Towards an Ecological Inquiry in Child-Computer Interaction
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ABSTRACT
This paper introduces an Ecological Inquiry as a methodological approach for designing technology with children. The inquiry is based on the “ecological turn” in HCI, Ubiquitous Computing and Participatory Design that shift the emphasis of design from technological artifacts to entire use ecologies into which technologies are integrated. Our Ecological Inquiry extends Cooperative Inquiry in three directions: from understanding to emergence of social practices and meanings, from design of artifacts to hybrid environments, and from a focus on technology to appropriations through design and use. We exemplify our approach in a case study through which we designed social technologies for hybrid learning environments with children in two schools, and discuss how an Ecological Inquiry can inform existing approaches in CCI.

Categories and Subject Descriptors
H.5.2. [Information Interfaces and Presentation (e.g., HCI): User Interfaces – theory and methods, user-centered design.

General Terms
Human Factors.

Keywords
Ecological Inquiry, design methodology, Participatory Design, social technology, school environment, Cooperative Inquiry.

1. INTRODUCTION
Cooperative Inquiry, and its envision of children as active design partners, has been successfully applied to the process in which Child Computer Interaction understands, intervenes and develops new technology [18, 19]. Here, the unit of analysis is not only the device, but also the social practice of children, their environment and their devices. The Cooperative Inquiry process model consists of an iterative process of Contextual Inquiry for understanding how children use existing technology, Participatory Design activities to engage children in the design of new technologies, and Technology Immersion to explore how new technologies might stimulate new patterns of use among children. As we acknowledge the general success and applicability of Cooperative Inquiry in CCI, this paper questions whether this process model is sufficient to deal with current challenges in CCI.

Based on current literature on Ubiquitous Computing, Participatory Design and HCI, this paper develops an Ecological Inquiry that extends the boundaries of Cooperative Inquiry into an iterative process model that incorporates aspects of emergence, environments and appropriation. We point to the fact that current research within Participatory Design literature does not merely emphasize an understanding of users’ current practice as their point of departure [3, 23, 31-33]. Rather Participatory Design scaffolds shared spaces in which new directions for design can emerge as a dialogical process between children, researchers, designers and stakeholders [33]. This technology enhanced space has been described as a “third space” [41], a “design collaboratorium” [7], and a ‘technology-enhanced activity space’ [34].

The objectives for design intervention have also changed according to current research. Whereas Cooperative Inquiry and its corresponding techniques emphasize the development of technological artifacts, current literature within HCI and Interaction Design, especially within Ubiquitous Computing, apply ecological perceptions of use practice as their unit of analysis [9, 10, 11, 42]. This approach shifts the objective of design interventions from the artifact to the entire use ecology. An Ecological Inquiry in CCI must accordingly expand the scope of design interventions to also include the entire activity space including the physical space of children’s technology use. Finally, an Ecological Inquiry does not only consider future use patterns as a result of technological immersion. Technological potentialities are according to Kaptelinin and Bannon [34] first realized when new technologies are appropriated into existing use practices, initiated already through the process of design. Thus, an ecological inquiry combines emergence of values and environmental discoveries with studies of appropriation to explore how new technologies fit and transform the social practices of children.

The paper is organized as follows. First, we will account for the “ecological turn” in HCI and Interaction Design to motivate the need for an Ecological Inquiry in CCI. We will discuss the ecological turn in relation to existing CCI literature in a related work section. Following, our approach to an Ecological Inquiry is unfolded as an iterative process of inquiries in social practices, user environments and appropriation of technology. We exemplify the iterative Ecological Inquiry process model in a case study through which a social technology application for school environments was designed in collaboration with teachers, school management and sixth grade pupils in two Danish primary schools. We evaluate the lesson learned from the case study to discuss how an Ecological Inquiry can inform existing approaches in CCI.
2. THE ECOLOGICAL TURN

Understanding the nature of collaborative interaction within mixed digital and physical environments has been an enduring concern within HCI and Interaction Design (e.g. [11, 25, 52]). This research field has led to multiple studies within CCI of how Ubiquitous Computing can support engaging and enhanced learning environments for new generations. Envisioning the paradigm of Ubiquitous Computing, Weiser [52] suggested a design approach relying on the coupling of interactive systems and their context of use, including the everyday practices of users and their relations to existing physical and digital tools. Weiser insisted, “the unit of design should be social people in their environment, plus your device” [8, 51].

Based on preceding research into ecologies (e.g. [36, 42]), Crabtree and Rodden [10] introduce hybrid ecologies to merge mixed reality environments and ubiquitous computing environments. They understand ecologies as the space or environment that cooperation takes place within and the socially organized ways in which the environment affords collaboration. Digital technologies and interactions are increasingly embedded across distributed physical and digital divides to form hybrid ecologies that merge both face-to-face interactions, and geographically distributed and fragmented interaction. Adding to Weiser’s virtuality-reality continuum, Crabtree and Rodden argue for combining hybrid networks and ubiquitous devices with hybrid models of space and virtual environments, to create collaborative spaces that merge the physical and digital across multiple environments. The scope is not merely on the artifact or device, but incorporates the extended spaces, relations and environments in which the technologies are developed and integrated.

