“Once upon a time, there was an inventor..”

A Cultural Historical study of making in a public library context

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Skåland, G., Arnseth, H. C., (submitted 2023). Making the library of the future. Toward the zone of proximal development for a Norwegian public library makerspace. Submitted to *Mind, Culture and Activity*.

1. Introduction

I am sitting by the large table where the children sit with their laptops, practising Tinkercad, and I draw with a pen on turquoise paper three big question marks with "Researcher Gro" written underneath. I am intentionally slow and concentrate on listening. It is difficult to catch what is happening behind the seven screens, but I can hear the visiting librarian. She wants to start a small makerspace in her library. "It is important to learn the technology with the future in mind," she says. "One must be able to use data in all jobs". "Although the boys are most interested in data now, the girls will soon catch up – they will see the benefit of it".

The anecdote above is an excerpt from my ethnographic notes written at an early stage of the project exploring a public library makerspace in Norway. When colleagues and friends ask what my PhD project is about, I usually have to provide a thorough introduction to what a makerspace is. The terms "making" and "makerspaces" in this thesis refer to an international trend in establishing communities where participants can create artefacts using diverse tools and materials. The program referred to as Tinkercad in the anecdote is a design program for 3D printing – a popular activity in most makerspaces. A makerspace may also provide technological toys for children, such as Little-Bits, sewing machines, microchips and fabric, screen printing or wood-work machines. Two makerspaces are seldom similar. In Norway, there are currently approximately eight Norwegian public libraries offering makerspaces for their visitors (Skåland, 2022), and the librarian in the anecdote was visiting to learn from the librarians in this library, who were early adopters of this trend. This thesis is about piloting this makerspace, and how making was collectively changed at this library. In this process, the 3D printers and an inventor course for primary school children had central roles. By following this process, this study aims to contribute insights into creative making in institutional settings and explore what making can be in a public library context.

The idea of implementing makerspaces in libraries connects to the aker movement. Common to the two is the idea that democratizing makerspaces by providing the tools free of charge will encourage entrepreneurship (Diaz et al., 2021). Moreover, public libraries frequently establish makerspaces to meet strategic plans (Britton, 2012). European and North American cultural policies are taking a *performative turn*, embracing user-participation, user-involvement, user-driven innovation and co-creation (Jochumsen et al., 2017). In the context of public libraries, visitors have traditionally been characterized as self-driven in their learning,

which is essential to the idea of public libraries as informal learning settings. Studies of learning trajectories within informal makerspaces resonate with this approach in that participants are characterized as self-driven in finding projects of interest (Sheridan et al., 2014). However, Blikstein and Worsley (2016) find that makerspaces adopted by institutions do not necessarily experience the same agency among the participants. A great deal of "onboarding" seems necessary to be a creative and self-driven maker. Similar findings are reported in studies in libraries. Challenges in encouraging new users to engage have started to appear, and it is argued that novices lack the knowledge to make use of the makerspace (Dreessen & Schepers, 2018; Einarsson & Hertzum, 2020; Taylor, Hurley, & Connolly, 2016; Koh & Abbas, 2015). This problem raises questions concerning pedagogy, which is a focus of this thesis. In that regard, it is essential to understand how the makerspace becomes a public-library-makerspace. What might a pedagogy in line with public libraries look like?

Studies of makerspace pedagogies in public libraries show that librarians tend to understand teaching in makerspaces in terms of formal education (Budd, 2020; Nicholson, 2019; Williams & Willett, 2019). At the same time, the focus on formal teaching in library makerspaces has been the subject of critique for not supporting important public library values of empowerment, such as solving social challenges in the local community and having a real impact in the real world (Hernàndez-Pèrez et al., 2022). It is argued that public libraries are in a position to experiment with new pedagogies because libraries are less constrained by a curriculum (Willett, 2018). One important factor for libraries when implementing making in their services is the idea of a performative turn. I argue that these efforts in transforming the public library have not been studied enough regarding what making becomes in libraries at the concrete level. This thesis fills this gap by introducing a cultural-historical approach to the institutional adoption of creative making. This approach is well suited for studying both the concrete practices and the institutional aspects of the makerspace.

