Design Thinking with Children: The Role of Empathy, Creativity and Self-Efficacy

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ABSTRACT

One of the main challenges in designing learning activities at the intersection of digital fabrication and solving complex problems is creating a motivating context to keep up children's engagement with the problem and going through the iterations of design thinking. Based on a four day out-of-school learning workshop with 18 children, we reflected upon ways to boost children's agency. The main question of our research relates to the interdependencies of workshop design and children's ability to steer the co-design of activities and outcomes. We present first evidence gained during the workshop series and suggest a framework for scenario-based, digital fabrication workshops.

CCS CONCEPTS

• Social & Professional Topics → User Characteristics • Applied Computing → Education

KEYWORDS

design thinking, digital fabrication, early education, co-design

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1 Introduction

The combination of Design Thinking (DT) and digital fabrication in education can be linked back to Montessori's quest for more observation and reflection in pedagogy [6]. Similarly, Papert's emphasis on constructing knowledge through experience [7] and Resnick's description of how learning can be designed in a more playful and creative way [11] provide compelling arguments for the integration of digital fabrication in education [14].

This paper presents an evaluative snapshot from a project (DOIT - https://www.doit-europe.net/), which aims to address societal challenges as presented by the UN Sustainable Development Goals through novel educational designs. Key of this project is a focus on entrepreneurial skills and attitudes during early education, supporting children at the age of 6 up to 16 on their path from recognizing a problem to creating potential solutions [13]. Envisioned areas of activities range from inclusive living environments and promotion of physical activities to environmental protection. Our workshop was structured around Design Thinking principles [12]. In this paper we present the argument that a main challenge in designing learning activities at the intersection of digital fabrication and solving complex problems is creating a motivating context to keep up children's engagement with the problem, going through the iterations of design thinking.

2 Research Questions

Our research interest in this paper is the relationship between the design of our learning workshops and the level of agency taken on by the children, since we see 'agency' to be a crucial driver for design as well as learning. 'Taking agency' is also an ingredient to self-regulated learning [9], which is a core requirement for problem solving and Design Thinking.

Our educational design had the task to scaffold planned activities, prepare the resources needed throughout the workshop and generally prepare facilitators for the orchestration of an event. Given that our main interest was in seeing as much of the action run by the children themselves, we aimed at consciously selecting a minimum of scaffolds in order to avoid over-scripting the intended flow of activities [15]. Agency and self-regulation are preconditions for freely choosing our actions, our ability to act in sync with the available information, develop personal standards, maintaining a critical stance towards group pressures ('how things are done usually') and other forms of socio-structural influences. We were explicitly looking for any activities evidencing Design Thinking skills and were then reflecting on how much of that could be attributed to specific workshop design decisions.Therefore, in this paper we aim to respond to the following question: *How can we facilitate specific Design Thinking skills and capture their development through observable activities?*

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3 Related Work: Design Thinking in Educational Settings

Broadly speaking, there were two main categories of previous work to consider: first, studies related to Design Thinking as part of teachers' lesson planning, and second, studies related to the impact of Design Thinking on learners' personal development. At the core of Design Thinking is a pattern of reasoning closely associated with abduction, i.e. the quest for tools or processes that can produce a desired outcome in a not entirely specified, but envisioned, way [4]. The relatively high uncertainty in this process requires the cyclical approach described in Design Thinking. Design Thinking is strongly problem driven, suggesting an approach to learning that excels in steering students' imagination and motivation [3]. Carroll at al. [3] define Design Thinking as a method, primarily 'developing children's creative confidence' during hands-on projects, where empathy and action are paramount in order to access the gist of the problem. There are a plethora of models suggesting different steps such as 'understand, observe, ideate, prototype and test' [12]. Eventually, children should ask questions such as 'what if I do ...' and 'what could be done, if ...' [3], opening up novel opportunities for children to develop their creativity in an applied way.

4 Workshop Setup

The mission of the workshop series was to enable children to find and develop creative designs related to the idea of a 'smart home'. The theme of smart homes was introduced as a home that would react in smart ways to problems the children knew about, e.g. cooling a house during a heat wave or detecting water in the basement. The overarching frame for our workshop design was derived from DT principles as explained in the 'related works' section. However, DT related skills had to be integrated with learning more technical skills such as card board handling, wiring of electronic components and block-programming. It is a known problem that 'learning necessary technicalities' – e.g. which wire needs to go where - and 'developing a DT approach' – e.g. understanding the core of a problem and why it matters for the people affected – can be at odds. We also put considerable effort in choosing a micro-board, suitable for children between 7 and 11 years old. Eventually we decided to use the Calliope board (https://calliope.cc/en). The workshops were held on four consecutive days. Day 1 introduced the facilitator team and the workshop ideas and started with analogue programming examples, Day 2 advanced practical examples using the Calliope micro-board. The objective of day two was to build up confidence with the technology in general and instill a sense about how technology could support the implementation of potential solutions. Day 3 provided time for children to continue to work on their prototypes or address a new challenge. Simultaneously we started working on presentation materials for the final event on the next day. Day 4 included discussions about future developments, the possibility to scale the prototype from an entrepreneurial point of view and also a little fair for the relatives and others, including the city mayor.

