

Research paper

Finding fun in non-formal technology education

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ABSTRACT

In this exploratory study into the world of 8–17-year-old children's non-formal technology education, two different types of technology education with varying levels of non-formality were investigated to see how participants find fun in these situations as it is apparent that if something is non-mandatory to attend to, there should be some type of enjoyment found in the process. The results of the analysis suggest that there are three main ways children and teenagers have fun in non-formal education: fun from the tasks they are doing, social fun by sharing with other attendants, and pedagogical fun that has been embedded in the learning process. Based on our findings, we offer suggestions for how to add elements of fun in the non-formal technology education, to make it more motivating and enjoyable to the participants.

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1. Introduction

Digital fabrication and making in education have aroused notable interest in the Child Computer Interaction (CCI) (Blikstein, 2013; Chu, Schlegel, Quek, Christy and Chen, 2017; Iivari & Kinnula, 2018; Iversen, Smith, & Dindler, 2018) and FabLearn communities (Blikstein & Krannich, 2013; Blikstein, Martinez, & Pang, 2016), among other communities; researchers have addressed the potential of the Maker Movement and maker technologies in transforming education, including digital technology education, for the generation of youth today (Blikstein, 2013; Chu, Schlegel et al., 2017; Iivari & Kinnula, 2018; Iversen et al., 2018). Some researchers have concentrated on the context of school and integration of digital fabrication and making into the basic education curricula (Chu, Schlegel et al., 2017; Iversen et al., 2018), while others have studied them in non-formal settings such as in computer, programming, robotics or maker clubs, museums or science centers (see e.g. Tisza et al., 2019).

Fun as a concept is widely recognized in the Human–Computer Interaction (HCI) (Blythe & Hassenzahl, 2003) as well as in the CCI community (see e.g. Nielsen, 2003; Read, 2012; Read & MacFarlane, 2006; Read, MacFarlane, & Casey, 2002; Sim, MacFarlane,

& Read, 2006). Entertainment in the form of e.g. video games easily comes to mind when talking about fun and technology; indeed, games and enjoyment derived from the playing of them has been extensively studied in HCI and CCI research (e.g. Fowler, 2013). In CCI, notable research addressing fun in connection to products designed for children has been carried out, and different kinds of methods and tools for measuring fun have been developed (Nielsen, 2003; Read, 2012; Read & MacFarlane, 2006; Read et al., 2002; Sim et al., 2006). Moreover, some studies addressing fun in connection to the design process have also been conducted (e.g. Chu, Angello, Saenz and Quek, 2017; Schepers, Dreessen, & Zaman, 2018; Tisza, Gollerizo and Markopoulos, 2019). Chu and colleagues (Chu, Angello et al., 2017) have considered fun in connection to making in the context of formal education of children. However, fun as experienced and emerging in the context of children's non-formal technology education has not been examined as much as it probably should have; as non-formal education typically is voluntary, one expects fun to play a significant part in such education. Surprisingly, we did not find studies exactly on the topic. In addition to the study on fun in making in formal education (Chu, Angello et al., 2017), one study was found to examine fun in making with children outside of the school context (Schepers et al., 2018), which did not address non-formal technology education per se. A couple of studies focusing on non-formal education were found to mention fun as a side note, such as Alekh et al. (2018).

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We reasoned an in-depth examination of fun in the context of non-formal technology education is warranted, considering the significance of technology comprehension for the young generation (Tuhkala, Wagner, Nielsen, Iversen, & Kärkkäinen, 2018) as well as the potential but also the challenging nature of voluntary non-formal education (see e.g. Tisza, Papavasopoulou et al., 2019) that should provide attractive experiences for children to continue participation. We also identified a lack of guidelines or recommendations for organizers of non-formal technology education on how to try to ensure fun experiences for the participants. This is where we also wish to contribute.

Thus, in this exploratory study we look deeper at the phenomenon of having fun in the context of non-formal technology education, to get preliminary understanding on the meaning of enjoyment and fun in this context. We ask as our research question, *what kinds of fun can be found in non-formal technology education?* To answer the question, we analyze data collected within two types of non-formal technology education of 8–17-year-old children in Finland: robotics clubs and programming clubs. We chose the concept of ‘technology education’ as a scope of this study rather than STEM (Science, Technology, Engineering, Mathematics), as technology education focuses on the specific activities studied in this paper. We rely on a highly data-driven approach in the examination of fun, while we will discuss our findings in light of existing CCI and FabLearn research on the role of fun in education.

The paper is structured as follows. The next section introduces related research on non-formal education as well as the concept of fun. In the third section we present the research design for this study. Then, we outline our empirical findings, discuss the implications of our study and conclude the paper with limitations and future research possibilities.

2. Related research

2.1. Non-formal education

This study considers fun in the context of non-formal technology education. Informal learning is a more widely used term than non-formal learning and often used to refer to both of them, while they can also be separated from each other. It is important to note, however, that the differences between informal, non-formal, and formal education are not necessarily linear or straightforward but lie in the middle ground (Hofstein & Rosenfeld, 1996). Table 1 summarizes the most distinctive features of informal, non-formal and formal learning (based on Eshach, 2007).

The easiest way to understand what informal and non-formal education are is to compare them to formal education, which is authority recognized, has curricula and in most cases leads to ratified diplomas or qualifications (Hofstein & Rosenfeld, 1996). Non-formal learning is something that adds upon formal learning, while the former can hold structures similar to the latter. Usually it is more flexible and produced by community, organizations or workplace centered agents. (UNESCO, 2012)

There are plenty of empirical studies on children’s non-formal education, also those that focus on technology education (Alekh et al., 2018; Bar-El & Zuckerman, 2016; Barker & Ansoorge, 2007; Cain & Lee, 2016; Eshach, 2007; Fischback & Lee, 2017; Hofstein & Rosenfeld, 1996; Horn, Solovey, Crouser, & Jacob, 2009; Maloney, Peppler, Kafai, Resnick, & Rusk, 2008; Wardrip & Brahms, 2015). Non-formal education takes place in places not daily visited by attendees, such as zoos, science museums, science media and science youth programs, aquariums, computer clubs, fab labs (digital fabrication laboratories), maker communities, workshops and after-school clubs. Typically, non-formal learning happens

outside of school (the building and the time) (Hofstein & Rosenfeld, 1996), while it is possible to hold non-formal learning events in ‘formal’ settings as well (Walsh & Straits, 2014); schools can have field days or excursions to inspire children, for example.

It is important to keep learners motivated so that they can keep on learning (Fischback & Lee, 2017). There are multiple reasons for a child to attend non-formal education. Letting a child to choose an interesting hobby is probably the first idea that comes to a parent’s or guardian’s mind but there are other reasons, including learning of science literacy skills (Sullivan, 2008). Motivation is a significant issue to consider in any education as in non-formal education as well. It is important for learners to feel successful (Fischback & Lee, 2017), and through motivation, play can lead to learning (Carroll & Thomas, 1988) The motivations for the attendees might be more intrinsic in non-formal education compared to formal education as the motivation to attend comes from within the attendee, not from outside pressures such as national school curricula or pressure from parents (Eshach, 2007). From the viewpoint of motivation, experiences of fun can be very significant factor.