Even though the predominant HCI literature dealing with hybrid ecologies remains on the design and use of products, extending the design process to include the entire use context is not new to HCI and interaction design. In 1990, Grudin [21] described this movement from artifact to use practice in relation to how the “computer reaches out”. Bannon [2, p. 27] emphasized how design should move from human factors, connoting a “passive, fragmented, depersonalized, unmotivated individual” as a component in a system, to human actors, conceived as active and engaged in the design process. This view is also found in Scandinavian Participatory Design and especially in Bødker’s seminal work on use practices as the scope for designing new technology [5, 6]. Muller [40] and lately Muller and Druin [41] describe the collaborative design space in which users are actively engaged, as a ‘third space’ or ‘hybrid space’; a fertile environment in which participants can combine diverse knowledge into new insights and plans for action, to inform the needs of their organization, institutions, products and services. The third space is further described as a design “collaboratorium”, a mutual learning space between design and use, by Bødker and Buur [7]. In the collaboratorium, design is not entirely focused on producing new technologies, but also to make people realize that they have a choice, to influence their future practice and use environment [4].

The shift from individual products and artifact to environment reflects a general ‘ecological turn’ within Interaction Design, emphasizing the need to develop new methods to support the concrete analysis and design of entire environments and habitats. As argued by Kaptelinin and Bannon [34, p. 280], the scope of Interaction Design is not only intended to help designers create better artifacts, but also to assist people themselves create better environments for their work, learning and leisure activities. In line with Crabtree and Rodden, but focused on the process rather than the product, of design, they emphasize the spatial and hybrid dimensions in their framework for constructing technology-enhanced activity spaces. They argue for shifting perspective from user requirements, design solutions, implementation and evaluation of digital artifacts, towards a view on technology-enabled practice transformation that happen through iterative processes of mutual collaboration between designers and users, hereby expanding the “object of design”.

Common for the ecological turn is a shift from understanding individual users and their existing practices, towards the potentials and aspirations of people living in dynamic environments who are concerned with improving their practices, including incorporations of various technologies. Digital technologies, in other words, “have become an organic part of the natural environment and should be understood and developed as such” [34, p. 290]. Social practice, hybrid spaces, and digital technologies are embedded with other technologies, social contexts, past and future events, in more holistic ecologies and continuous acts of appropriation. In this way, the construction of new digital technologies and solutions for the real world involves managing disparate technologies and complex facets of environments and social contexts into coherent conceptual frameworks [34, p. 297].

Defining the object of design to include spatially and temporally organized practices and ecologies, affects our understanding of the design process, to include new ways of collaborating with people in their existing environments. Moreover, users and designers cannot simply be defined in these terms, but should perhaps be addressed as constellations of variously positioned actors and teams who crisscross the design space in diverse ways and at certain moments of design. Binder et al. [3] make an important shift in the conception of the design space from being a confined space in which professionals design and create certain objects and products, to spaces created by the iterative movements and transformative representations of various people and stakeholders involved in the collaboration. Such a perspective affords a focus on the design space as extended and decentralized, into various social, digital, physical contexts, in which the coming together of certain possible futures emerge. This is a shift from predictability and instrumentalism of design practice, towards enabling and becoming of potential futures that can be negotiated and rehearsed in and through collaborative processes of design [3, 24].

Extending both the object and process of design through an ecological perspective is particularly relevant when designing social technologies. Hagen and Robertsen [22, p. 77] argue, that our methods of design must respond to the “participatory, emergent and social nature of social technologies”, recognizing that such technologies are designed as much through use, as through their development and design. Social technologies, they contend, “are containers or scaffolds that rely on participation and user-driven contributions to take their form. Their shape emerges through activities of use, over time, and their use is social and situated and depends on the activities of those who use them”. As the ecological turn suggests, we move from designing technologies to facilitating appropriation for creating technology-enabled practice transformations [34]. Appropriation here is understood, not as end-user appropriation after design, but as a balanced and continuous process of negotiated practice transformations, through the design process. As Kaptelinin and Bannon [34, p. 284] argue, “[T]o be successfully appropriated by their prospective user, innovative technologies should fit with the needs, expectations, and strategies of people transforming their practices (i.e., intrinsic practice transformation). At the same time, the design of innovative technologies (i.e., creating preconditions for extrinsic practice
transformation) greatly increases the range of resources available to people and thus facilitates intrinsic practice transformation.” Scaffolding relations for collaboration, enabling future practices to emerge, and designing for continuous appropriations of technologies as part of people’s environments, therefore become vital elements in the design of sustainable hybrid ecologies.

As we have found, approaches to the ecological turn within HCI, Ubiquitous Computing (on hybrid ecologies of mixed reality), and Interaction Design and Participatory Design (on technology enhanced activity spaces), are separated by their focus on products and processes. However, the perspectives align well in the design of hybrid environments, in which the object of design is expanded. We draw upon these approaches in our iterative process model for an Ecological Inquiry presented below. First however, we will examine how the ecological turn is reflected in current IDC literature.

