning that themes with clear distinction were created [6].

Affinity Diagram

Creating Affinity Diagrams is a similar process to Thematic Analysis and was used in this research project to analyse the outcomes of the future workshop. The ideas generated by the participants were organized hierarchically in order to create the diagram. The process involves grouping similar ideas into categories and then grouping similar categories together [4]. In this project we created affinity diagrams for each phase of the future workshop: critique, fantasy and implementation. An affinity diagram was also created to analyse the results from the lo-fi prototyping workshop.

2.2.6 Participants

24 girls between age 13-18 participated in the survey and the future workshop, and 12 girls between 13-14 in the lo-fi prototyping workshop. 5 girls between 13-18 evaluated the prototype. All participants were experienced users of technology but with little to no experience of using technology for creation and lack technological skills such as programming. Further, all reported an interest in learning more technological skills.

2.2.7 Ethics

This project applies informed consent. To ensure ethical research, all participants were presented with the consent form orally and in writing. As most of the participants are minor, their parent received information about the research in writing and was also asked to sign a consent form to approve their child's participation in this study. In the workshop activities, the girls' teachers also received the information orally to grant their students participation. All participants and all parents signed the consent form. The consent form describes the research objectives and procedure in detail, as well as how the data will be handled and who can gain access. It also described that we will do our best to ensure privacy and anonymity, and have made efforts to ensure that participants cannot be personally connected to any contributions to this research. See appendix 7 for consent form.

3. Results

This section presents the results and analysis of the survey and participatory design activities.

3.1 Survey

Coherent with the findings from the literature review, the questionnaire results indicate that girls are advanced users of technology, but do not use technology for the creation of things. Most commonly used technology is a smartphone followed by the computer. The most frequent answer to why and how technologies are used is for communication with friends and family and the use of social media. After analysing the results thematically [6], four main themes were uncovered about how and why the participants use technology as well as their motivations and interests. See appendix 6 for a thematic table.

Sociability

The Sociability consists of the sub-themes *Feeling connected* and *Motivated by a sense of community*. The majority of the participants mentioned that they use technology for communication more than anything else. They either stay connected with friends or family or use different social media platforms such as Instagram and Facebook.

Some participants stated that their reason for participating in the future workshop was that their friends were going, a clear indication that girls were driven by social motivators as stated in the literature review. *"Some of my classmates really wanted to go here, so I joined them" (p. 24).* Other participants mentioned that they came because they wanted to meet other girls that are interested in technology, a desire for belonging: *"Because not many of my friends like these subjects" (p. 17)*. These participants had a further developed interest and knowledge compared to others: *"Good opportunity to meet more techy girls" (p. 23).*

These findings show that a sense of community and social exchange are important factors and motivators for girls to develop and maintain an interest in technology. Combined with the fact that many mentioned that their interest is to spend time with their friends and that they use technology for communication.

Fun

The participants use technology because it is *Fun to use*, and because you can *use technology for other entertainment*. A majority of the participants reported that they use technology for things such as watching videos on YouTube, watching TV, and gaming. Technology was also used when participants feel bored.

Technology as a tool

According to the survey results, technology if often used as a tool to achieve tasks such as school work**.** Technology is used for *Productivity, To fulfil other interests, For learning* and because it *Makes life easier*.

Empowering

The use of technology can lead to feelings of empowerment for the participants, because they gain *Access to information* and knowledge, as participant 13 described: *"you get all the news about what's happening around the world."*. Many of the participants also possess a great *Belief in Technology* and what it can achieve. Participant 18 stated that using technology *"is like having the world in your hands."*. Participant 21 explained that her motivation behind learning to use technology for creation is "*To make the world better"*.

3.2 Future workshop

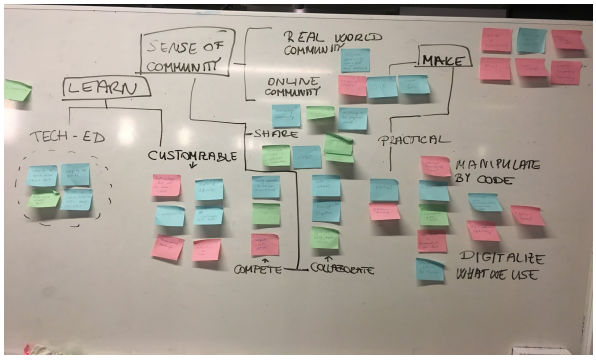

Figure 1. Affinity wall summarizing the findings from the Future Workshop

Sense of community

In the critique phase of the future workshop issues were raised about the feeling, or fear, that women who are interested in technology could be seen as social outcasts. This is related to the fact that technology is considered as male domain, and the sense that women should not be interested in technology. These issues were traced back to social structures that influence how technology is perceived by girls (boring, difficult), should be used (for fun, as a tool) and discourage women to develop an interest in technology. Others discussed that women "don't think about technology", like it barely exists in their worldview or it is not viable option for them to learn more about it.

