About us:

The Gothenburg Working Group for Interaction Design and Children (IDAC – idac.se), focus on technology development for children for learning, well-being and leisure. The mission of the group is to include all children (typically and non-typically developing), their parents, caretakers, teachers and siblings as co-designers in the design process. In this we will study the physical, interactional, social and digital materials and opportunities surrounding children. We emphasize the need for interdisciplinarity and have a team of researchers coming from aesthetic, pedagogical and technological research disciplines from Chalmers University of Technology, University of Gothenburg and Interactive Institute Swedish ICT. We do research, vocational education, education and training, dissemination to the general public and consultancy services.

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Digital Fabrication by IDAC – Aims, Steps and Transferable Principles

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Abstract

This paper aims to present the digital fabrication approach driven by Gothenburg Working group for Interaction Design and Children – IDAC in Sweden. In addition to supporting local makerspace environments, educating teachers, school leaders and politicians, and conducting hacker clubs for children, we suggest including children in special education in a European agenda for digital fabrication at school, and make the maker movement matter for all children. In this paper, we identify three transferable principles for this.

Author Keywords

Digital fabrication; School; Special Education;

ACM Classification Keywords

H5.2. Information interfaces and presentation: User Interfaces – Theory and Methods, User-Centered Design

Introduction

The use of digital fabrication in school raises awareness of science and technology among children and their teachers. It provides a place for making and reflecting, working and experimenting. It teaches methodologies and practices that might inspire children to go into design, programming, manufacturing or making. By integrating practices of iterative design and rapid prototyping into school, shorter feedback loops

Figure 1. Hacker club.

Vision for digital fabrication:

Include design thinking on equal basis with the material

Develop pedagogy for how to incorporate both materials and design thinking in school

Revise design methods to fit the age of the children

Share knowledge about materials and methods (like the crafting tradition and open source process)

Develop technology for digital fabrication in schools

Encourage cross-subject teaching and learning

Include special education.

between learning and time of assessment are created, which in turn enables better formative practices. Digital fabrication joins several subject matters in space and time, which facilitates collaboration and exchange between teachers and helps students to see connections between subjects. Introducing IT as a design material helps to uncover its purpose and function in everyday life, and digital fabrication can enable pupils' agency, empowering their minds, supporting innovation, experimentation and collaboration.

In the IDAC working group in Gothenburg we propagate that it should be the right of every child to get the opportunity to learn this at school, on equal basis with other crafting subjects. In order to make digital fabrication matter in school, and as a part of the school curricula, we have set up a vision in which we promote digital fabrication as a creative school subject, see table to the left.

Steps Taken so Far

In line with our vision, we have undertaken several concrete steps in order to increase the interest for digital fabrication in schools and in general. Some examples of projects are listed in short below.

Digitalverkstan – Digital workshop - aims at engaging young people aged 18-30 in digital literacy, creation, innovation and entrepreneurship. Through various interventions, the stakeholders of the project want to enable young people to explore and realize their ideas and learn about new and novel technologies and methodologies.

DIY MusicTech - consists of workshops for teaching children how to construct interactive music instruments from what would otherwise be seen as waste. Here the children's own experiences, skills and interests are in focus, combined with their lust to explore and innovate and the use of digital tools and materials. They also get to re-think and re-appropriate used things – what they are, how they work, for what purpose, etc, encouraging an open mind and sustainability in general.

Touch AT! - aims to investigate how interactive assistive touch based technologies for children with intellectual disabilities (ID) in grade 6-9 in special education schools can be designed. Children with ID, teachers, families, care takers and adults with ID will participate as co-designers in the development process. Through active participation in the education, we will also investigate the possibilities for establishing digital fabrication as part of the workshop setting and setup.

Hackerklubben – the Hacker club - is more of a quest than a project, an ambition to educate and inspire children in science and technology in general and creativity and programming more specifically. Hackerklubben runs as a self-sustaining initiative hosted by Interactive Institute Swedish ICT and the makerspace Collaboratory. Hackerklubben teaches children between the ages of 8 and13 to create computer games or interactive stories, with physical, sensor-based interfaces, and then showcases these in public. In spring 2014, 25 participate weekly, with more than 200 on a waiting list and the activity has been forked in three other locations that run independently. A large-scale event was also run with 100 pupils and 10 teachers during an intense full week at a school. For a description of the structure of Hackerklubben, see table to the left on next page.

Structure of Hackerklubben
Hackerklubben makes use of the Scratch environment developed by MIT. This is installed on Raspberry Pi. Hackerklubben further makes use of a Scratch plugin that allows the participants to program the I/O pins on the Raspberry Pi from within Scratch in order to connect electronics to it, including basic soldering. The participants also use the Makey Makey platform to construct their own game controllers from everyday conductive materials such as aluminum foil, fruits and vegetables, pencils and play-doh.