3. RELATED WORK
Since the first IDC conference in 2002, the research field of Child-Computer Interaction has embraced methodological issues of how to engage children in the design process. These methodologies are accounted for in [27, 43]. Despite epistemological differences among the different, sometimes intertwining, design methodologies such as Cooperative Inquiry [16, 18, 19], Informant Design [46], Participatory Design [20, 30, 44] or Co-design [50], some overall objectives are pursued in CCI. In general CCI methodologies aim to: further the understanding of children and their relations to technology; provide new methods, tools or techniques to support the design of technology; test and evaluate children’s benefits from supporting technologies.

We will briefly reflect on these general concerns according to the ecological turn in HCI presented above. We recognize some similarities among the ecological perception of HCI and current literature. However, as our analysis indicates the ecological turn is not fully covered within the different methodologies in CCI. As stated by Druin [17], children are not “just short adults” but an entirely different user population with their own culture, norms, and complexities. Hence, CCI methodologies often develop an understanding of children’s needs as a starting point for design research. Competing methodologies suggest how understandings of children can be obtained through theoretical accounts of children’s physical and cognitive development [27], contextual inquiries [16], interviews and questionnaires and open-ended design processes. Interviewing and engaging children in the design process as design partners [20, 33]. Creating an understanding prior to design is widely accepted in CCI. However, as a result of the ecological turn in HCI literature, the understanding of children and their relations to technology, provide new methods, tools or techniques to support the design of technology, test and evaluate children’s benefits from supporting technologies.

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4. TOWARDS AN ECOLOGICAL INQUIRY
Based on the view of designing with children advocated above, we have developed an Ecological Inquiry, an iterative process model, as a way of approach the design of technologies for hybrid environments. We argue that designing novel technologies for hybrid spaces of activity and interaction demands a focus on social practice, space and technology to be instantiated in a collaborative and iterative design process (figure 1). These dimensions are intertwined and no dimension has more weight than others. Rather, they are always present qualities of any given context – social, physical or digital – into which we as designers inquire and intervene. Below we present our approach underlying the three dimensions.

4.1.1 From Understanding to Emergence
Our approach sees social process and cultural meaning as fundamentally emergent and dynamic, and moves from a perspective of understanding social reality as means for creating “implications for design” [14], to scaffolding ecologies of emergent relations and practices. In this view, understanding social reality per se, by observation, interview or collaborative engagement, is not something done prior to the design process. Rather, we aim to integrate the vitality and complexities of on-going social processes into the design process, by creating rich spaces and forms of collaboration that allow their inherent dynamics to be embellished.

This interventionist and constructivist approach to social practice and meanings does not attempt to categorize values and behaviour, but to work with their heterogeneous qualities as they are enacted in everyday practice [15] and emerge as part of a dialogic design process [33]. In this view cultural practice is processual and performative, a form of assemblage, in which the always-emergent qualities of the present are drawn to attention [38, pp. 101-102]. Linked to Deleuze and Guattari’s [12] notion of assemblage, Marcus and Saka argue that “[T]he time-space in which assemblage is imagined is inherently unstable and infused with movement and change (…) It generates enduring puzzles about ‘process’ and ‘relationship’ rather than leading to systematic understandings of these tropes of classic social theory and the common discourse that it has shaped” [38, p. 102].
Intervening into everyday contexts in creative processes of collaboration, moving into and across multiple domains, enables people’s practices to become externalizable to a degree, that make them a resource for negotiation and transformation. This happens socially and collaboratively, between present and potential understandings, and dynamic contexts that both emerge and are created through the design process (see also [3]). Influenced by this cultural constructivist perspective and the ecological turn, the smallest unit of analysis is necessarily relational [42] and social, rather than individual or cognitive. And aligned with third paradigm of HCI [26] interaction is understood as phenomenologically situated, in the complex actions, contexts and technological opportunities of particular environments.

4.1.2 From Artifacts to Environments

In an Ecological Inquiry the focus on space emphasizes the importance of co-located, distributed and hybrid environments of activity. Space, whether digital or analogue, therefore should incorporate understandings of the physical, social and digital dimensions of particular spaces and environments [34]. Moreover, when designing hybrid environments, or technology-enhanced activity spaces, we should incorporate perspectives on space: seen as the generic and structural qualities of particular existing or potential environments, with the intrinsic experiences and cultural embeddedness of place; whereby people inhabit and appropriate particular settings through situated acts of experience. According to human geographer Tuan [48], there is a clear distinction between space and place: space is abstract and place is specific, or place is space that people have made meaningful. Anthropological studies of space emphasize that places, like social practice and meanings, are dynamic, inscribed and embodied, and draw together lived experience, agency and location as central features of being and acting in the world [1, 37]. Place is experienced and performed and, in a Deleuzian sense [12], always in the becoming, never finalized and not bound to specific physical places. Rather, people move in networks of relations to the world, making the constant becoming of place into a cultural phenomenon, linked to experiences and actions across multiple locations and boundaries.