Expansive learning (Engeström, 2015) is a central concept for this thesis, providing both a methodology and a theory for explaining how systems learn. A most exciting aspect of this concept is that what seems like a breakdown concerning public library making in practice and research is understood as an opportunity for change instead of failure, as the core concept in expansive learning embraces *contradictions* as the driver of change (Engeström, 2015). Engeström (2015) provides a methodology for understanding how the current adoption of makerspaces embodies underlying factors associated with tensions in the historical transformation of public libraries. The grounding idea of expansive learning is that merely importing a practice as observed in another context will probably provoke tensions and not be

sustained over time, because practice is an ever-changing, collective and creative process. In line with this understanding of learning institutions, this thesis aims to explore *in what direction the participants collectively re-construct making in this public library.* This aim is divided into two objectives:

1. Explore how pedagogies supporting creative making are re-constructed.
2. Discuss how the re-constructions suggest changes for public library institutions.

To pursue these objectives, research questions with different aims were posed and analysed in the following three articles:

Article I

Skåland, G., Arnseth, H. C., & Pierroux, P. (2020). Doing Inventing in the Library. Analyzing the Narrative Framing of Making in a Public Library Context. *Education sciences*, 10(6), 158. doi:10.3390/educsci10060158.

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Article one discusses how the course design of the inventor course frames creative work and how the participants deviate from the frame by their actions. Article two discusses how the children negotiated their position as contributors to the shared task, and how opportunities for positioning as a maker were related to verbal, embodied and material contributions to the conversation. Article three analyses the historical emergence of the inventor course and the contradictions occurring in the process and suggests a zone of proximal development for

children`s making in this public library. This extended abstract discusses findings from the three articles, focusing on how the negotiations found in articles one and two make sense differently when findings from the cultural-historical analysis are included. Together, the three articles offer a window into how participants expand the practice of creative making and how underlying institutional contradictions drive changes.

1.1. Outline of the thesis

Chapter 1 introduces the project and situates the study within the research field. Chapter 2 presents a literature review of how learning has been discussed within the public library field in research on makerspaces and literature on makerspaces in public libraries. Chapter 3 presents the theoretical framework used in the three articles. It first presents cultural-historical theory as the overall perspective of the current study, and then unpacks concepts used in articles one and two, organized under the topics collaborative creativity and negotiating participation. Chapter 4 is the methods section, introduced with a description of the initial state and a definition of the project. A description of participants and the empirical material, including a thorough presentation of the inventor course follows this. The next section of the chapter presents how I have approached expansive learning methodology in design and analysis, followed by a section on the credibility of the study and ethical considerations. Chapter 5 provides a summary of each of the three articles included in the thesis. Chapter 6 discusses key findings in relation to previous empirical research, followed by reflections on how the cultural-historical analysis provides new insights into findings in the interaction studies. The last part of the chapter summarizes the theoretical and methodological contributions, followed by concluding remarks in chapter 7. This extended abstract comprises the first part of the thesis. The second part includes complete versions of the three articles.

2. Literature review

In this chapter, I review research that will help me to discuss in what direction participants in this public library collectively change pedagogy in a makerspace setting. Compared to previous research presented in the three articles, the review's function in this thesis is to give a stronger focus on the activity systems in play – public libraries and the maker movement. While reviewing, I found that library-making was repeatedly connected to learning. How learning has historically been understood in public libraries is therefore important for understanding pedagogy for making in the library. The first section of the review focuses on learning in public

libraries. The second section is a selection of literature on how learning in makerspaces has been understood within the maker movement and in research on makerspaces, and the final section is on making in public libraries.

2.1. Learning in public libraries

One study of current public library innovation shows that STEM programming in makerspaces typically connects to *learning* (Nicholson, 2019). Moreover, it is argued that library making has moved librarianship towards "explicit education" (Jochumsen et al., 2017; Williams & Willett, 2019). At the same time, "explicit education" is a subject of critique, where the correspondence with core library values such as self-directed learning is questioned (Williams & Willett, 2019). This review section therefore focuses on how learning as a concept has historically been treated.