2.2. Finding fun

‘Fun’ is a complex and elusive concept that has many dimensions (McManus & Furnham, 2010). Enjoyment, pleasure, fun, and attraction are widely used to address similar types of feelings (Blythe & Hassenzahl, 2003). Enjoyment can be a reward (Eshach, 2007) in learning (Sim et al., 2006) and hobbies (Eshach, 2007), or result from play (Hanna, Neapolitan, & Risden, 2004; Read & MacFarlane, 2006). Excitement can also be equated with fun, although it can also mask dissatisfaction (Stewart & Jordan, 2017). When humor provides positive feelings (Sharma, Papavasopoulou, & Giannakos, 2019) it can be considered as one aspect of fun as well. Fun can originate from many different things, for example from the physical such as dancing, problem solving, and even social gatherings (Shneiderman, 2004). Challenges can be stimulating and provide fun for individuals who want to test their *spiel* (Brandtzaeg, Følstad, & Heim, 2018). Easy tasks can be more fun than difficult ones, though, in the sense that there was no irritation or teeth-grinding related to performing them (Carroll & Thomas, 1988). Fun can be related to the tools used for learning; Scratch, for example, does excite learners to learn programming, and can be even described as “a ton of fun” (Malan & Leitner, 2007). LEGO Mindstorms has been documented as being enjoyable (Stewart & Jordan, 2017) and even more fun than Scratch (Merkouris, Chorianopoulos, & Kameas, 2017). Sometimes working can also be more fun than playing. Some clubs hold play time specifically for the children to play and enjoy themselves, and sometimes the “work” children have to do in the clubs is preferable to the play time which ends up with children asking if they can skip it (Weibert, Sprenger, Randall, & Wulf, 2016).

For Shneiderman (2004) fun is social. Positive peer pressure can lead to heightened results when performing a task. Seeing others improve and succeed makes participants more motivated to get there as well. Working together helps with tension and pressure attendees feel. Alekh et al. (2018) Social interaction, effectiveness and satisfaction can also influence each other. Most likely by having a higher quality of collaboration between the members in the group, the processes they take upon themselves are more effective (Sharma et al., 2019). Social aspects can lead to other people becoming interested in these types of activities as well, as children like to talk about how they are having fun (Alekh et al., 2018). Some researchers include group work *de-facto* into the fun category alongside with humor and games (Francis, 2013).

Although we rely on a heavily data driven approach towards fun in this paper, for the definition of fun, we agree with a

Table 1
Different features of formal, non-formal and informal learning [18: 174].

Formal	Non-formal	Informal
Usually at school	At institution out of school	Everywhere
May be repressive	Usually supportive	Supportive
Structured	Structured	Unstructured
Usually prearranged	Usually prearranged	Spontaneous
Motivation is typically more extrinsic	Motivation may be extrinsic but is typically more intrinsic	Motivation is mainly intrinsic
Compulsory	Usually voluntary	Voluntary
Teacher-led	May be guide or teacher-led	Usually learner-led
Learning is evaluated	Learning is usually not evaluated	Learning is not evaluated
Sequential	Typically non-sequential	Non-sequential

broad, inclusive view on fun discussed by [McManus and Furnham \(2010\)](#) who stress the complexity and multidimensionality of fun. Fun can be seen both as an attribute of a person and a property of an activity ([McManus & Furnham, 2010](#)). They propose five categories of fun: (1) *Sociability* which entails joking, laughing, engagement, and entertainment with other people; (2) *Contentment* which connects with peacefulness, warmth, relaxation, love and care; (3) *Achievement* which is associated with focus, challenge, accomplishment, absorption, engrossment, and flow; (4) *Sensual*, which connects with intimacy, sensuousness and romance; and (5) *Ecstatic*, which is associated with craziness, excitement, energy, amusement, and exhilaration ([McManus & Furnham, 2010](#)).

From the viewpoint of education, fun has been considered to be pedagogically useful since the 90's ([Draper, 1999](#)). Fun is connected with intrinsic motivation ([McManus & Furnham, 2010](#)), which is seen as significant for learning. Many aspects of fun discussed above, especially in the Sociability and Achievement category ([McManus & Furnham, 2010](#)) connect with learning (see e.g. [Gee, 2008](#)); especially with learning theories advocating a socio-cultural, socio-constructivist, situated understanding of learning (see e.g. [Gee, 2008](#)). Also the role of emotions in learning has been acknowledged: emotions provide motivation driving learning (see e.g. [Gee, 2008](#)) and fun as a concept closely links with emotions of various kind.

According to the literature on introducing fun to education, one way to bring fun to the formal context is humor ([Berk, 1996](#)). It can be used as a communication tool to alleviate anxiousness and to improve learning abilities ([Berk, 1996](#)). Humor can create a more relaxed atmosphere and genuine enjoyment, which leads to a cognitive break for students, leading them to assimilate what they have learned more easily ([Garner, 2006](#)). In order for teaching to be effective and for the learners to internalize the subject, it is important for them to think about learning in a positive way, which can be eased by having a laugh or even a snicker ([Berk, 1996](#)). If you are experiencing positive emotions, it is also more likely that you will be doing what you are doing for longer periods of time ([Sharma et al., 2019](#)). Humor in formal classrooms is a straightforward way of increasing retention of information ([Garner, 2006](#)) and motivation of the students ([Francis, 2013](#)). Humor can also close the bridge between students and educators, and give students the impression that the educator has gone the extra mile in their background work ([Garner, 2006](#)). [Berk \(1996\)](#) warns, however, that educators should not be entertainers and should only employ low risk humor techniques.

There are conflicting findings in the CCI field whether formal education and fun can mix. It depends of course on how we approach and define "fun". [MacFarlane, Sim, and Horton \(2005\)](#) in their study on children using different software in school context came to an assumption that in children's minds school and fun do not belong together. Similarly, in [Dreessen and Schepers' study \(Dreessen & Schepers, 2018\)](#), children distinguish between fun in freetime activities, where they are free to just have fun

with friends, and "school fun", which is something nice to do but clearly intended for learning and not just for the sake of enjoying the activity. [Chu, Angello et al. \(2017\)](#) found out in their study of curriculum-integrated making activities in the elementary school setting that children seemed to find enjoyment and had positive feelings in their work. In their study, children self-reported liking making and science related themes most, and listed many items and activities that they had particularly liked to work with. In their video analysis of one working day of six children, they focused on issues that seemed somehow 'positive,' such as positive comments or gestures, or e.g. smiles, and found out that children's positive feelings seemed to be related to the making activity itself, some form of social interaction related to the activity, or something unrelated to the activity.

In a makerspace setting, [Schepers et al. \(2018\)](#) report from a study of 6–12-year-old children designing making workshops for themselves that they identified children having fun when experimenting, overcoming challenges, and the work itself but particularly the older children enjoyed also finalizing their work, and social interaction with each other. Seymour Papert advocated 'hard fun', as in enjoyment received from working hard with an interesting topic ([Papert, 2002](#)). [Schepers et al. \(2018\)](#) argue that finding the sweet spot where working is not too easy and not too difficult, i.e., it matches the capabilities of children, seem to be connected with whether working is considered fun or not by children.