In the fantasy phase, there was a general consensus among participants about the need for creating a space for learning about technology. Some pointed out that this space should be "safe" allowing girls to try out new things without the fear of failing. Others focused on the rather practical side of such space - more towards the implementation side, they thought such space should provide courses, trainings, meetups related to technology. Being able to discuss topics related to technology with other women as well as sharing ideas was identified as a probable solution to engaging more women with technology by multiple groups. Other solutions feature elements of acceptance to the new notion that technology is indeed for girls, by learning that girls can like technology they aim to reduce the social stigma.

Online and real-world community

Having an online community for support and sharing was a feature that occurred in many implementations. In addition to or even better complementing the online community, participants thought that a real world community of girls and women could allow more to engage with technology.

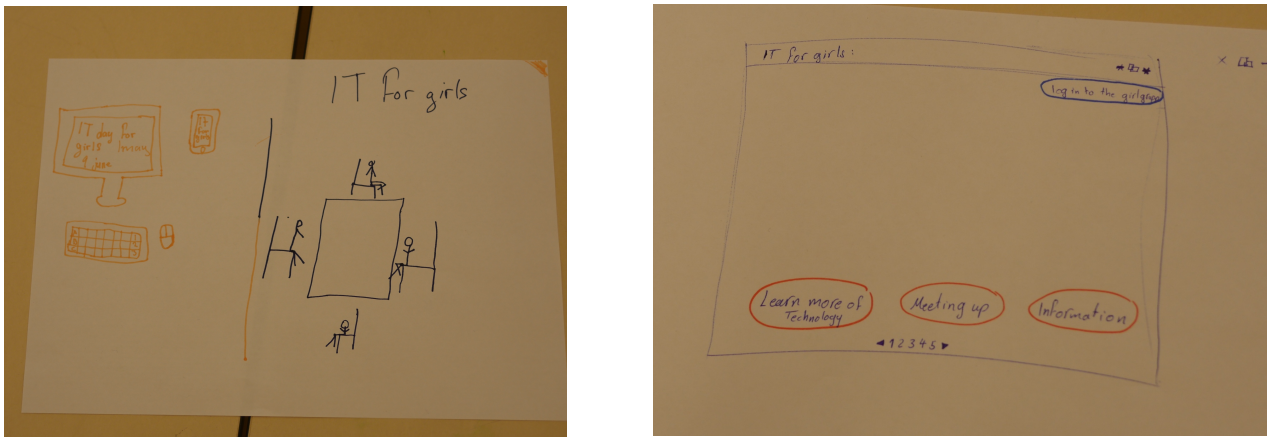

Figure 2. Examples of ideas/prototypes around creating an online as well as real-world community where girls can learn about technology

Share

Being able to share tips, ideas, tools and challenges could contribute to a better engagement of women with technology.

Interact: Compete and Collaborate

Multiple prototypes created by the participants involved the possibility of users building and solving problems together as well as being able to showcase one's achievements and have a healthy competition with other women learning technology.

Learn

An overall assertion in the fantasy phase was that girls should be encouraged to engage with technology from an early age. In addition to being encouraged girls should also be educated about technology and given more opportunities to engage with it.

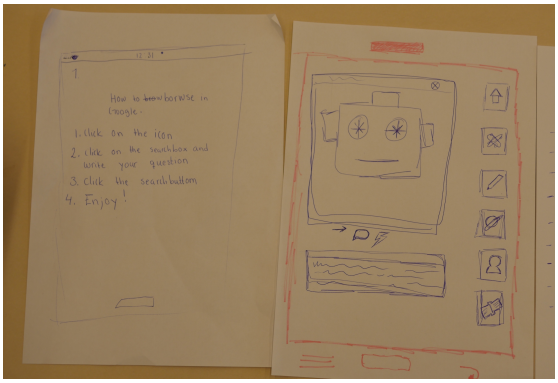

Figure 3. A prototype illustrating a platform that would allow girls to become more educated about technology

Tech-ed

Several solutions worked around the idea of educating users about technology for example apps that teach how to create websites or applications.

