Young smart thing designers

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Abstract

Smart thing design can benefit children in several ways, such as by augmenting their understanding of technology, stimulating their creativity and allowing them to participate in collaborative activities. This paper outlines the research gap, and presents the research questions, methodology, main actions and results of a PhD research dedicated to investigating how to frame smart thing design with children.

Keywords

smart thing, game, card, toolkit, model, framework, design, making, children, action research

1. Introduction

Smart things are things, physical objects, augmented with computing capabilities [1]. The concept of “smart things” is often difficult to be grasped by children. This situation changed in the latest years, thanks to physical computing toolkits for children (e.g., [2, 3]). Most of the times, however, researchers focus on engineering and programming aspects of such toolkits, whereas creative design remains less addressed [4]. Recently, there has been an effort to include a “designerly” approach to physical computing and prototyping by combining design thinking, making and reflection (e.g., [5, 6]). In spite of that, there is a lack of research for guiding children in using this kind of technology in a creative way, for their own purposes.

This PhD is about enabling children to design their own smart things. A design model and a toolkit, namely SNAP, were specially created towards this goal. The model and toolkit for smart thing design evolved through action research experience, with 70 children, 8–16 years old. Each action took the form of smart thing design workshops. Data were gathered and analysed, in relation to the model and toolkit, but also in relation to children’s benefits, throughout the 4 years of the PhD. An overview of the actions and main results are presented below.

2. Related Work

Engaging children in design has been extensively explored in the Child-Computer Interaction community. Lately, researchers voiced the need that design with children should not only focus on the tangible outcomes, but also on children’s benefits [7]. Design, where children and their benefits are the center of attention, requires thus a special approach. Towards this goal, specially adjusted frameworks and models were introduced that engage children across
exploration, ideation, programming and prototyping stages (e.g., [8, 5, 6]). In most cases, however, physical computing toolkits for children have more of an optional or supportive role. In a process, however, in which children are expected to implement their ideas by using such toolkits, e.g. for designing smart things, the process should consider the characteristics of them and guide children accordingly. Proper scaffolding that guides children in ideating and programming with physical computing toolkits should thus be part of the design model.

Design toolkits, that traverse the entire design process, can also support this direction. Cards, for example, that represent input and output devices of physical computing toolkits and things to be made smart, can help children be aware of and get familiar with the technology involved in the process [9]. In addition, toolkits can guide children in programming their solutions with simple if-then rules, as they do for adults [10], besides adding playfulness [11]. Design toolkits for smart thing design by children, however, are missing from the literature.

Overall, design with children remains a fertile area for further research, in general, and smart thing design, in particular. The goal of this PhD is to cover this gap and investigate how to frame smart thing design with children, by considering children’s benefits out of this process.

3. Research Questions

The main research questions related to this PhD are as follows:

RQ1. What is the design model that can allow children design their own smart things?
RQ2. What is the design toolkit that can allow children design their own smart things?
RQ3. What are children’s benefits by designing their own smart things?

4. Methodology

The term Action Research (AR) was first introduced by Kurt Lewin as “a spiral of steps, each of which is composed of a circle of planning, action, and fact-finding about the result of the action” [12]. AR studies are usually conducted through multiple cycles, each of which involves the identification of practical problems, the solution of those problems, and reflection on the part of the researcher. The goal, in general, is not to arrive at the solution of a given problem, but to create a solution that is better than the previous ones, and at the same time, to allow all participants derive benefits [13]. For the purposes of this research, the model and toolkit for smart thing design evolved through AR, by including the following steps (see also Fig. 1):

1. Development: Different versions of a design toolkit in the form of a game, SNaP, were developed based on past reflections. A design model was also created based on existing models and re-adjusted in each cycle according to new identified needs of children.
2. Actions: Actions were workshops with 8-16 y.o. children designing smart objects in the span of 3 years. They adopted the latest evolution of the design model and the SNaP game (e.g. see Fig. 2). Moreover, across all actions, data were processed by considering children’s benefits in terms of engagement and learning, besides their overall experience. Data were collected with a mixed-method research design, by means of observations (direct and
indirect), questionnaires (e.g. [14]), and children’s products. See [15, 16, 17, 18, 19] and Table 1 for an overview of all main actions.

3. **Reflections**: Every time the model and game were developed and used in actions in the field, designers reflected on results of actions. Reflections triggered decisions about the next evolution cycle of the model and the game: if the model assisted children in designing smart things and learning during the process, if the game was understandable, engaging and helped children design.

![Figure 1: The action-research evolution of the SNaP toolkit along spiralling cycles](image)

![Figure 2: The SNaP toolkit and design model of Summer 2019 action](image)

5. **Main Results**

Results regarding children’s smart thing design competence, learning and engagement are overall positive. They indicate that the game-based structure of the workshops can help children in developing the skills for smart thing design, in terms of ideating and programming, and keep them engaged. What is more, SNaP can help children in reflecting towards their solutions through structured insights and make them evolve, besides fostering children’s creativity. A step-by-step scaffolding, enabled by SNaP and the design model, allowed younger children who had never designed smart things, to grab how to ideate and program these, whereas more experienced children preferred a more open-nature version of the toolkit for creating more complex ideas. Overall, SNaP-based workshops can enable children to design smart things and over-time become independent in doing so, with minimum help from adults.
Table 1
Information concerning actions with SNaP

<table>
<thead>
<tr>
<th>When</th>
<th>How</th>
<th>Where</th>
<th>Data</th>
<th>Instruments</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>In presence</td>
<td>Athens, Milan, Bolzano</td>
<td>engagement, learning, experience</td>
<td>observations, questionnaires, products</td>
<td>12 (8F, 4M)</td>
</tr>
<tr>
<td>Summer 2019</td>
<td>In presence</td>
<td>Bolzano</td>
<td>engagement, learning, experience</td>
<td>observations, questionnaires, products</td>
<td>27 (10F, 17M)</td>
</tr>
<tr>
<td>Autumn 2019</td>
<td>In presence</td>
<td>Bolzano</td>
<td>engagement, learning, creativity</td>
<td>observations, questionnaires, products</td>
<td>4 (1F, 3M)</td>
</tr>
<tr>
<td>Summer 2020</td>
<td>Hybrid: at a distance, in presence</td>
<td>Ioannina, Milan, Bolzano</td>
<td>engagement, learning</td>
<td>observations, products</td>
<td>7 (3F, 4M)</td>
</tr>
<tr>
<td>Winter 2020</td>
<td>At a distance</td>
<td>Salerno</td>
<td>engagement, learning</td>
<td>observations, questionnaires, products</td>
<td>20 (7F, 13M)</td>
</tr>
</tbody>
</table>

Total n. of participant children: 70 (29F, 41M)

6. Conclusions

Despite the recent interest in integrating design thinking and making, there is still a lack of research for guiding children on how to design with physical computing toolkits creatively. This 4-year PhD has this goal, enable children to design their own smart things. This paper reports briefly on relevant literature and presents the research questions, the methodology and actions conducted up to the 4th year of a PhD research. Main results are also briefly presented.

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References