There are tools for measuring fun, such as the 'Fun toolkit' that has utilities for measuring engagement and ranking of activities based on how fun children experienced them ([Read et al., 2002](#)). In FunQ ([Tisza, Gollerizo et al., 2019](#)), experiencing fun is measured through six dimensions, Autonomy, Challenge, Delight, Immersion, Loss of Social Barriers, and Stress, through a Likert-style scale. In quantitative and qualitative studies with questionnaires or surveys, it is good to keep in mind that children as young as seven-year-olds can discern between "high concept" ideas such as ease of use, fun, and learning ([Sim et al., 2006](#)). For subjective (self-reported) fun, reading of body language and listening for laughs, grunts, and other explicit confirmation of fun can assure a researcher of its existence in a situation ([Nielsen, 2003](#)).

Measuring fun can be challenging, however. Children typically respond by giving higher or highest ratings if they are asked in what kind of mood they are in and things like Smileyometers might not give researchers the most reliable answers to questions they are asking ([Sim et al., 2006](#)). Children also respond more positively to tasks and products that seem interesting before surveying them ([Read, 2012](#)). Laughter can also be something people hide their insecurities and nervousness in. Feelings of content, appeal and satisfaction are important factors when fun is measured ([Shneiderman, 2004](#)). Overall, it is indicated that studying fun is a challenging task that requires different kinds of data and sensitivity towards different kinds of cues. One challenge is also that so far the HCI and CCI literature has focused on

developing tools for measuring fun of products or systems and less on measuring it as an inherent part of the process, while in this study we are interested in examining fun as a part of the learning process in the context of non-formal technology education.

3. Research design

3.1. Interpretive case study method and the cases involved

This study represents an interpretive case study (e.g. [Walsham, 1995](#)). Case studies in general are characterized the following way: “A case study examines a phenomenon in its natural setting, employing multiple methods of data collection to gather information from one or few entities (people, groups, or organizations). The boundaries of the phenomenon are not clearly evident at the outset of the research and no experimental control or manipulation is used” ([Benbasat, Goldstein, & Mead, 1987](#)). Interpretive case studies, in particular, emphasize understanding and making sense of the phenomenon in question, rather than attempting to measure or explain it in the predictive sense. Moreover, interaction between the researchers and study participants and the influence of the researchers’ background and experiences are underscored in interpretive case studies: the research data is seen as collaboratively constructed in interaction among the researchers and the participants, and researchers as analysts are seen as heavily shaped by their background knowledge and assumptions – those guide what kind of interpretations emerge during the data analysis phase ([Denzin & Lincoln, 2000](#); [Klein & Myers, 1999](#); [Walsham, 1995](#)). In the current study, the phenomenon of interest is fun and there are two cases involved: two organizations engaged in non-formal technology education of children.

The context for the case studies was a large European project with a focus on informal and non-formal science education. We conducted the case studies in Finland in the course of eight weeks to understand the nature of non-formal technology education. We studied technology education clubs in organizations A and B that both offered programming and robotics clubs for children. The cases were selected as they offer a rich and diverse sample of technology education in the case city area: they are organized by two notable actors within technology education in Finland and they include diversity in the sense of activities offered for learners. The observed clubs from Organizer A (organized in a daycare center) were geared towards 7–15-year-olds (called ‘younger children’ from now-on) and from Organizer B (organized in the university premises: in computer labs and the fab lab) towards 15–18-year-olds (called ‘older children’ from now-on).

The procedure of the sessions of both organizers was managed by the teachers/instructors and the researchers did not have any role in the design or management of the activities; they acted as outside observers (see [Walsham, 1995](#)). There were differences in the clubs in how teacher/instructor-guided the sessions were. Regarding formality, the Organizer A’s clubs were more formal than the Organizer B’s clubs as A’s clubs had a curriculum to follow, there was more structure and sequence in the activities, the activities were more teacher-led, and the instructors clearly had a role of a teacher, even though the relationship between a teacher and a student was an informal one. With both organizers, the instructors helped the attendees to set up their projects and were there to help when something went awry. Their main task was to keep the attendees with the activities and to aid them with all the problems they had with the tasks. Attendance was not mandatory.

Organizer A’s curriculum consists of different levels that build on top of each other. The students can choose their orientation between more game programming-oriented modules and

more Internet of Things (IoT) -oriented modules. Teaching is relatively formal, school-like, with a clear structure and topic for each session and all participants working with relatively similar projects. In the **robotics clubs**, the curriculum comprises five levels. The studies start from basics of mechanics (concepts, terminology, materials, 3D understanding, creative problem solving, design), and continue to electronics and programming of robots and embedded systems. In robotics clubs, there were two main technologies in use: Lego Mindstorms and BBC micro:bit. With Lego Mindstorms, they (1) greeted and waited for other attendees (2) got told of the topic of the day by the teacher (3) started gathering resources, and then (4) building the project, mainly from an image or instructions. (5) If they managed to finish the project, playing and improving the design followed. (6) Then, taking apart the built structure and putting the blocks into the right containers, and (7) leaving. For micro:bit, the procedure included (1) greetings and waiting for other attendees, (2) opening computers, (3) the teacher telling the children what the topic of the day is and distributing the micro:bits, (4) programming the micro:bit using children’s own laptops, (5) checking the functionalities and playing with the micro:bit, (6) returning the micro:bits and closing the computer, and (7) leaving. Organizer A’s **programming clubs** comprise six levels with altogether 10 different modules spreading over the levels. The studies start from learning of concepts, terminology, logics, problem solving, and visual programming, and continue to textual programming. A typical procedure for a programming club session was (1) greetings and waiting for other attendees, (2) opening computers, (3) the teacher telling the children what the topic of the day is, (4) programming, (5) finishing, (6) shutting down computers and leaving.

In **Organizer B’s** clubs working is very informal, ‘open doors’ type, with participants popping in and leaving at times most convenient to them. Names of the attendees were gathered because Organizer B provides 15–17-year-olds a possibility to work with them during the summer as a part of the City’s summer job coupon program. Working in Organizer B’s clubs is based on participants’ existing level of knowledge. No previous knowledge is needed when coming to a club for the first time. Teaching is informal and based on participants’ situation with their personal projects; the participants work with their own schedule. There is always information projected on the screens about how to continue or get started with the work, but the instructors are there to help with whatever problem the participants have. In the **robotics clubs** Organizer B offers, they teach 3D modeling, 3D printing, electronics, and Arduino programming, and offer a possibility to design and implement some electronic device, based on participants’ personal interests. In this club, different programming environments, Arduino, and different digital fabrication design software and machinery (e.g. 3D printer, laser cutter) were used. In the **programming clubs**, they teach game development, web (application) development, and mobile application development for Android. See [Table A.1](#) in [Appendix](#) for more details of the technologies used by both organizers in their clubs and what skill development was targeted with different technologies.

3.2. Data collection

Data collection for the study was carefully planned as it was acknowledged that studying fun is a complex task. Due to the reported limitations of the existing measurement instruments (e.g. children typically giving high ratings in questionnaires), we decided those will not be used, but instead we prioritized qualitative data collection methods, most notably interviews and observation in order to gain in-depth, rich insights on the potential manifestations of fun in the clubs. In line with the guidelines

on case studies, multiple methods for data collection were used (e.g. Benbasat et al., 1987). Observation was considered as a suitable method for revealing what actually happens in the clubs and how fun may present in the activities. Observation enables noting what is said and done, including participants' facial expressions, sounds, gestures, movement, and proximity, among other things. Interviews, then again, enable probing participants' own experiences and opinions about fun in the clubs, providing thus additional, complementary information, interviews offering also opportunities to validate researcher's interpretations.