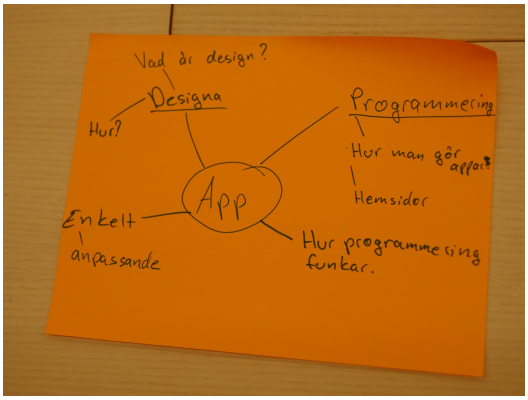

Figure 4. One of the teams that brainstormed ideas around creating an educational app to tech technology for girls

Customizable

Participants identified customizability a feature that their implementations should have. For example, multiple groups created applications that would have different levels of difficulty as well as would be adjustable based on the user's age. One group took the idea further to fully personalized study plan based on the user's interest, age and other qualities.

Make

Based on the problem statements in the critique phase, we can see that the girls think the use of technology is fun, coherent with the results of the survey. Creation however, was described as being perceived by some as boring. A part of this critique was that

young women does not use technology “for serious”, but just for fun. Another critique was that technology is closely related to other interests that are considered male such as cars. Several groups stated that girls are taught to like things other than technology: that is how women are being raised. Some traced the issue back to early childhood with the design of toys being coded distinctly male or female. Also, young women lack the exposure to technology for learning actual skills. They are presented with few chances to get in touch with technology in this way. One concrete example mentioned is that there are too few toys that teach technological skills and that existing ones are perceived to be for boys.

As solutions, participants identified many interests of girls and thought that these already existing interests could be “digitalized” so that they allow girls to acquire knowledge of technology. A focus of such solutions should be on encouraging girls to “build” things as participants believe designing is something girls already have exposure to.

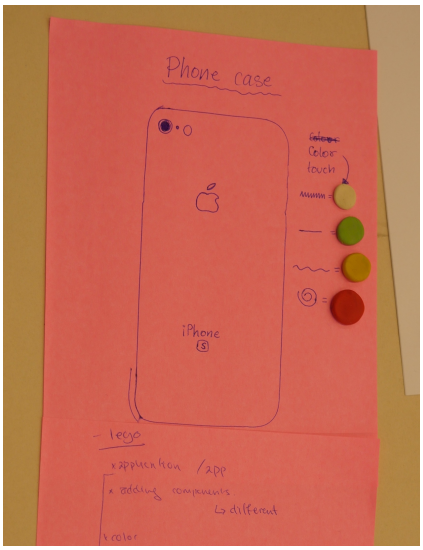

Figure 5. One solution that would digitalize an object all girls already own: the phone case

Practical

Practicality both in terms of relatability to the real world and in terms of problem solving was a feature of multiple implementations. For example, engaging girls with technology through helping them put together real life objects.

Manipulate by Code

Multiple groups incorporated technology into their implementations in a way in which technology allows users to manipulate their environment and/or everyday objects through programming.

Digitalize what we use

During the fantasy phase multiple groups thought that digitalizing everyday objects that they use could engage girls with technology. In the implementation phase there were two solutions along this theme. The first solution fitting this theme is “Robot doll” a programmable doll and the second an interactive changing phone case.