In the development and design of collaborative and hybrid environments, Harrison and Dourish [14, 25] argue, there has been an overdue focus on spatial metaphors and models of interactions, for structuring fragmented and distributed opportunities for interaction, identity and presence. As their 1996 article contended, “[S]pace is the opportunity; place is the (understood) reality” [25, p. 1]. However, as Dourish [14] argues, space is never pre-given. Both space and place are social products, and the widespread use of networked and mobile technologies emphasize the complicated and interchangeable relations between people’s actions, environments and technologies. Kaptelinin and Bannon [34] stress that contexts, places and ecologies are complex phenomena that are not, as such, “designable”. Rather, they are transformed by actors and evolve in unpredictable ways through use and appropriation inside the environments people always already inhabit. Therefore, we argue, the design of hybrid environments for children’s interaction, should combine both physical, digital and social dimensions and integrate rich perspectives of space and place, that allow complex experiences and activities of particular environments to be co-created and appropriated by its inhabitants, through the design process.

4.1.3 From Technology to Appropriation

Rather than reduce the complexities of social practices and hybrid environments in order to design technologies to specific user requirements, our approach aims to bring all three ecological dimensions into play in their complexity through the design process. We orchestrate a collaborative design process releasing prototyped technologies inside children’s existing contexts, to see what meanings and potentials emerge as part of the process. In this interventionist approach, we engage in dialogic and situated explorations of social practices and environments, to catalyse potentials for designing new technology. This approach differs from Technology Immersion [18] in which children are exposed to arrays of technologies through intense lab explorations. Rather, we intentionally use appropriation as part of exploring the technological dimensions and potentials in children’s own contexts. Based on inquiries into social practices and environments, we study how prototyped technologies are appropriated into these contexts to create sustainable ecologies. Design and use, hence, are merged into a focus on continuous appropriation and development through the collaborative design processes.

Particularly when dealing with hybrid ecologies of social technologies in institutional settings, the development of technology goes hand in hand with the transformation of present and future practices [22, 47]. Organizational change becomes an integral and extended part of the iterative process of design, or what Simonsen and Hertzum [47] calls a sustained Participatory Design approach. They introduce iterations of design and implementation from the early stages of design through to the organizational implementation and use of technology, and emphasize improvisation, experimentation and learning as part of an open-ended process of inquiry. Hagen and Robertson [22, p. 79] argue for extending prototyping “into the wild”, as a living form of design research that enables designers to co-design with community members in their own environments. Hence, in line with Kaptelinin and Bannon [34] who emphasize the construction of intrinsic technology-enabled practice transformation, focus is on the emergent opportunities that occur through iterative developments of technologies through anticipated, desired, and finally, intentional change [47]. Technologies are not designed for, and implemented into, particular environments, but emerge through appropriations and improvisatory iterations of design and use, through a mutual design process. In other words, technologies and social transformation emerge through the same process of discovering and prototyping, rehearsing potential futures inside children’s everyday contexts.

In sum, based on the ecological turn, our Ecological Inquiry employs an interventionist approach to social practice, environments and technologies through collaborative explorations inside people’s own contexts. In particular, we focus on scaffolding the emergence of dynamic social practices and meanings, rather than fixed understandings, through the design process. Rather than designing technological artifacts, the object of design is extended to discovering and creating environments and ecologies that integrate the complex physical, social and digital dimensions of space and place. And finally, we move from a perspective of designing technologies to iterating appropriations, rehearsing the future of particular technology enhanced environments with children. In the following, we will present a case study demonstrating how we practically worked with these three dimensions.

5. CASE STUDY: LITIRUM

The Ecological Inquiry presented in this paper was applied in Litirum, an eight-month project that took place from August 2012 funded by the European Union through the European Regional Development Fund. The objective of the Litirum project was to develop a new social technology application, and a physical school installation, to support formal and informal learning in
The application was targeted primary schools and applied to children aged 8-14. Litirum was an interdisciplinary research project engaging researchers from computer science, anthropology, architecture and pedagogical research, as well as two industrial partners specialized in school development and production of tablet and smartphone applications. The research team and partners worked together with pupils, teachers and administrators from two primary schools in the Danish region of Jutland. One school was involved as a result of their progressive efforts to integrate technology into the school environment, whereas the second school represented an average Danish school with more limited integration of digital technology in their educational practices. Danish schools are currently investing extensively in new technologies to enhance formal learning practices. More important however, is the challenge of ubiquitous computing. Pupils increasingly bring their own devices – smartphones, tablets and laptops – into the school, together with the social practices of their connected lives. During classes they can engage in multiple online activities, games and social networking sites, as well as contribute to their teacher’s knowledge, challenging the nature of formal education. From this perspective the introduction of an application combining formal and informal learning in school environments is both promising and controversial, and even contested in some school environments.