Altogether, 34 sessions in the different clubs were studied. 55 participants consented to this study: 33 8–17-year-old children, 6 parents and 16 instructors. Different kinds of documentation (e.g. webpages of the clubs) were also utilized and children's creations during the clubs were documented. The main data contains altogether 53 h of observation of the sessions, field notes of around 8000 words, less than an hour of video, 22 recorded interviews of around 420 min (6 instructors, length 17–50 min.; 6 parents and 10 8–17-year-olds, length 10–15 min.), and 67 photographs.

The first author of the paper carried out the data collection, supported by the other authors. In the observations, the researcher wrote down in the field notes all occurrences that she interpreted as 'fun' for the participants. What is considered fun is very subjective, and the observations are of course the researcher's interpretation of the situation. All authors discussed together before the observations what could be considered as fun. When observing, the researcher listened to discussions and chatted with the participants and considered carefully whether there was some element of fun/enjoyment present in the discussions (e.g. joking, laughter). She read facial expressions of the participants (e.g. smiles, nods), observed what happened in general (e.g. participants working intensely together and their dialog clearly showing enjoyment of the task), and situated the discussions/what happened in the wider context of both the activities and the life world of children (for example use of memes or references to games or TV series in the discussions or creations in a 'funny' way) and whether it seemed to create enjoyment to the participants. The researcher carefully considered whether something really was related to fun/enjoyment, i.e., laughter, jokes, or discussions of games were not considered as 'fun' unless the researcher was somehow able to identify the element of enjoyment in what happened (as an example, laughter could remark genuine enjoyment but also nervousness, and jokes can also be cruel towards other participants; in these cases the occurrence was not marked as fun).

Interviews were also used for triangulation: some researcher's observations of fun were discussed with the interviewees to gain validation for the observation. All volunteers for interviews were interviewed. Interview themes discussed with the children were the following: Participants' own description of the activity and their participation; Relation to formal education (how similar/different); How could you use what you did here in the future; Perception of the activity, fun/enjoyment. The themes were adapted for the adults' interviews, to ask their views on the activities and how they assume that the children experience the activities. The interviews were conducted by an adult already familiar to the interviewees (both children and adults) and the topics were familiar to the interviewees; this was considered to ease the interview situation particularly for the children. The interviews were audio-recorded and transcribed.

3.3. Data analysis

The main data used for this study were the field notes, interviews of the children and their parents, interviews of the

instructors, and public material of the clubs (web pages). In the data analysis, the focus was on all occasions where fun/enjoyment somehow manifested either in the field notes, or was reported by the club participants, their parents, or the instructors in the interviews as something that could be considered enjoyable. The data analysis was data-driven in nature and in line with interpretive research tradition; it is emphasized that the analysts' are the central research instruments (Denzin & Lincoln, 2000; Klein & Myers, 1999; Walsham, 1995) – their background, preknowledge and assumptions shaping what they consider to be a manifestation of fun. Three researchers were involved in the data analysis: one junior researcher (the first author) completing her Master's degree on Information Systems (IS)/Human-Computer Interaction (HCI) with a minor in sociology and background as a Girl Scout leader (i.e., experienced with interacting with children), and two senior researchers with backgrounds in IS and HCI and with extensive, over ten years background in technology education of children. Initially, the first author collected all occurrences of fun in the data in one file. During the iterative analysis process of the occurrences, the categorization of fun started to inductively emerge, while theories of fun were used as sensitizing devices: they helped to see and decide what all can be considered as a manifestation of fun. The theories used at that phase do not exactly match with the theories discussed in the section two of this paper, as some new literature on fun has been added later on in the paper. During the initial data analysis, the first author conducted literature searches on different views and categorizations of fun, familiarizing with different conceptualizations of fun and with methodological challenges involved in studying fun. This phase also involved searching for supporting literature specifically relating to the categorization of fun that was emerging in a data-driven manner. The three authors collaborated during the analysis phase: the first author delivered the analysis results for review and the authors collaboratively discussed the findings to clarify what they could entail and how they affect the categorization, in order to reach an agreement. Notes of these discussions were written and reflected upon by the first author. Later on, the two senior researchers separately analyzed the data to finetune and validate the emerged categorization. Important to note is that the final categories have been analytically separated for the purposes of this paper, but they are overlapping in the real life.

4. Fun in the clubs

The categories of fun, emerging from the data were the following: (1) Pedagogical fun; (2) Fun in doing; and (3) Social fun. Next, these three types of fun prevalent in children's technology education are discussed.

4.1. Pedagogical fun

With pedagogical fun, we refer to such fun that the instructors intentionally introduce in the activities either when doing the actual instructing work or in the pedagogical planning of the activities, to make the activities more enjoyable for the participants.

The data shows that instructors can clearly contribute with their own *behavior* to fun experienced by children. As one of the instructors commented:

"...the teacher is able to [make it fun for the children] with using humor and, well creating a warm atmosphere" (Instructor, Organizer A club)

Joking was one way identifiable in our data where the teachers consciously tried to bring fun and enjoyment in the activities (Field notes). This type of pedagogical fun was more clearly shown with the younger children (in Organizer A's clubs) where the relationship between a student and an instructor was more formal, teacher–student style: there was one instructor with multiple children, the instructor was using curriculum-based methods, and the children even called the instructor “ope”, i.e., an informal term for “a teacher” in Finnish. In these situations, the instructors had some jokes that came up and all the attendees went silent in the anticipation of the punch line. There were even some running gags, for example ‘what are all the different occupations of one teacher’; he sometimes made jokes about being a firefighter, a police officer, a chef etc. (Field notes)

Fun was also intentionally integrated into the activities. The organizers had chosen such *topics* for the clubs that they assumed to be fun for the participants, for example designing and implementing video games (both organizers) or making Transformer robots (a well-known TV series). They had also chosen to use specific *tools* that are generally considered as fun to use, such as LEGO Mindstorms and Scratch. Having fun in general was also considered beneficial for the activities. The instructors mentioned in the interviews that *they encouraged the children to have fun while working with their projects*, and it was also *a built-in part of the activities*. In the observations, there are mentions of the younger children playing their finished game and controlling a LEGO Mindstorms car of their own design and having races; this seemed to be a very enjoyable activity for the participants. One instructor had as the final lesson a voting system for the micro:bit that the younger children programmed into their devices, and the participants were then able to create votes with their own questions. With the micro:bit, the younger children seemed to enjoy trying out the different properties they learned to program, like the metal detector or the thermometer (Field notes).