If the time allows, the participants are also introduced to more advanced techniques and technologies that others are working on in the makerspace, and relate this to what they have learned themselves. E.g. it is easy to explain how a drone works based on the experience the participants have from Scratch and the electronics work.

Principles of Hackerklubben

Hackerklubben is based on a number of principles that take inspiration from design research, fablabs, hacker culture, FLOSS programming and traditional crafts. These have grown out of the experience of running Hackerklubben. We suggest these principles to be transferred to other users and contexts.

- Peer learning

The participants are encouraged to collaborate with each other rather than asking a tutor if they get stuck. This encourages the participants to pool their knowledge resources and connect different partial solutions that they already know. This is also applied to the relation between tutor and participant. For instance, in the first Hackerklubben, the tutors had not used Scratch before but came to know it together with the children in a mutual learning process. The participants are also encouraged to share their code, which can be done via the Scratch interface, and to look at the source code of other people's games if they want to understand how something is done.

- Lack of knowledge as creative opportunity

Since the construction of computer games is more arbitrary than utility programs, the participants are in this way also encouraged to think creatively of how they could achieve the same or similar effect as they desired by creative use of the limited knowledge and means they have already acquired.

- Agnostic outcome of learning process

By having the participants construct games and game controllers in their own pace and according to their own desire, Hackerklubben allows participants to choose which aspects they want to concentrate on. Some will use the time to explore many functions and make complicated games; others will focus of aesthetic expression and the look and feel of the game. Since the aim of Hackerklubben is to make the participants comfortable with the technologies and have a personal and active relation to them, it is not necessarily the case that more complex understanding of the functions of the programming language or of electronics gives a better relation to the technology. This is rather a subjective choice based on the personality and interest of the individual participant.

Purpose of Hackerklubben
The main motivation behind Hackerklubben is to foster a playful and active relation to technologies that children otherwise come into contact with as consumers of closed systems. Hackerklubben aims to make children comfortable with the principles behind designing software and how to construct hardware, including electronics, and to empower them to think and design for themselves. The participating children should understand how software comes alive and how hardware is put together and gain a sense that everyone is able to participate in the development.

Hackerklubben does not aim to appeal talented children who might become innovators or entrepreneurs and have a special interest in computing and computational devices. Rather, Hackerklubben is for everyone since all children growing up today will most likely be dependent on computation and computational devices for both

Focus on computer games
In Hackerklubben, there is a focus on developing computer games, in order to allow the participants to explore both functional and aesthetic aspects of computing and allow them to self-determine the goal of their practice.

Dissemination:
As a dissemination activity, the hacker club for children has e.g. visited an educational fair in order to demonstrate how to work with programming and crafting in school. Here, the children aged 10-12 taught programming and digital crafting to the teachers, and demonstrated how IT as a material can be used for design based on your own skill set and experiences.

Figure 2. DIY music instrument.

professional and social life. However, by favoring games and personal expression instead of utility programs associated with work life, Hackerklubben also fosters a critical technological literacy that differs from computer classes aiming to prepare for future office work [1]. We believe that engaging in digital fabrication empowers the children to better meet the future in a more active way. There is a parallel to the wood- and handcrafting concept in schools which also had the original goal of knowing the world through the use of craft rather than fostering professional arts and crafts practitioners. A secondary aim of Hackerklubben is to demonstrate that it is possible to create an educational environment at a low cost, using off the shelf products and available materials, and without requiring a high degree of skill level from tutors. This setup can be run by a school without much investment in equipment and staff, and can enhance several school subjects beyond the immediately affected STEM subjects. The approach is also relevant to arts and crafts teaching, it teaches teamwork and collaboration, and by specifying a specific theme to the games and devices made it could even be used by teachers in social sciences, history and similar subjects as a learning tool and starting point for discussions (for a related case see [1]).

Conclusion

Through the experience derived from the different projects undertaken by IDAC, and Hackerklubben in particular, we have identified three principles which we strive to transfer to other age groups, schools and to special education schools. *Peer learning* is a basic parameter that makes both adults and children stand equally. It is an important factor both for solving problems as well as practice social behavior and cooperation, which is something we investigate in for instance in special education in the project Touch at!. Further*, Lack of knowledge can act as creative opportunity*, meaning that the teachers or the children who are more advanced programmers, or carpenters, do not necessarily make better designs. This further points to the democratic and equal basis for learning opportunities that is gained through digital fabrication. Finally, *Agnostic outcome of learning process* points to the principle that learning derives from the interest of the child rather than from the teacher, something that can increase motivation among both typically developed children as well as children with special needs [2]. There is a major need for children with special needs to be able to develop inventions on their own, and for the teachers to be able to support the children on their individual level and interests. This is why we aim to find means and ways to make this a part of the curricula for special education schools as well.

References

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