The ecological inquiries leading to the development of the application and two interactive installations were conducted in a Participatory Design process with seven key collaborative workshop activities, held in parallel strands, in the two schools. Between these events internal research and design workshops took place, between members of the research team, partners and school personnel. Each school workshop engaged 16–80 pupils, and 5–10 teachers and school administrators. In all, about 120 pupils and 25 teachers and administrators took part in the Litirum project for longer or shorter periods. The outcome of the project was the Narrify application, a social technology that runs in a web browser on computers, tablets and smartphones. The application, as well as two physical installations, promotes a knowledge-sharing environment that engages pupils, parents and teachers in a digital context for creating and sharing formal and informal knowledge.

5.1 Ecological Inquiry in Litirum

In the following, we present our iterative process model through three Litirum workshops, spread over the fall of 2012, each focusing on one dimension of our Ecological Inquiry. In the Litirum project, the three dimensions of social practice, space and technology, were instantiated as motivations for learning, school environments and social technology (see figure 2, with workshops indicated by dots), with the purpose of transforming practices of knowledge creation into hybrid learning environments. Like other iterative models, the Ecological Inquiry uses multiple cycles of design explorations to gradually produce a focused design solution in response to the particular context and environment. The dimensions are never isolated but closely interconnected in the holistic framework of the overall inquiry. Each workshop presented below emphasizes one of the dimensions, but is always informed by previous and/or merged into subsequent inquiries.

5.1.1 Inquiring into Motivations for Learning

One month into the Litirum project, a workshop was held to explore motivational aspects for integrating informal learning practices into the formal school system. Apart from the research team, sixteen 6th grade pupils, six teachers and five members of the school management participated in the Garden of Motivation workshop, held in central indoor square at Kjellerup School.

We initiated the workshop to support the emergence of individual and collective motivations for integrating formal and informal knowledge. As pupils’ motivations are central to their learning activities, we sought to explore the intrinsic motivations for learning both inside and outside of school contexts. The teachers were kept in a separate group in order to discuss similar issues, but from their vantage point as educators. Our aim was not to identify the (primary or secondary) motivations for the children’s learning, but to scaffold the emergence of practices and values as part of the dialogic encounter. Inspired by [32] who used storyboards for inquiring into the values of disabled young adults, we asked the participants to bring a storyboard detailing a good personal experience, or learning experience, that connected their private lives and school environment. Based on the storyboards, we facilitated discussions in groups of four pupils, about the values and meanings underlying their experiences, their motivations for choosing particular events, and the relations between their everyday lives and school context. Through the discussions, we helped the pupils make, individual or collective, motivational statements. The statements were written onto motivation cards and planted in a potted plant, containing QR codes linked to a Facebook site established for the project.

Subsequently, the Garden of Motivation was established (see figure 3). Each participant placed their plant and presented their motivation card to the whole group, who were instructed to acknowledge the statements they liked. Having established the garden, all participants wrote their names on the motivation cards they supported. The process of planting and liking motivational statements served to create a shared understanding among the projects’ participants, being they pupils, teachers, designers, and commit them to the project. After the workshop the participants were asked to scan the QR code, link themselves to the Facebook group, and upload a picture of their plant from their private homes or classrooms. This was a way of sustaining their motivations, and to integrate their contributions into a shared space for collaboration reaching across multiple boundaries. The pupils’ storyboards and narratives represented a wide array of experiences dealing mainly with: sharing and recognition from friends and family; combining spaces and technologies for learning and; alternative ways of peer-to-peer learning. Common for them were that they
related to experiences that had somehow been extraordinary, and contained both personal and social values and meanings. One third of the storyboards and one quarter of the motivational statements dealt with sharing things that made one proud. Amir (aged 12) described the first and only visit from his Afghan grandparents. Bringing them to the school was an important way of showing them “everything I’ve achieved here, and it made me really proud of my life in Denmark.”

Anna (aged 12) was thrilled about her new puppy, and had also just got her own iPhone. She described the excitement of bringing images of the puppy on her mobile, to share them with her girl-friends in school. Such experiences triggered motivational statements such as “it’s nice to share things with your friends”, and “sharing with your friends and family when you’re proud of your achievements”. It was evident that recognition and appreciation from peers was an important motivation for sharing. But moreover, it highlighted the extent to which practices of sharing in themselves were central to constructing and maintaining identities and social relations. Interesting motivations emerged relating to learning and school environment, dealing with using one’s own technology in the teaching, as in an assignment where pupils interviewed a priest in the local church using their smartphones. Motivational statements described, “combining things from school with things outside school is nice and varied”, “it’s cool when you get to use IT and your own knowledge in school”. Relating personal technologies and outside explorations, extended the digital and physical boundaries of learning, and combined personal technologies with unfamiliar learning contexts. Finally, peer-to-peer learning was an important motivation when it came to learning in new ways. Here examples of motivations revealed a focus on peer learning and the breaking of routines inside the school environment: “you learn a lot from your friends,” “you learn more when you learn from each other” and “it’s fun when you break the routines in school.”