Finding a pedagogically correct or best suited *level of difficulty* for the attendees can be hard, but a suitable level of challenge can also feel rewarding and satisfying, bringing enjoyment when participants succeed in given tasks. An older interviewee (in Organizer B's club) told that the robotics club was harder than the Arduino assignments done at school, but he concluded that it is good that it is a bit more difficult. The same interviewee was interested in attending the club again next year. We interpret this as having fun to improve willingness to attend also later on. If the activities are too difficult and there is no feeling of success though, it results in frustration and giving up even with the older children:

“it does not work out if the exercises and such are too difficult in the beginning as many get frustrated and give up ... that's why I did not feel that it was very fun [for the participants] ... it's very important that the participants feel that they learn something and know how to do something and if they don't get that feeling they give up” (Instructor, Organizer B club)

Having a *suitable level of flexibility* built in the activities was also a conscious decision at Organizer A for keeping the activities fun with the younger children, as reported by one instructor – to give the children a chance to try out and build with the theme of the session and then continue with their personal interests for the rest of the time:

“You notice that sometimes the students are not so excited with the theme, so we aim for trying out and building that little and then they can do their own things for the rest of the time, this way it remains fun” (Instructor, Organizer A club)

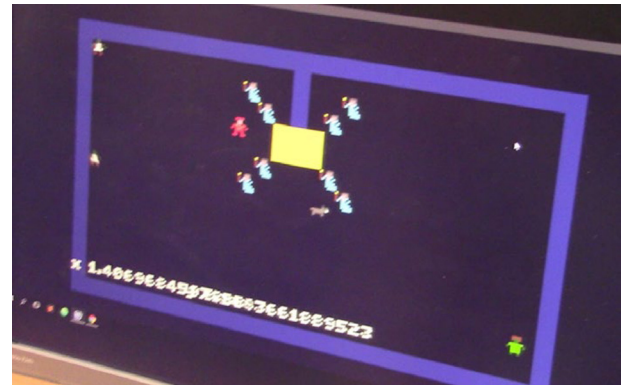


Fig. 1. Shreek game made by Organizer B programming club attendees.

Organizer B had made a similar decision, going even so far with the flexibility that after the orientation part of each session, the participants in the clubs were able to freely choose what they do. They had received also feedback from the participants that it was specifically liked that the activities were not school-like but very free and relaxed instead.

4.2. Fun in doing

Task related fun in our data can be characterized as more all-encompassing, compared to e.g. trying out your finished project. It was experienced in the activity itself while designing, building, making, and programming. For example, programming was reported fun by one of the club participants:

“You learn new things and it is fun to look at new blocks and then wonder what will happen with this (laughing)”. (Interviewee, boy)

Immediacy of the reward for success seemed to contribute to having fun; seeing your work doing something firsthand is satisfying. For example Tic-80 and Unity 3D seemed to be high pay-off types of programs to use while learning, as with little input it is possible to see the work you have made with the visual aspects. An older child mentioned in the interview that the primary time he would consider programming fun was when he could see what he had done on Tic-80 ‘coming alive’. This was also visible with enjoyment from designing sprites for one's own game, playing and testing the game and from programming itself – programming Arduino and LED strips, for example, was specifically described as fun by an older interviewee.

Some *ideas for projects arose from having fun*; we observed, for example, how a “Shreek” game developed by the older children started as a joke drawing of Shrek, the titular character from the popular movie series, and an idea for a donkey herding game rose from there as well, and developed through multiple iterations. Thus, joking and having fun can have fruitful outcomes and *the design work itself can be fun*. The older children described that work as half way between serious work and play, the serious part is when they were looking for online aid or resources and the fun was making practical jokes on each other and even the making of the game. The funniest part of that, according to one interviewed pair of older children, was *messing around with the code and finding out what happens*. For them, thus, the whole process of designing, learning and finding out new things was fun in itself. Fig. 1 is of the “Shreek” –game; the name is such because the developers “did not want to get sued” over using the name of Shrek.



Fig. 2. Butterfly knife with the design originating from a video game, made with a laser cutter.

One older interviewee described fun as “it’s fun because you can basically do anything”. We interpret that as enjoyment derived from *freedom to do what you please*. A related example in our data was making of a butterfly knife depicted in Fig. 2. In one club, multiple older children were making knives and other things that did not seem very suitable for young people, but the instructors were still extremely helpful with their design and making. The observing researcher was originally concerned with that, as even though the knives were not sharp and could not be used to harm anybody, making of them still raised some questions about accepting violent interests. It was clear, however, that the fascination with the knives was authentically aesthetic and for ‘fun’, enjoyment of the possibility to produce something out of a game that was familiar to the participants. In the end it seemed like a good fit for young people to explore these things in a safe and monitored environment. With Organizer A’s clubs this would not probably have been possible since the attendees were noticeably younger on average and the curriculum for the clubs was relatively strict. This leads to the question of freedom: the freedom to do whatever you want seems to be linked with the possibilities offered for creative thinking and doing, and links back to the connection between non-formal education and fun. Freedom was also contrasted with school environment:

“It’s fun [for the children] that there are no limits, compared to school environment, not that many limits” (Instructor, Organizer A club)

Finding alternate ways of implementing the idea can also contribute to fun: the butterfly knife was previously made with a 3D printer but a new laser cut version of it had more mobility and was therefore apparently also more satisfactory to play with.

In many ways, enjoyment derived from *accomplishing something* or *succeeding in something* can be connected with fun, as the following two excerpts from our data shows:

- Interviewer: “What is your favorite thing (in the club)?”
 Interviewee, boy: “Maybe coding and testing the code”
 (...)
 Interviewee: “When it is all ready, it is nicest when the game is ready”.
 Interviewee: “I think it’s the successes when you succeed in making a game or a code and it’s a really nice feeling. And just great fun”.

In the club meetings, alarming expressions of frustration were observed. Multiple times in different meetings, especially related to programming, there were visible and audible groans and annoyed yells, usually after this an instructor was on their way to discuss with the participant. A few minutes later, a silent, or

more audible “Yes!” could be heard. It is clear that something had gone right for the one having the troubles; we interpreted this as getting enjoyment of succeeding in a difficult task, when overcoming obstacles. The observing researcher was baffled at first why would somebody attend a voluntary occasion if they had such a bad time in the club. One older interviewee answered that the best feeling in the clubs was when you got over a challenging part in code or design. We interpreted in our data analysis the exclamation of “Yes!” as a representation of the tension in the situation dissolving, marking extreme satisfaction. This is a good example of an occasion where fun/enjoyment does not express itself with laughter. This was also discussed in the interviews for confirmation of our interpretation:

- Interviewer: “Are breakthroughs the thing that motivates you [to come to this club]?” (Fieldnote from the interviewer: “I asked this question as during observations I often noticed [this boy] to get frustrated in a loud way, i.e. asking help from the teacher and voicing that ‘this is going nowhere’.”)
 Boy 2: “Yes, because I particularly enjoy succeeding [in the tasks]”

The younger participants also enjoyed *entertaining themselves and others* by intentionally building ‘silly’ things and showcasing them to the other participants. This is a good example of how fun in doing and social fun are linked. The parents seemed to also somewhat support this type of fun:

- Interviewee, mother: “Those names [you have given for the outcomes of your work] are funny”
 Interviewee, boy: “Yep”
 (Laughing)
 (...)
 Interviewee, mother: “Why to use stupid names when you can also have funny ones”

4.3. Social fun

Social fun was related to enjoyment derived from the social aspects of the work, very well summarized in the following two data excerpts:

“Doing things with your friends, things that we are interested in and it is fun that the instructors are also interested in the same things” (Interviewee, boy at Organiser B club)