5 Methodology and Data Collection

In order to capture specific design details and individual experiences of facilitators, we used structured documentation and focused interviews [10].

The structured documentation of workshops had a twofold motivation of (a) stimulating facilitators' reflections on their workshop design in order to identify gaps for further improvement and (b) revisiting the effectiveness of the Design Thinking approach. The interviews helped to gain a better understanding of what the actual activities were, since making comprises a wide range of foci and technologies e.g. the modelling of a smart home at the scale of a shoe carton (as we did in our pilot). A second objective was the clarification of 'summary judgments' [10], e.g. if the workshop documentation stated that a particular activity 'worked well' or 'did not work well'.

6 Analytical Perspectives

"Entrepreneurship education is about learners developing the skills and mind-set to be able to turn creative ideas into entrepreneurial action" [5]. Reading the above definition, creativity and practical action come to the fore. These are also elements defining DT together with underlying human characteristics such as empathy, creativity and self-efficacy [5].

6.1 Empathy and Ideation

Empathy is a state of mind including mental models, frames of references and value choices [8]. For us, empathy is an essential ingredient to the DT process, as it leads to understanding the importance of a problem. Our central theme was a smart home, able to react to various forms of natural phenomena such as flooding while being aware of safety needs and energy efficiency.

Figure 1: Envisioning truly clever homes

Figure 1 shows a large box where the children could post first issues and possible reactions of a ‘Schlauhaus’. The first questions of the interview were related to children’s identification with social challenges and their awareness of social problems in general. The facilitators’ responses indicated that even though children might know concepts such as ‘climate change’ , there was not necessarily a corresponding awareness of their importance. Throughout the workshops, global challenges needed anchoring in children’s individual life worlds and experiences.

6.2 Creativity and Innovation

There are still uncertainties about just what ‘creativity’ is and whether it can be taught. In general, two types of resources can support creativity: person-centred resources (e.g. knowledge and motivation) and contextual resources (e.g. supportive peers). In terms of *knowledge*, we attempted to follow the principle of selective exposure, i.e. the conscious decision of “which aspects of the technology should be foregrounded or backgrounded”[2].

Figure 2 (left) shows how a lamp was used on the spot as a source of heat, to test the temperature sensor. On the right of Figure 2 we can see how materials were used to display the details of a room used to wash and dry clothes, whereas a humidity sensor regulated the fan.

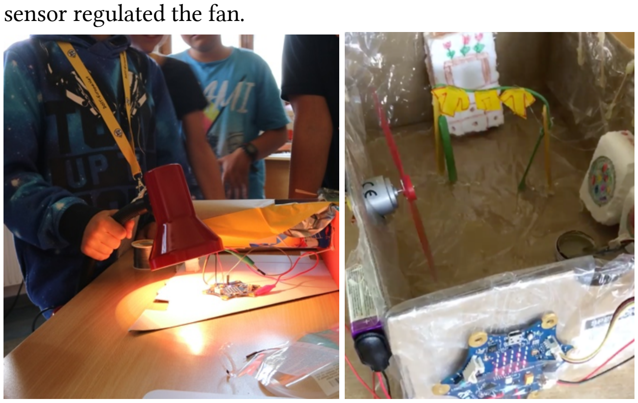

Figure 2: Imagination and emerging uses of resources

6.3 Self-Efficacy and Iteration

Bandura [1] described self-efficacy as the most pervasive mechanism driving people’s agency. People’s believe to be able to influence events that affect their future is central for the goals they set, their persistence on pursuing them and their ability to use existing skills effectively [ibid]. Perceived self-efficacy is influenced by comparing ourselves with others, mastering tasks after mobilizing some effort or developing cognitive strategies [1]. Scaffolding interaction between children and technologies seemed essential to us. Figure 3 shows children experimenting with a humidity sensor in isolation (left) in order to design a warning mechanism that indicates various degrees of emergency due to raising levels of water.

Figure 3: From testing sensors to embedded solutions

During the interviews, the facilitators mentioned an interesting barrier to iterations. First we thought that children could do a simple prototype on the first day, start re-designing their idea in a more compact way or using an alternative mechanism in order to find out which one would work best and have a second prototype on the next day. However, children were reluctant to redo their working solutions, so that during the review stages we looked for things that could be added rather than replaced.