The workshop initiated the emergence of motivations for learning, bridging formal and informal context of learning, into the in situ design process. We did not attempt to define motivations for learning, but focused as much on issues and values that merged as part of the discussions. Thus, we established a shared possibility space for bringing forth the pupils’ personal and collective experiences and motivations, that influenced our common perceptions and framing in the design of a hybrid learning environment.

5.1.2 Exploring Pupils’ School Environment

Based on the motivational workshop, we established a collaborative exploration of the school environment. The following Toponaut Expedition workshop was carried out at Kjellerup School with sixteen 6th grade pupils, five teachers and two school administrators. The aim of the workshop was to explore meanings and relations connected to various locations inside the school. Building upon the insights into pupils’ motivations and practices, we aimed to investigate how particular places and spaces contained properties and potentials for creating a technology enhanced environment. School environments tend to be highly inscribed, centred around formal learning spaces, e.g. classrooms, chemistry labs, etc., which afford learning in pre-defined ways, and ascribe expectations to the behaviour of pupils and teachers. In contrast, informal spaces of social activity or learning are rarely planned, but emerge in the corridors, courtyards, etc. These spaces arise as dynamic and contingent places, only in movements and interaction that allow certain spaces to be transformed into places [49].

In the Toponaut workshop, inspired by Fictional Inquiry [13], we asked the pupils to rethink their physical everyday environment by articulating potentials and challenges of different spaces. As part of the Toponaut Corps, pupils had unlimited access to all areas of the school. While astronauts explore outer space, the toponauts were sent off on expeditions to explore local place, or topos in Greek. Each group was tasked with finding three places for each member: a favourite place, a place he/she disliked, and a mysterious place. Pupils took turns in having one of three roles: the captain who led the group to his/her place; the photographer who with an iPad made on location recordings of the captain’s description of the place; and the journalist who wrote down the captain’s explanation on post-it notes. The predefined roles helped the pupils keep focus through the activity, and enabled them to document their findings, creating a rich data set. Returning from the expedition each pupil presented his/her three places, using printed photographs with post-it notes attached, creating a collective mapping on a blueprint of the school environment (see figure 4). The video recordings from the expedition were uploaded to the Facebook group to be accessible to the whole school. The toponauts chose a wide, but often coinciding, range of places on the school. Mysterious and disliked places were mostly in-between-spaces, e.g. basement corridors or shafts, corridors next to classrooms, but also educational places, such as the classroom and the community library linked to the school. These spaces were characterized by being non-spaces, or by limiting behaviour. Most places were contented, however. For example, for Eva (aged 12), the classroom was a favourite place because it allowed her to be with her friends, while three classmates disliked it because they had to sit still and be quiet. Favourite places were mainly social places, e.g. the school’s community cinema, the football field, and creative educational spaces for domestic science or music. These places where characterized by the level of freedom they gave the pupils in practicing certain skills, the creative educational content, and the collaborative and social engagements they afforded.

To further explore the pupils’ relation to the school environment, we fused the output of the Garden of Motivation into a second toponautical expedition. Based on the previous motivational statements we created twelve new statements such as “here, we break the routines”, “here, we share what we know” and “here, we

![Figure 3. Creating the Garden of Motivation.](image-url)
have a good time”. The statements were divided into two groups of six cards: blue cards for learning places and orange cards for social places. We asked each group to identify places where one of the cards matched, or could be used to transform the space. A picture of the place and the chosen card documented the choices of each group.

Figure 4. Pupils creating a topological map of their school.

The pupils again presented their places, collectively placing the picture and cards onto the blueprint of the school. One group had chosen to match the blue card, “here, we share what we know” with the library, creating a system of “liking” the books, making visible which books were popular and recommended by other pupils. Another group developed a place for social interaction and knowledge sharing inside the library, turning a previously disliked space into an attractive social place. A third group thought that the pupils could expand their use of Facebook to include the sharing of knowledge and experiences, and chose the schools assembly hall as a potential physical place for merging the digital platform into the physical place.

The Toponaut workshop allowed us to explore and create new understandings of the properties and meanings of diverse locations, and their potentials as learning and social spaces and places. It produced insights into the pupils’ perceptions of the school environment and the opportunities for creating new hybrid environments for informal/formal learning, based on the spatial and social dimensions of their everyday context.

5.1.3 Developing a Social Technology Platform

Based on analysis and insights gained from all school interventions, the design team developed an early prototype of the Narrify application for the two schools. The application was created primarily as a platform and tool for teaching, integrating opportunities for working collaboratively through the digital technologies between teachers and students. Based on the pupils’ motivations for learning and their existing social practices, the platform afforded teaching in untraditional ways, supported a higher degree of peer-to-peer learning, and allowed on- and off-school locations, and multiple resources and technologies, to become an integral part of learning. The application allowed pupils, or educators, to ask “What do we know about the weather?” drawing on the knowledge and skills of their peers, teachers and family, as well as online sources of information, images and videos, to create shared knowledge-bases about diverse subjects. The system was designed as a local area network, to be open for input from people inside or connected to the school environment: pupils, educators, librarians, parents, and visiting members of the public. For example, a pupil could invite his meteorologist father to participate if assignments concerning weather conditions, or whole school classes could use Narrify as a platform for project work on specific topics, building pools of knowledge from various sources. Once integrated into the physical environment of the school, it would also function as a platform for making visible the types of work and projects pupils were engaged in across school subjects, age division and grades, as well as physical locations.