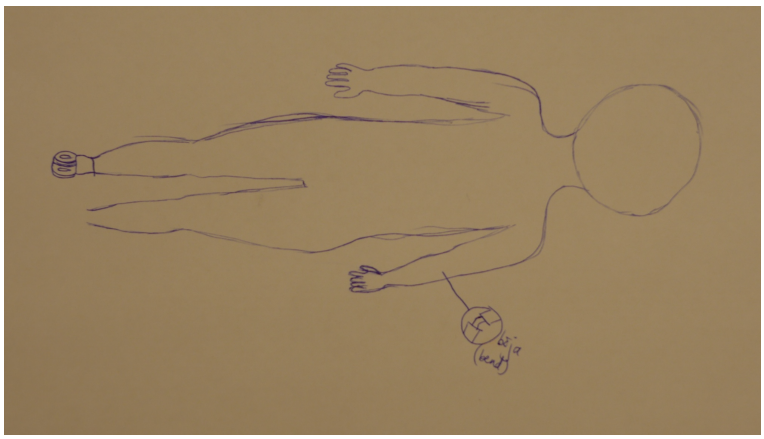

Figure 6. Another solution around digitalizing what we use focused on creating a “Robot doll”

3.2 Lo-fi prototyping

It was clear that the participants had difficulties with the concept of coding, which is not surprising as none had any experience with coding. What the participants did instead was to focus on different features that they wanted the phone case and app to feature or that they wanted to be able to create or manipulate, and used drawing to illustrate coding.

Several prototypes treat the phone case like a second display, a few like a second phone with a touch screen. The prototypes of the app draw similarities to structures that we are used to seeing in applications and are influenced by the girl's own technological environment. Chat-functions are similar to that of Facebook Messenger and Iphone's Imessage. Many of the sketches features icons of commonly used social media services such as Snapchat and Facebook Messenger. The use of emoticons can also be related to their previous experience and use of technology familiarity with emoticons as a means of expression.

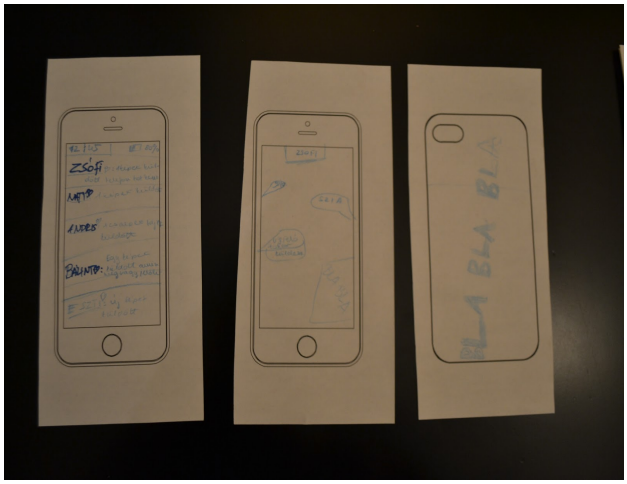

Figure 7. Sketch of chat feature inspired by Facebook-messenger and/or iPhone imessage

Self-expression and customization

The features that the participants focused on in their prototypes are those that facilitate communication, collaboration and self-expression through customisation. Almost all sketched contained elements of self-expression. Hence, the device should facilitate self-expression by allowing the user to customise their case based on their preferences. Coding provides the possibility of customisation to a greater extent than is possible with your smartphone where customisation is basically limited to the image of your contacts, home and locked screen and ringtones. Being able to change the design of the case also creates a fun, encouraging and challenging way to learn code.

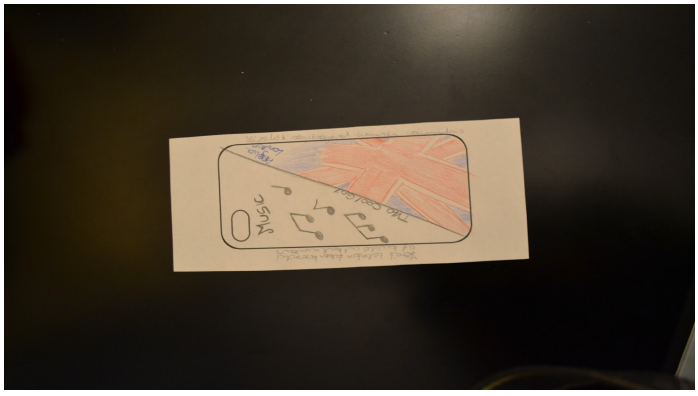

Figure 8. Personal design of phone case. Expresses the participant's music interest and preferences.

Real-time communication and collaboration

Communication with friends and others for support was recurring features in the prototypes. The artefact should allow for real-time collaboration and exchange with friends and other people in the community based on need. In the prototypes, the

communication was set in a real-time messaging feature, both with friends and unknown members of the community for support on projects. In one design, users could create and play a game simultaneously with another user. Other forms of communication suggested was to be able to send images to each other's cases, either as messages or as alteration of the design of a friend's case.