6.4 The next step: Scenario-led Co-design

The experiences of these four days prompted us to rethink our workshop design for upcoming events. On the one hand we had the challenge to orchestrate a process that kept the children motivated, on the other hand we were also aiming for children to take as much leadership in the design approach as possible.

A key condition for a successful workshop turned out to be examples and problem definitions children could directly related to. Design-driven problem-solving was then a suitable framework to test feasibility and effects of different actions, in line with local conditions. Figure 4 depicts our consolidate workshop approach. The co-design process starts with children being prompted by a high level issue (e.g. how to deal with a heat wave). As described earlier, such an abstract prompt might not directly resonate with the children, hence a further dialog is used to add details from their daily lives (lower circle in Figure 4).

The facilitator’s role is then to provide a corridor for the scenario to unfold or hint at material restrictions (upper circle in Figure 4). We had also made the experience that core technologies do not need to be demonstrated in abstract, but included in the scenario discussion. Children would still learn about the sensor in a separate exercise, but with their own solutions in mind, they are more engaged since a meaningful transfer of the learned is eminent.

The resulting design options for parts of their problem are then ranked based on three criteria: intrinsic motivation, fitness for purpose and feasibility. The process described is not meant to be a fixed sequence of steps.

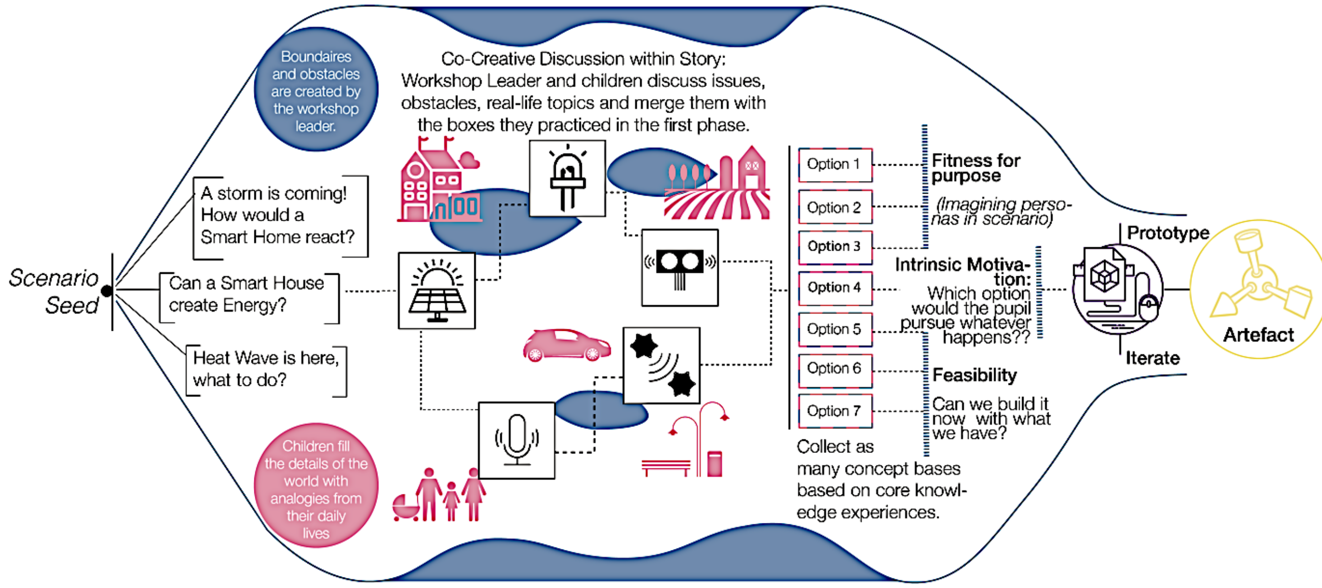

Figure 4: Scenario-led Co-design

8 Conclusion

We established a number of elements being critical for the action- and creativity focused definition of entrepreneurial education such as (a) empathy to thoroughly understand a problem, (b) creativity to ideate solutions that work considering constraints that can't be solved quickly and (c) iterative prototyping to learn from past experience and test hypothetically better designs. Empathy was strongly dependent on children's ability to connect with the problem definition on a personal level. Creativity was very much an emergent phenomenon enabled by the sustained dialog with peers and facilitators. Iterations were bound to different levels of personal identification with the problem. Here again, empathy can be renewed by finding ways to provide feedback to current designs, not from the facilitators but from outside people with a natural interest in children's solution.

All in all, we found that the overarching benefit from having design driven and digital-fabrication enabled learning was the accessibility of the format for all children, since by constructing material objects, children could use different epistemologies in forming their understanding

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