“From a father’s perspective, it sounds like it has been fun together with friends, just that there are like-minded friends” (Interviewee, father at Organizer A club)

Sharing of interesting resources and ideas is one example of that. The observing researcher sat down besides two older game programming club participants and listened for a while when they were doing their “Shreek” game with Tic-80. When programming a game alone, it consists of writing code, searching for the solution for a problem, coding more until you find another problem, maybe designing some sprites or elements once in a while. Together the game programming process is more complex and reactive. The two observed attendees had different sprites and mechanics and while making those, they searched the Internet for inspiration. While doing that, the two were laughing, making jokes, and causing each other trouble in a friendly manner. This type of fun could not have been had alone; surely they could have had a great and entertaining time by themselves when designing and programming a game but the social element of fun would have been missing. Designs and ideas, like using videogame-based designs as cores for different projects, were discussed and

sometimes shared with others as well. These two children were also a good example of enjoyment derived from *working together*, although many older participants clearly were happy also *working on their own*. With the younger children, similar issues were reported in an instructor interview: some children specifically wanted to work with their friend and were unhappy if that was not possible, while some children particularly enjoyed working on their own.

Sometimes the social fun originated from the attendees intentionally *entertaining themselves and also others*, for example one younger attendee in a robotics club naming his projects in a very funny way, as shown in a previous data excerpt. The other children did not react to it too much, but the instructor and the researcher were laughing about it and when the child's parent came to take him home, they laughed at the names as well. We interpret this as social fun being very context dependent and also related to reciprocity. With Lego Mindstorms, building and making 'unorthodox' designs was observed to be exhilarating for the group of children, the younger children turning e.g. hammers into "torture chairs". However, sometimes the entertainment attempts did not succeed; some things were just not considered as fun by everybody. There were times during the observations when somebody said something that could be perceived as fun, but it did not resonate with the other attendees. For example, humming a fun song or a tune did not get any laughs even though it was visibly geared to other people. This was observed by the researcher few times and it was characterized with having the participant looking around for reciprocation.

Talk of popular culture such as video games, television shows and music was quite usual both with younger and older children, even between the attendees and instructors. For example, one instructor was aiding older children with 3D printing and talked about the design that was being printed. The discussion started from the shooter game which was the source of the inspiration for design and continued to BB guns (air guns) the instructor had customized to look like another game's weapon by 3D printing new parts to it, so called 'skins' for real-life videogame BB guns. Memes and games seemed to be a nice way of communal excitation: there was talk about "different skins", "what games do you play", and citing memes at almost every observed occasion. Some of the Organizer B instructors were closer in age with the participants and instructing was then done in a peer like manner, with holding a conversation about ideas and problems. The relationship was then more informal, a mentor-mentee type of situation where the instructors were more peer-like, but the instructors still had *jokes* and fun together with the participants. This characteristically belonged to the category of social fun rather than pedagogical: there was no "silence, the teacher is talking" kind of vibe when the jokes were uttered.

At times, *social fun could also be distractive*. Sometimes it led to the attendees not doing what they came to do and instead they fooled around on the computer or with other stuff. It was not necessarily bad thing, as participation was voluntary and breaks in between intense learning and creating are important. In a programming club, two older children that were making the "Shreek" -game together said that they usually took breaks during the gatherings to take a walk and think about their design. The fun they had when looking for inspiration for their sprites derailed sometimes, however, and they started to focus on making practical jokes on each other. A younger children's programming club was also prone to distractions as some participants were observed playing with the finished Scratch projects for most of the club's time. If the instructors noticed someone not making their own project and instead playing other people's creations on the site they usually commented that maybe that was enough playing for now. This sometimes spread like a spitfire; when

another young attendee noticed how fun the game some other attendee was playing they would ask the name of the game and start playing that instead of developing their own. This resulted in sharing high scores and/or discussing which level they were stuck on. Gameplay exhibited social fun altogether, most young children played together and fun was then visible and audible.

5. Discussion

This article took an in-depth look at 'fun in non-formal technology education,' which so far has not been addressed in the field of CCI comprehensively enough and with actionable implications. We contribute by examining our research question, *what kinds of fun can be found in non-formal technology education*, addressing fun from different angles and identifying three prominent forms of fun in the context of non-formal technology education: Pedagogical fun, Fun in doing, and Social fun. Next, we discuss our findings in more detail.

Non-formal technology education has been studied from the viewpoint of its practices and tools or its impact on learning, but enjoyment and fun have not been in the focus. Fun in making in formal education (Chu, Angello et al., 2017) as well as fun in making in a makerspace setting (Dreessen & Schepers, 2018; Schepers et al., 2018) have revealed aspects of fun, but a focus on non-formal technology education is lacking. Our three forms of fun can be connected with the existing literature: Fun in doing as connected with the sense of accomplishment, success and overcoming of challenges has been reported also previously (Chu, Angello et al., 2017; McManus & Furnham, 2010; Schepers et al., 2018) as well as social fun in the sense of interaction with others and entertaining of others (Chu, Angello et al., 2017; McManus & Furnham, 2010; Schepers et al., 2018). Fun in doing as manifested in the materials and activities enjoyed by the children has also been brought up (Chu, Angello et al., 2017). Our findings on fun together with the literature point towards the relevance of Autonomy, Challenge, Delight, Immersion, and Loss of Social Barriers in experiencing fun (Tisza, Gollerizo et al., 2019) as well as to Sociability, Achievement and Ecstatic senses of fun (McManus & Furnham, 2010). Our data contains less evidence of fun in the Contentment or Sensual sense (McManus & Furnham, 2010), however. All in all, we maintain our categorization offers a contribution to the literature as it comprehensively captures different forms of fun as experienced by children in the non-formal technology education context as well as adds a new form of Pedagogical fun, whose significance in the context of non-formal technology education needs to be underscored. The study underscores the relevance of fun for intrinsic motivation – significant in voluntary educational settings – as well as the connections between different forms of fun and socio-cultural, socio-constructivist and situated learning theories and theories on the importance of emotions in learning (see e.g. Gee, 2008); all three forms of fun we identified align with these learning theories. Additionally, this study contributes by offering actionable insights for educators on arousing fun in non-formal technology education.

It is important to note, however, that fun is a complex concept and challenging to study. The concept of fun has been addressed in versatile ways in the literature, using a variety of concepts and frameworks. Enjoyment, excitement and humor are seen as different qualities of fun (Cain & Lee, 2016; Hanna et al., 2004; Read, 2012; Stewart & Jordan, 2017) but some other qualities such as pleasure and attraction can be looked at as well (Blythe & Hassenzahl, 2003). All these qualities connect well with our observations: enjoyment of doing tasks, excitement when a hard bit of code went through the compiler, and humor in memes and jokes are good examples of different manifestations of fun. Then

again, it is quite hard to scientifically delimit what fun is as it is such a natural and personal thing: while theories and data about fun in its multiple forms can be recorded and analyzed, fun comes from different stimuli and situations for different people (Cain & Lee, 2016). This was present in the empirical part of this study as well. While some participants were absolutely livid with fun, for example reciting last Saturday's TV show's catch phrases, some attendees would not even react, or they could be seen visibly getting annoyed.