As a tool linked to distributed online resources the Narrify’er extended the opportunities and resources available for the students to work with. Pupils could also use the platform to work collaboratively on their homework, help each other gather information, negotiate and build knowledge, while in their homes or other off-school sites. In this way the digital application established a hybrid workspace in an open but secluded network. The Narrify’er was meant to integrate people, resources, and locations into an extended ecology that reached across the traditional boundaries of social practice, physical space and digital technology in school environments. Thus, it was necessary to explore how the platform could be appropriated into existing practices and, further, to develop the physical integration of the technology into the school environment.

5.1.4 Working with Appropriation of Technology

The last workshop presented here, named Narrify your School, was aimed at integrating the social technology into the school environment, strengthening possibilities for formal/informal learning practices. A full-day workshop was held at Vinding School with sixteen pupils, four teachers and two school administrators. Based on previous explorations into pupils’ motivation and school environment, the primary focus was the appropriation of the digital platform in context of use. Secondly, we investigated how the Narrify’er could be incorporated into the physical school environment. Thirdly, we investigated and experimented with the social practices that the new ecology of knowledge might lead to.

In the first part of the workshop we tested the early prototype of the digital Narrify platform. Pupils were supported in logging onto the system, proposing and answering questions among each other, concerning both formal and informal learning themes. The pupils were not asked to test or evaluate the system, but rather we explored how the pupils used and appropriated the technology individually as well as collaboratively. Occasionally designers or teachers would intervene, e.g. posing questions about a specific book the pupils were reading as part of a subject. The teachers found that using the system served to motivate some pupils, who wrote considerably more in their online answers than they would typically do in classes.

Working with the pupils’ informal knowledge, such as interests and hobbies led to a range of questions, falling into three broad categories: social relations, e.g. jokes and chats; preferences, “who is the best soccer player in the world?” or “what’s your favourite movie?” and knowledge, “what do we know about speedway?” or “who is the seasons top scorer on Champions League?” With our aim of supporting collective constructions of knowledge, this category was most interesting. However, the initial inquiry showed that we had assumed, and possibly overestimated, the manner by which pupils would naturally engage in gathering or creating knowledge. Existing practices from online chats and social sites such as Facebook - where less information is often desired – we discovered, needed to be appropriated to the new system to become a source for collaborative learning. Moreover, the exercise demonstrated how pupils challenged the con-
figurations of the application, minute functions, the layout or graphics, and how the social practices around the system were important in achieving the goal of creating new cultures or learning.

In the second part of the workshop pupils worked with designers to create physical and spatial mock-ups, based on their evolving understanding of the technology. Eight pupils worked together with designers in two groups and created ten mock-ups and ideas, for specific sites chosen based on the topographical data. One site was a physical platform in continuation of a staircase, a non-place [1] as it was mostly experienced in transit. It was chosen as a potential informal learning place where collective interactions could be sustained. One of the mock-ups showed an installation for recording short video responses to questions in the Narrify system. To record a video, an individual or a pair of friends, had to stand on a pedestal with his/her head in a box containing the camera (see figure 5). When the recording began, the pedestal slowly moved down, ensuring that the head of the participant left the view of the camera after about twenty seconds. This served as a dynamic and fun way of interacting, while also keeping the recordings short. Other concepts concerned navigating and visualizing the content of the Narrify system through various modes of expression and interaction.

Figure 5. Two pupils and a designer mocking up an idea.

The aim of realizing the future environment was to explore how space could become place, and how new spatialities would arise as a consequence of these interventions [14] as the pupils transformed their environment. At once, the parallel exploration and integration of physical, social and digital dimensions and activities allowed questions to emerge concerning the navigation of distributed spaces and content, and how practices and relations were established through diverse interactions in the new ecology. Based on previous explorations into social practice and environments, the workshop explored appropriations of a future social technology within a specific school environment. Working from within the everyday context of pupils and teachers, various appropriations – digital, physical as well as social – emerged as part of the collaborative process, prompting further developments to the technology.

6. DISCUSSION

Ecological Inquiry bears some similarities with existing methodologies in CCI. Both Participatory Design and Cooperative Inquiry foreground active engagement of children into the design process. This is also the case in Ecological Inquiry. Whereas Cooperative Inquiry and Participatory Design often investigate children’s existing practice as a way of understanding their needs and wants, Ecological Inquiry foregrounds the emergence of a design space as the starting point for collaborative design. Understanding becomes connected to the emerging design space, rather than to a pre-existing or fixed social reality.