Originally, the learner was pictured as a self-directed user of the library resources, and the main task of librarianship was to give access to information through cataloguing and references (Pawley, 2003). Further, access can be understood in different ways. Jochumsen et al. (2017) explain access as *democratization* and/or *empowerment*. Democratization emphasises free access to information, focusing on the collection as a source to inform the public. Learning in the library has consequently focused on information literacy and has its roots in enlightenment philosophy, which holds that *reading could transform society by informing its people* (Pawley, 2003, p. 422). *Empowerment* expands access to include possibilities to express and have a voice in producing authentic cultural products, supporting identity and aspirations for the future. The empowerment rationale typically invites participation (Jochumsen et al., 2017; Miettinen, 2018), including stages for self- expression and a bottom-up organization, driven by the initiatives of the users. For example, it is suggested that information literacy instruction should allow for practical experience in a real team, producing real media messages for a real audience (Mackey & Jacobson, 2011). Participation and engagement in real-world problems also include artistic and civic engagement, opportunities to experience that contributions matter, and feeling a social connection with others (Nicholson, 2019). These ideas are at the heart of what has been described as a general performative turn in public libraries and the embracing of concepts such as user participation, user involvement, user-driven innovation and co-creation (H. Jochumsen et al., 2017). The trend also incorporates ideas such as collaborative learning, engagement, a connection between life spheres such as home, school and community, relevance to identities and interests, creating and solving problems, meaningful play and experimentation (Nicholson, 2019). A critical stance toward empowerment also invites

users to problematize the library itself as a path towards their own identities and understandings (Elmborg, 2006), as well as involving users in decision-making processes and the design of library services (Miettinen, 2018; Nicholson, 2019).

The *four spaces model* (Jochumsen et al., 2012) has been central in European library planning (Hernández-Pérez et al., 2022), including the new central library in Oslo (Jochumsen et al., 2012). The model explains *learning* in the library as one *space*, which overlaps with the *inspiration space*, *meeting space* and *performative space* (Jochumsen et al., 2012). The performative space provides access to tools and workshops with professionals supporting creative activities, such as writing, sound, video, interactive games or makerspaces (Jochumsen et al., 2017). The model's authors underscore that spaces are not physical rooms and therefore overlap. The aim on a societal level is to support empowerment in turning knowledge into creativity and innovation (Jochumsen et al., 2012). Further, it is emphasized how opportunities to publish users` work notably support the "digital natives" known for producing culture, not consuming (Jochumsen et al., 2017).

In sum, although learning is implicitly embedded in these different ideas, pedagogy has been given little attention in public libraries. Following the enlightenment philosophy, learning is understood as the self-directed use of literature provided by the library. Pedagogy in public libraries has, therefore, traditionally been understood as facilitating learning through making the collection of books and other materials in the library available. Makerspaces are part of a performative turn where the societal aim is to support empowerment and is linked to different learning models that suggest knowledge can turn into creativity and innovation. Moreover, making programmes are often connected to formal learning in terms of "explicit education". In this sense, formalized teaching approaches that can foster the public sense of empowerment, creativity, and innovation represent a new kind of learning and a new kind of librarianship pedagogy in public libraries.

2.2. Learning in makerspaces

A makerspace can be broadly defined as an informal workshop where people participate in creative production in art, science and engineering (Sheridan et al., 2014). These learning environments have been of great interest and inspiration to informal education institutions such as museums, libraries, and schools (Halverson & Sheridan, 2014).

The aims of participation in a makerspace may be to make physical and digital artefacts relevant in day-to-day life (Lakind et al., 2019), explore technology just for fun (Dougherty, 2012) or serve as a gateway to transforming hobbies into innovation and potential income

(Sheridan et al., 2014). On a societal level, makerspaces are valued as a way to prepare the future workforce in the STEM fields and stimulate innovation (Lakind, 2018). Makerspaces vary in terms of content and the profile of the participants, and each workshop appears as a unique maker culture with one uniquely composed group of people. What is offered in the workshop is influenced mainly by users' interests (Sheridan et al., 2014; Dougherty, 2012). Nevertheless, some tools have become canonical in makerspaces (Brahms & Crowley, 2016), for example, components for making circuits, including batteries, cords, light bulbs and microcontrollers such as Arduinos or pre-made circuitry kits (Sheridan et al., 2014). Common elements in makerspaces are computers, design software, and digital fabrication tools such as 3D printers and laser cutters (Halverson & Sheridan, 2014).