As for the three types of fun identified, some additional remarks can be made. Fun in doing is affected by the materials used and if the tasks planned are enticing, suitably challenging and provide enough level of freedom (see also Chu, Angello et al., 2017; Schepers et al., 2018; Tisza, Gollerizo et al., 2019). Game programming is considered fun and Sim et al. (2006) say that it can be an innate property of Scratch. Scratch was observed to be fun also in this study, even if one attendee saw it as a chore and preferred other programming tasks. Satisfaction is also a form of fun and it has a lot to do with tasks and performance. It was observed and found in interviews when visible anger released itself as a "yippee" or when an attendee stated that it was fun to get things working, i.e., as a sense of accomplishment. Enough challenge in the task performed is a good thing (Brandtzæg et al., 2018) and that was found in the interviews as well.

Social fun was also found in this study (see also Chu, Angello et al., 2017; Schepers et al., 2018; Tisza, Gollerizo et al., 2019). Social fun in this study is characterized with sharing amongst peers, like cooperating and launching ideas for a game project or by laughing together at memes. Popular culture and games played a prominent role in social fun. These findings are related to the non-formal nature of the clubs observed as memes would probably not be tolerated in a formal classroom.

Pedagogical fun identified from our data is novel for the CCI literature. Previous literature has touched upon whether teachers should be fun in the classroom (e.g. Garner, 2006), i.e., fun as a pedagogical tool, and productization of fun in form of e.g. video games. Pedagogical fun is also related to Berk's (1996) study listing humorous tactics. As Garner (2006) said, humor can bridge the gap between attendees and educators. Our data also shows the instructors could get the whole group of attendees burst out laughing. It was also noticeable in our data how fun was useful as a cognitive break in learning (Berk, 1996; Garner, 2006) like for example with the case of the two attendees who made the "Shreek" game. They took breaks so that they could look at their project with renewed eyes and having fun was a part of the programming experience in itself. We maintain that pedagogical fun can be accomplished in multiple ways: by joking and engaging in humorous activities and discussions with the participants, by utilizing fun materials and activities as well as by carefully planning the materials and activities so that they offer suitably challenging experiences, experiences of success and accomplishment as well as freedom and autonomy.

Regarding the age of the attendees, social fun and fun in doing seemed to be important in both age groups. Both younger and older children enjoyed joking between themselves and with the instructors; discussions of pop culture in different forms, particularly related to video games, were also a source of enjoyment and fun with both groups of children. Not surprisingly, the younger children were making more childish jokes, got more excited with trying out their projects (e.g. racing with the LEGO Mindstorms

robots), and were more prone to be distracted from the work when having fun. The older children seemed to enjoy more the achievements and success after challenges, or at least they reported about those on their own, but they enjoyed practical jokes and silly ideas as well as the younger ones. In our study, the clubs for the older children were not curriculum-based but the clubs for the younger children followed a curriculum. We assume that pedagogical fun might be more important if the activities are relatively formal and have a clear curriculum that is followed, to keep also those activities engaging that the participants are not so interested in.

As for the practical implications, we maintain that a lot reported in this paper can be considered common sense knowledge, but we also maintain it is not explicitly available for educators or instructors working with children in non-formal technology education. Many of us probably implicitly assume fun is beneficial for learning and we may even have initial ideas on how to arouse fun in learning settings with children. However, we lack a comprehensive, systematic discussion on different forms of fun and on different means by which one may be aiming at fun experiences. Especially such discussion is valuable for people not considering themselves as innately fun persons (cp. McManus & Furnham, 2010), which may actually include most of us.

Based on the findings of this study, we have compiled a list of suggestions for the educators and researchers to consider when aiming at fun experiences for children in the context of non-formal technology education. Even though some of the suggestions are not tied to fun exclusively, based on our data they seem to support fun and enjoyment. Regarding the age of the children, the suggestions provided below are not age-dependent but some of them may need some tailoring for different age groups, as indicated below.

From the viewpoint of pedagogical fun, we suggest the following:

- Consider the nature of the work with children: if it is curriculum-based (compared to relatively free, child-led working), pedagogical fun can help keeping also those activities engaging that the participants are not so interested in.
- Build fun and enjoyment consciously in the activities: try to select fun topics for the work, utilize fun materials and activities, and encourage participants to have fun while working, but be also sensitive to possible different interpretations of what is fun and what can be even hurtful to somebody.
- Include games and game play as part of the activities as children seem to always enjoy those; in our data the instructors specifically mentioned that children come to the Organizer B's activities due to games and game development; remember that computer games can sometimes be too immersive, though, and can guide focus to wrong direction.
- As an instructor, build rapport, make use of popular culture, jokes, and memes the participants are familiar with, i.e., build on the common ground; there is no need to be a comedian, though. Note also that not everybody is familiar with every meme, movie, or video game — be careful to include everybody in your jokes in some way.
- Offer experiences of success and accomplishment. Consider the pedagogically suitable level of difficulty for the activities so that they are rewarding but not too easy, as that can support feeling of satisfaction when succeeding in the tasks. Share and celebrate accomplishments together to support positive and fun atmosphere.

Regarding fun in doing:

- Coming back to the suitable level of difficulty for the activities, on the one hand, plan for immediacy of the reward particularly with younger children to keep them engaged and enjoying the work; older children can appreciate this as well but most likely are better able to enjoy also the challenge. Thus, on the other hand, consider what is suitably challenging for the participants (Brandtzæg et al., 2018), so that they can experience also ‘hard fun’ (Papert, 2002), but not too difficult, so that they do not give up. Be mindful with the participants’ age and consider the children’s cognitive development stage. Consider also the amount of scaffolding needed with any age of participants, so that it is possible to experience the moments of satisfaction after the challenge and not only frustration.
- Consider having fun as a resource for work (see also Iivari, Kinnula, Kuure, & Keisanen, 2020); new ideas for how to go forward with the project can be acquired from playing with even the silliest of ideas and iterating them together. We argue that this is not an age-related issue in any way – anybody can enjoy a good laugh every now and then.
- Offer participants freedom and autonomy both in what topics they work with as well as materials and methods as that seems to contribute to enjoyment of the work. If there is a curriculum to be followed, consider how to embed a suitable amount of flexibility in the activities, to give the participants time to focus also on their own projects. Provide enough support and instructing to make the freedom an enjoyable and fun experience instead of a stressful one; pedagogical planning is needed also with freedom and autonomy. Consider once again the children’s cognitive development stage and scaffold their work appropriately.

As to the viewpoint of social fun, the following suggestions can be useful:

- Support collaboration and sharing of ideas, and find and set up situations for presenting one’s own work and discussing what others have produced. This can be both useful for everybody but can also support open and positive environment and be in itself fun, and through that support fun and enjoyment of the activities in general.
- If possible, give children a choice at least sometimes to work also on their own if they wish to do so, as that can be more enjoyable for some children and in some situations. Consider carefully when collaboration is a pedagogic choice and when it is possible to let the children choose their way of working (collaboratively or on their own).