In the Litirum case, participants’ motivations for combining informal and formal learning spaces were constructed in situ, through as well as between the design intervention. Motivations emerged as a part of the collaborative process of establishing the Garden of Motivation among all participants, in the same way that new understandings of the school emerged through the Toponaut Expeditions, exploring the physical environment. Based on the early prototype of the Narrify application, we worked with appropriations of the technology and its integration with the physical environment. In this way, the Ecological Inquiry developed and integrated strands of insights, created through explorations into social practices, school environment and social technology, scaffolding the emergence of an extended design space for collaboration and negotiation among variously positioned stakeholders.

In contrast to Cooperative Inquiry, the Ecological Inquiry changes the focus on artefact, to spaces and ecologies, emphasizing how the design of technology transforms the practices and environment for which it is designed. In the Litirum project, a new social technology was the design objective. However, the scope of the inquiry was the pupils’ future school environment, and their potential ways of learning, in an entire ecology of interaction. As Dourish [14, p. 301] argues, introducing technologies into people’s everyday settings does not simply create new opportunities for sociality, i.e. the creation of places; rather it transforms the opportunities for understanding the structure of those settings, hereby developing new spatialities. An Ecological Inquiry envisions the sociality and spatiality as the unit of analysis when designing children’s technologies.

Finally, an Ecological Inquiry scaffolds the appropriation of technologies as part of the design process. In the Litirum project, the final workshop was aimed at supporting the appropriation of a social technology into a particular community and school environment. Opposite Cooperative Inquiry’s technological immersion, working with the technologies inside the school context over an extended period of time, created a greater understanding of the practices and aspirations of the pupils and teachers, and thus for designing sustainable solutions for their particular environments. Moreover, involving pupils and teachers, not as informants or evaluators of technologies as often practices in forms of Cooperative Inquiry, Informant Design and other participatory methodologies in CCI, but as design partners throughout the process, forged the emergence and rehearsal of future learning methods as part of the design process, hereby impacting the success of technological appropriation. In this way, the ecological approach not only affords new collaborative ways of designing technologies, but also intrinsic and extrinsic practice transformations inside the environment or organisation, through temporally extended iterations of developing and appropriating new technologies.

The Narrify application afforded novel digital opportunities for learning, but also challenged practices and conceptions of education fundamental to the Danish, or Western, school system. View-
ing the integrated dimensions of Ecological Inquiry, of social practice, space, and technology, for developing hybrid learning environments, three areas emerged in which the technological application and the new ecology it sustained, challenged traditional practices and conceptions of the school:

1. **Conceptions of teaching**: The social technology platform challenged the authority of teachers and educators, to include pupils, and other agents, in creating different modes of learning and ways of working collaboratively with teaching subjects. This democratization meant that teachers had to create new social practices of education combining formal and informal ways of learning, in and across digital and physical domains where pupils often had more skills than their teachers, hence transforming conceptions of teaching.

2. **Conceptions of environment**: The digital platform created connections and assemblies of people and resources across extended and overlapping digital, physical, and social, locations and environments. As a result of this new ecology, spaces inside the school were transformed into active and social places, for interacting with digital environments inside and outside the school. At once, it involved off-the-grounds sites and people into the school community, hereby extending the physical boundaries of the school into a larger ecology.

3. **Conceptions of knowledge**: Including disparate and distributed information and visual, digital, and physical resources, opened for new ways of working collaboratively with hybrid constructions of knowledge in the school. It also gave way for parallel or multi-vocal “versions of the world” to be produced and negotiated, eschewing goals of finding absolute truths or educational result. Understanding and knowing emerged as constructivist assemblages of people, practices, and materials, which, interwoven with technologies, were constructed through appropriations, between development and use, over extended periods of time.

The social technology is still being developed and appropriated to support new educational practices for the schools in question, implemented both digitally and spatially into hybrid learning environments. Qualitative anthropological research and documentation is being conducted as aspects of the design process, technology appropriation and transformation of practices inside the school. This again will create new insights into the potential and challenges of working through an ecological approach. An Ecological Inquiry resonates well with Participatory Design, and its emphasis on empowering the users, focusing on the design of new technologies, were constructed through appropriations, between development and use, over extended periods of time.

In this paper we have proposed a new direction in CCI towards an Ecological Inquiry. This methodology is not radical new to CCI. On the contrary, Ecological Inquiry bears some epistemological similarities with existing methodologies such as Cooperative Inquiry and Participatory Design. In the paper, we argue however that Ecological Inquiry differs from existing design methodologies through combining and extending current models in three significant ways. Firstly, the design process takes it starting point in the emergence of a shared design space in which understandings are negotiated among participants. Secondly, the Ecological Inquiry focuses on the sociality and spatiality of particular environments rather than on the digital artifact itself. And finally, an Ecological Inquiry includes the appropriation of new technologies into sustainable use practices as an end goal of the design intervention. In an Ecological Inquiry, the context of inquiry is extended to include complex constellations of actors and technologies in particular hybrid environments. In contrast to tested approaches such as Cooperative Inquiry and Participatory Design, Ecological Inquiry to this stage does not contain an easy-to-use recipe of defined tools and techniques. We therefore invite CCI researchers to further the understanding and applicability of Ecological Inquiry based on the conceptual framework presented in this paper.

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9. **REFERENCES**