Practical features

The artefact should contain practical features such as reminders and notifications. The application should allow for creation and manipulation of these features; i.e. set the reminder through code. The case should display the reminders and notification. Another idea was that you should be able to code and send location for meetups with friends.

Emoticons and images for communication

The participants made extensive use of emoticons and images to organise and make sense of the content in the prototypes of both the application and the phone case. The majority of coding project examples in the prototypes are creations of virtual images to either be sent to a friend's case or displayed on the user's own.

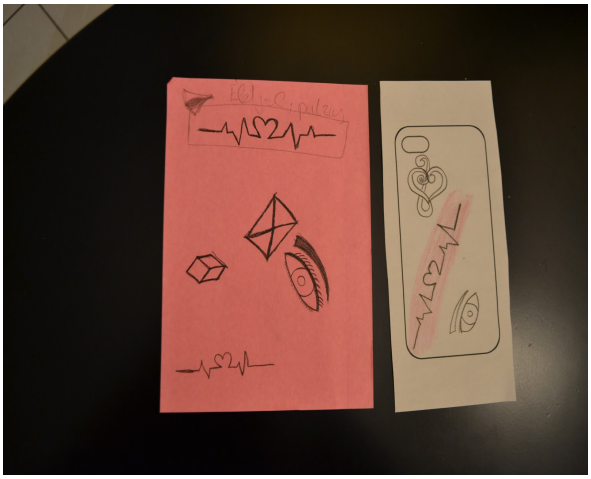

Figure 9. An image sent to a friend's phone

Preview of written code

As stated, the participants had no previous experience of coding. To make sense of using code for creation, it was suggested that the coding environment should feature a preview of the case or message to be sent to a case. This would let the participant see the effect of the added or changed code directly, also if there are errors in the code. I.e., if a participant's change the colour of the case to blue, the preview should visualise the changes as the code is written.

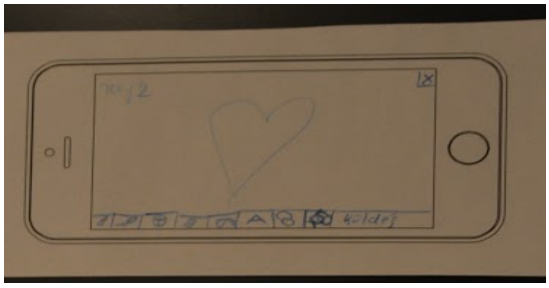

Figure 10. Environment in which the code is written, simultaneously showing a picture of the code

Text-based communication in the app

While the projects that users send to each other or create to be displayed on their own cases should be image-based, communication about collaborative work on or help with projects, should be text-based and carried out in the phone application rather than on the case.

3.3 Initial design and hi-fi prototype

Based on the knowledge and prototypes yielded from the future- and lo-fi workshops an initial design and hi-fi prototype was created using Adobe XD. The prototype created manifested the identified design requirements in terms of its features as well as feel.

A community platform for sharing and browsing coded phone cases

Throughout the research project the sense of community and support was a reoccurring theme that was given importance by participants. Therefore, the application was designed to support sharing one's ideas as well as learning from others. Figure 11-A shows this feature of the application. Users are able to brows projects based on themes both those created by their friends as well as by others around the world.

Customise and change the design of one's own or a friend's phone case

The application was prototyped to have a coding environment that allows users to design and code the phone case they would like to have or send to their friends. Figure 11- B illustrates the coding

Send coded designs and messages to a friend's phone case

The application allows users to not only express themselves through changing the design of their own phone cases but also to send coded designs and well as messages onto a friend's phone case. In figure 11-B once the coding is finished one has the option to either "upload" the work to their own case or once saving it to send it to a friend.

Messaging feature for support by friends or others in the community

In addition to community in general a reoccurring theme among our participants was a safe space for asking and learning. In order to better facilitate learning and co-discovery of the potential of the app users can quickly "ask help" from specific users who are their friends as well as the entire online community through posting the project under development and the relevant issue/question. Figure 11-C illustrates this feature.