We also urge the researchers and practitioners to consider what is fun after all. Remember to take a responsible, ethical, (context) sensitive stance towards fun. Experiencing fun is a very personal and context dependent issue; not everybody finds the same things fun. When facilitating fun, approach the classroom or the club setting as a “complex microcosmos: as a multifaceted constellation of people, objects, tools, relationships, discourses, as a stage with particular performances” (Iivari et al., 2020) that requires a careful study before fun can be meaningfully facilitated. Hence, one can and should not approach fun with a cookbook type of approach, as a simple ingredient that can just be thrown into a soup. A “self-reflective as well as a responsible, ethical stance towards one’s own role” in facilitating fun (Iivari et al., 2020) is needed: good intentions can go wrong and what was originally meant to be fun may hurt or insult others. Adults’ careful contemplation is always required with ‘fun,’ also in case of pedagogical fun.

In more practical terms, consider what is the (current, preferred) relationship between children and instructors and based

on that decide what feels an appropriate amount and style of fun in the activities. Take into account at least the following: is the role of the instructor in the activities intended to be relatively similar to the role of a teacher in formal education, or is it intended to be closer to an adult friend; what is the (educational) background of the instructors and how that possibly affects their instructing style; are the activities strictly organized and instructor-led or are they participant-led and very free-form; how much there is time for socializing and still reaching the objectives set for the club; what is the background of the participating children; how large are the age/cultural differences between children and instructors, i.e., how well they understand each others’ jokes, do they play the same games, listen to the same music, watch the same television series etc.

All in all, non-formal technology education seems to provide a good basis for fun. There were few negative emotions in the clubs, and one interviewee stated that what he would change in the clubs would be “to make them last longer”. This does not mean that non-formal education is inherently fun, as in our study there were definitely a few occurrences when enjoyment was clearly lacking, but it gives fun a good platform to flower on. We assume that one element here is the freedom that non-formal education is able to provide the participants (compared to formal education). We also think that there are plenty of opportunities to facilitate fun in non-formal technology education, even if it should not be viewed as a straightforward or simple task.

6. Conclusion

This study contributes by identifying three forms of fun, pedagogical fun, fun in doing and social fun, in the context of non-formal technology education. Pedagogical fun identified from our data is novel for the CCI literature. In such a context where participation is usually voluntary and the participants should somehow enjoy the activity and perceive gaining something valuable in order to continue their participation, fun is a significant aspect. Therefore, it is useful for those involved in the fields of CCI and education to note the different ways fun can influence the time spent (and enjoyed) in non-formal technology education. Based on this study, the relationship between non-formal education and fun is not clear, but it can be stated that fun seems to have a freer platform to develop and express itself in the non-formal spaces compared to the formal ones.

For practitioners working in the non-formal education context, this study makes it visible how fun exists in that context and that it should be appreciated and nurtured. Motivation is important when it comes to signing up for a club but enjoyment of the activities is an important factor in keeping the attendees to come back, and the different forms of fun can have a decisive effect. Thus, we argue that fun should be given room to blossom and should be even consciously incorporated into the curriculum. Freedom to choose your topic and share your feelings, jokes, successes, and positive experiences provide a nice basis for a fun environment where the different practices of non-formal education can reach their full potential. As to the formal technology education context, the clubs for the younger children in our data were relatively close to formal education. There is one unavoidable but significant difference, though: the children came to the clubs voluntarily. This is such a big difference compared to the mandatory formal education that we wonder is it ever possible for children to have anything else than “school fun” (Dreessen & Schepers, 2018) in the context of formal education. Nevertheless, we still think that the practical implications presented in this study can be applied in the formal technology education context as well, although we see a need for further research on what would really work in that context.

As for the limitations of this work, we acknowledge that there is a multitude of research approaches and epistemological positionings for research on fun, each with particular strengths and limitations. We think future research using quantitative methods to analyze the different forms of fun identified in this paper could bring increased understanding: qualitative data gives in-depth insights to the phenomenon but not how widely it is spread in the larger population. Thus, quantitative data with a larger group of children could yield interesting new viewpoints. It might have also helped to understand which activities were most fun for the children, if it had been possible to ask the children to fill in a survey every time. This would help in developing the activities further to be more enjoyable to the participants. Additionally, psychophysiological measurements might have offered exciting insights into fun – this data could be compared with self-reported fun. However, the researchers opted for a qualitative inquire in which they did not want to influence the natural flow of the clubs. Hence, only observation was used as a method there. Only one researcher conducted the observations; additional observers might have yielded complementary understanding of the phenomenon of fun. Some interview aids could have been also included, such as pictures or memory ques so that the interviews themselves could have had a fun atmosphere to wake up memories of fun. Then again, we think that in terms of in-depth qualitative, interpretive inquiries into fun in non-formal technology education we could have gone even further: more participant led research methods could be utilized and collaborative data analysis involving both researchers and participants could have been experimented with. As for case study research, we also see that case studies of more positivist nature could have been utilized, with multiple case study research design and theory generation on the antecedents and consequences of fun in non-formal technology education of children (following e.g. Yin, 1994). Regarding limitations, moreover, we acknowledge that it is not known if these three types of fun comprehensively capture all the forms fun can take in this setting and whether these forms of fun apply to every situation or whether the fun types identified are very case specific. Most likely the answer lays somewhere in between. Due to the nature of the clubs, only the topics of robotics and programming were looked into. Other kinds of clubs involved in technology education could have been inquired as well. For non-Finnish people the city where the study took place with around 200 000 inhabitants might seem small but in the

scale of Finland, it is the fifth largest city in the country. However, the instances studied here might not be applicable outside of the largest cities or socio-economical contexts that do not give children as much free time or that do not encourage learning outside of school.

This study took a look into the practices of non-formal educators. In future research it would be interesting to see how researchers themselves would set up a 'lab' like situation where they non-formally taught the attendees something and observed fun in a set up situation. There could be examples of the different fun mentioned in this study in focus or other things that relate to fun, such as different levels of observed engagement connected with surveyed or interviewed feelings of fun. New quantitative meters for fun could also be developed based on the findings of this study. As the locational problems were discussed above, this type of mapping could also be done in a wholly different cultural context, maybe rural areas or bigger cities in other countries. The intertwining of memes and pop culture in education would also be an extremely interesting study topic relating to fun.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix. Technologies used in clubs of organizers A and B and the different skills learned

Table A.1
Technologies used in clubs of organizers A and B and the different skills learned.

Technology	Classification	Club	Skill
Scratch	Web site/informal game development tool	A programming	Game development
Android Studio	IDE/Software	B programming	Android app development
Freecodecamp.org	Community/informal web development learning tool/web site	B programming	Web development (HTML, CSS)
Unity 3D	Game engine/all-in-one editor	B programming	Game development
Tic-80	Game engine with retro feel	B programming	Game development
LEGO Mindstorms	Building 'toy'	A robotics	Mechanics instruction (levers, 4-wheel cars etc.)
Micro:bit	Programmable development board with sensors	A robotics	Electronics and robotics wiring and commanding
Micro:bit IDE	IDE with Java or block-based language	A robotics	Electronics and robotics programming
Arduino	Multipurpose tool/development board	B robotics	Electronics and robotics wiring and commanding
Arduino IDE	IDE with own language	B robotics	Electronics and robotics programming
Fusion 360	Modeling software	B robotics	Modeling 3D models for printing
Inkscape	Vector graphics illustrator	B robotics	Modeling 2D models for laser cutting
RAISE3D Pro2	3D printer	B robotics	3D printing
Epilog Laser	Laser cutter	B robotics	Laser cutting

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