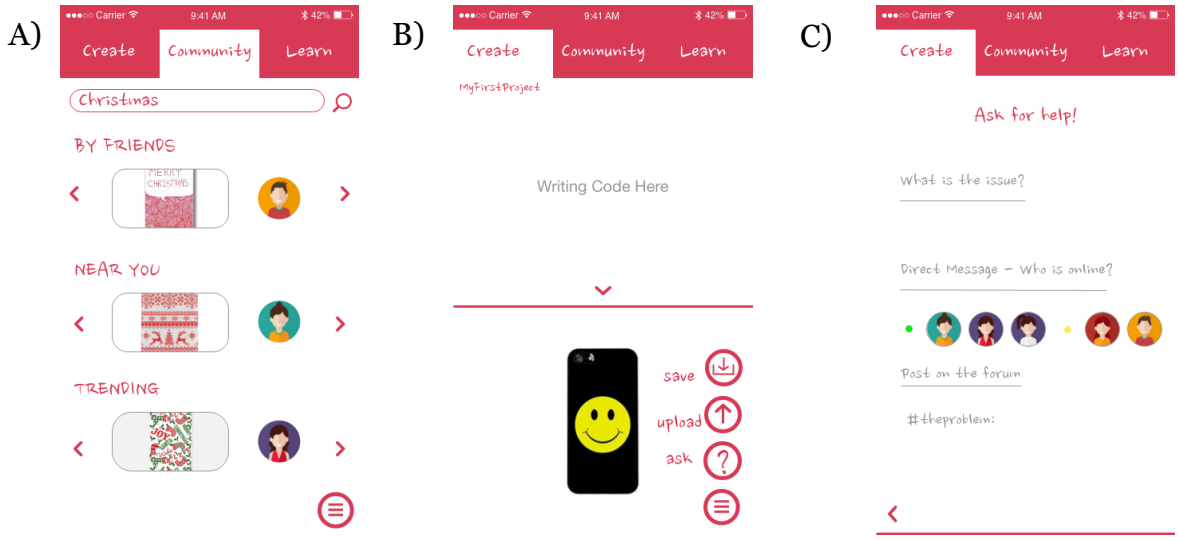

Figure 11. Hi-Fi prototype created in Adobe XD. A) Community platform for browsing and sharing projects. B) Coding environment with the preview of the phone case visible. C) Messaging feature for support from friends or other is the community

3.4. Evaluation

Based on observations while participants freely clicked around the application, while performed certain tasks given to them as well as based on their responses to the post-testing short inquiry several major observations were collected.

Figure 12. Participants were first asked to freely explore the prototype on the mobile device

The main findings from the participatory evaluation in terms of critique and hardship were the following:

- The idea of setting the design of the case is not intuitive
- Preview-function (figure 11-B bottom half) is not intuitive; its availability should be made more visible
- When wanting to ask for help many participants went to the "community-site" instead of help-chat (figure 11-C)
- Icons representing "Sharing", "Saving" etc. were not always intuitive (figure 11-B)
- Need for tutorials and/or wizard, make more predominant feature in the app
- Participants seemed to not read the text, which might be pointing to problem with the font

The main feedback from the participatory evaluation in terms of general design and feel of the artefact were the following:

- Participants liked that once can share their own project, especially with friends
- Participants liked the design, found it clean and overall quite easy to understand
- Participants found the idea a fun way of learning code, something they would use

4. Discussion

The outcome of this research is imagiCase, an interactive smartphone case and app designed to engage and motivate girls to learn code. The design focuses on sociability and creativity. It embodies the research findings in throughout this study and responds to the research problem. The fact that communication and other social aspects are vital motivators was evident throughout the study. It was displayed in different manners in the survey as well as in the outcome of each design activity. In the evaluation it was evident that the fact that you could send their projects to friends was considered the most valuable feature. That sociability is vital to girls in their technology use is in line with previous studies mentioned in the literature review such as that of Oosterholt and colleagues [18], Lane [14] and Miller et al. [16]. Oosterholt et al. [18] came to the conclusion that similar artefacts for girls should allow them to interact with each other.

This study also shows that it could be important for the development and sustainment of both an interest and fluency in technology. Many girls said that the feature that allows users to share their work with friends would make them want to use the proposed device. In addition, this research shows the need for a sense of community to be established between girls, where one can meet others that are also interested in

technology. This was first discussed in the survey, were the girls with further advanced skills stated that they participated in the study to meet other girls that share their interest in technology. Almost every solution from both the future workshop and lo-fi prototyping session featured elements of a community where girls could support each other, collaborate on challenges or ask for help. There were also solutions that would allow girls to meet up physically, or suggest organised tech meetups. The latter could be inspired by the setup of the future and lo-fi prototyping workshops. However, there is still much evidence to show that a sense of belonging is important for girls to even pursue technological skills. To see that other girls are also learning and are interested in technology will challenge the male dominance and feeling that technology is for men, a problem discussed both in the problem phase of the future workshop and in previous studies [7, 21].

The survey showed that technology is indeed still considered as a tool for girls, as stated found in the literature review. This also showed in the lo-fi prototyping workshops, where many designs incorporated practical features, such as using code to set reminders. However, in difference to Giacquinta [10], it seems that girls are beginning to see technology itself as something fun, not only as a means to achieve a task. Many of the respondents stated that technology is fun to use but can also be used for fun. However, none mentioned that they use technology for creation, that boys do according Giacquintas [10] and Barron [2].

Oosterholt et al. [18] found that it is important to stimulate creativity. Findings from this study are similar. The girls wanted to create images by coding to send to each other's' phone cases. By stimulating creativity, we can motivate girls not only to engage with a product but to learn code as well. A finding that is closely related to the importance of stimulating creativity is the importance of stimulating self-expression. Customisation and self-expression seemed to be important factors for girls, evident in their own solutions from the future workshop as well as in their prototypes from the lo-fi prototyping workshop. The girls wanted to be able to manipulate the design of their case to match their preferences and interests.

4.2 Conclusion

Based on our research we were able to identify several crucial design requirements for creating technology for girls. These requirements include creating a sense of community, facilitating personalized learning, being able to share and interact and finally engaging with technology through objects of everyday life, items that are already used by girls. Beyond just identified design requirements this project also aimed to deliver the design of a digital artefact based on the outcomes of the research activities. This artefact, imagiCase is an interactive smartphone case and app designed to engage and motivate girls to learn code based on findings from surveys and participatory design workshops.

4.3 Future work

To understand if a device like the one we have proposed in this paper can actually help women to learn code, further studies will have to be conducted. These studies should investigate learning, and would be required to take place over an extended period of time. The artefact would also need to be further developed and implemented for such research. While this research project provides, and confirms and evolves important findings, further studies in the area are required to be able to determine design principles for, for example, inclusive design with focus on girls.

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Appendix 1 - Table: From research to results

Table 1: From research to results. Adapted from Buchmüller [8]

<table>
<tr><td colspan="4">Research Issues</td></tr>
<tr><td colspan="4">• Not enough women in technology
• Girls do not develop technical fluency
• Technology is considered “boyish”</td></tr>
<tr><td colspan="4">Sample</td></tr>
<tr><td>Workshop I:
~20 girls of age 13-17</td><td>Workshop II:
~20 girls of age 13-17</td><td colspan="2">Validation Workshop:
~20 girls of age 13-17</td></tr>
<tr><td colspan="4">Research & Design Phases/ Duration/ Methods</td></tr>
<tr><td colspan="4">[1] - Survey / 20 minutes / At the beginning of each workshop
[2] - Participatory Design Workshop / 1.5 hours / Ideation and Prototyping
[3] - Analysis / After each survey + workshop cycle
[4] - Validation / Validation of the final prototype</td></tr>
<tr><td colspan="4">Results/Outcomes</td></tr>
<tr><td>Survey</td><td>Design Research Analysis</td><td>Design Practice/ Ideation</td><td>Validation</td></tr>
<tr><td>Using Thematic Analysis:
• understanding girls’ interest
• knowing technologies used by girls</td><td>-Affinity Diagram</td><td>• 6-7 prototypes after each workshop</td><td>• Results on the effectiveness in increasing technical fluency</td></tr>
</table>

Appendix 2 - Survey Questionnaire

Pre-workshop survey

Hi! Thank you for participating in the survey and workshop. Please answer as detailed as you can and like. Participation is voluntary. Your participation is anonymous, so you do not need to put your name on the survey. If you have any questions just ask us. Thank you for contributing to our study!

General

- What made you interested in attending this event?
- Describe some of your interests and favourite things to do?

Experience with technology

- List some of the technologies you use, if any.
- What do you like about these technologies?
- Why do you use these technologies?
- Describe what you use these technologies for and how you use them.

Appendix 3 - Scenarios

Scenario 1. ***Code***
During class, Anna sees that her phone case blinks. It's a message from her friend Sophia who is also learning how to code. Anna and Sophia do this all the time, change things on each other's phone case or write messages or things and send them to each other. She thinks it is so much fun and exciting to see what Sophia has done every time. As soon as she gets out of the classroom, she looks at her case to see what Sophia sent her. As she has some extra time between her classes in school, Anna opens up the app to finish a message she began coding earlier for Sophia and sends it to her.

Scenario 2. ***Community***
Anna hangs out in her room in the evening and plays around on her phone. She opens up the app to look through projects that other girls have done and uploaded. She usually does this to get some inspiration of new things she can try do herself on her phone and case or send to her friend. Anna has just finished one project that she is very proud of, and decides to share it with everyone else. She uploads it to the app. She thinks it is so nice that other girls like what she has done and that they can encourage each other.

Scenario 3. ***Learn***
Anna is on her way back home from school- as usual taking the bus. To kill some time and also to do something fun Anna opens the app and tries to solve a challenge given in the app. She usually does this type of challenges every other day because they are fun and she also feels like she is learning from them. However, the challenges have been becoming more and more challenging. When she gets stuck Anna also uses the app to turn to the community for help on how to solve the challenge.

Appendix 4 - Evaluation tasks

Tasks

1. You want to get started with the app - search for a beginner lesson.

2. In order to get inspiration from the community you can see what others have been coding and designing. Look for a cool Christmas project a friend of yours made. Try the design on your case.

3. Start coding a new project, but there is something that you can't solve. Ask a question to a friend or someone else who might be able to help you.

4. You want to change the design on your own case. Start a new project. Create a smiley. See if you can preview the When you are done, save the project. Try it on your case.

5. Go to my projects. Select your christmas tree project and send it to your friend Sofia.

Appendix 5 - Post-evaluation interview

1. Design. Tell us what you think about the design of the app?

2. Features. Do you feel there is anything missing?

3. Can you tell us what you think about the device? What do you like? What don’t you like?

4. Is this something you would use? Why? Why not?

Appendix 6 - Thematic Table

THEMES	SUB-THEMES	CODES
Sociability		
	Feeling connected	social, be with friends, talk to friends, talk to family, social media, connection to the world
	Motivation by community/sense of community	be with friends, social media,
Fun		
	Fun to use	for fun, technologies are fun to use
	Use for other entertainment	watch to, YouTube, Gaming, video games, game consoles, against boredom
Technology as a tool		
	Technology for Productivity	Helpful, track progress
	Use to fulfil other interests	communicate, watch tv, watch YouTube, gaming
	Makes life easier	accessible everywhere, works well
	Learning	learn things, look things up, school work
Empowering		
	Access to information	search for information
	Belief in technology	make the world better, world in your hands

Appendix 7 - Consent Form

CONSENT FORM

You/your child is invited to join a research study looking at why young women do not develop or lose interest in technology. We are investigating what features that attracts women to develop and maintain an interest and skills in the use and creation of technology. The outcome of this research is the design of a technological artefact, aimed at young women, that embodies the knowledge obtained from the study.

You/your child will be asked to participate in a workshop to design and prototype a technological artefact. The workshop lasts 1,5 hours. At the workshop, an entry and exit survey will be performed with questions about your/your child's interest and experience with the use and creation of technology. Each survey will take 5 – 10 minutes to complete. While there will be no audio or video recording, we might take written notes during the process and photograph the prototypes. You/your child will not appear in any photographs. Participating in the study is voluntary. Attending the workshop does not mean you/your child is obligated to participate in the study.

Every effort will be made to keep personal information and research records confidential. You/your child's name will not appear on any research records and no contribution can be traced back to a specific person.

I understand that I/my child will attend a design workshop as a part of Girls in ICT Day at KTH in Kista. I hereby give my/my child permission to participate in the study as described in this form. I understand that I/my child have the right to withdraw their participation at any time, including after the participation is completed.

Call Sara Eriksson at +46(0)702000157 or email saraе9@kth.se, or Dora Pálfi at +46(0)706956772 or email dorap@kth.se if you have any questions about the study or this consent form.

Student Name and Signature:

_____

Date:

_____

Parent/guardian Name and Signature:
(required if student is under age of 18)

_____

Date:

_____

Researcher Name and Signature:

_____

Date:

_____