Makerspaces, as we know them today, have their origin in the Maker movement, closely associated with the American Make Magazine, which stresses that democratizing access to tools will enable anybody to innovate (Dougherty, 2012; Hatch, 2014; Lakind et al., 2019). The constructionist theory of learning (Papert, 1993) is central to the maker movement (Halverson & Sheridan, 2014; Dougherty, 2012). Constructionism was a reaction to the instructional teaching dominating the field of programming in the nineties, and a result of research on teaching programming (Papert, 1993). Learning by constructing is described as negotiation or conversation with the material (Turkle & Papert, 1990), improvising with the resources at hand (Papert, 1993), or tinkering: a playful mindset or improvisation with problem-solving in mind (Petrich et al., 2013). Tinkering comprises diverse activities such as the ability to repair a broken car by trying and failing, modifying second-hand medical equipment or open-source computer programmes (Dougherty, 2012). Through this lens of the maker movement, a good learning environment should be child-centred and self-driven, providing opportunities to improvise and fail and supporting creativity and motivation (Sheridan et al., 2014; Dougherty, 2012; Regalla, 2016). Understanding learning within a constructionist view, the created artefacts are understood as representations of the learner's thinking and external representations for interpretation. This way, one can further one's thinking by modifying objects (Sheridan et al., 2014). Moreover, it is argued that tinkering together as a participant structure can foster more equitable learning environments (DiGiacomo & Gutiérrez, 2016).

As makerspaces are based on self-directed and interest-driven learning, makerspaces have also been understood as *communities of practice* (Sheridan et al., 2014). Through this lens, Sheridan et al. (2014) did a cross-case analysis of three makerspaces in the United States in order to describe what makes a makerspace across all the differences. The unifying themes were that all the spaces supported making across traditionally separate disciplines, such as sewing

and circuitry, provided a low entrance barrier to participation and inspiration for innovative combinations, and focused on the evolving product, not a particular set of skills. Nevertheless, the approach to learning in all three spaces was a blend of informal participation cultures and formal structures. Demonstrations, workshops, critique and novice-expert apprenticeship-like relationships provided just-in-time access to support their self-directed and self-motivated projects. The same study concluded that hanging around in the makerspace and tinkering was a productive way to find new projects and combine existing interests with learning technology, for example, fixing bikes and making an LED light decoration for the bicycle.

It has been criticized that makerspaces may not be for everyone, as suggested by the Maker movement. The participants in makerspaces are relatively homogenous (Blikstein & Worsley, 2016) groups of college-educated white men with high incomes. The same pattern is found in a discourse analysis of *Make Magazine* (Brahms & Crowley, 2016). Furthermore, some kinds of making may be more valued than others, creating barriers to participation (Keune & Peppler, 2019; Vossoughi et al., 2016; Willett, 2018). Other challenges have started to appear, as formal contexts for children`s learning more often adopt pedagogy stemming from makerspaces (Marsh et al., 2017).

Blikstein & Worsley (2016) argue that learning in maker cultures is an extreme version of autodidactic learning in hacker cultures that we cannot expect novices to master. Therefore, they argue that novices in making need a great deal of "onboarding", learning and facilitation to reach a self-directed learning style. The same authors point to the "keychain syndrome" in introducing novices to makerspaces, arguing that organized makerspace activities tend to focus on the product, not learning how to use the machines (Blikstein, 2013). This critique has prompted a line of research focusing on equitable learning practices. One study finds that one way to "onboard" children in learning by tinkering is to provide simple tasks. *Squishy Circuits*, for example, may allow children to "jump into the practice" of tinkering without needing prerequisite technical knowledge (Resnick & Rosenbaum, 2013). The *Little Bits* used in the inventor course in my study is a typical example of such easy-access technology.

Summing up ideas about learning in makerspaces, the pedagogy can be understood as facilitating the material environment, as the learning happens in dialogue with things while constructing. Creativity is described as an inherent part of this process, often termed tinkering. Moreover, the process of learning to tinker has been characterized as participation within communities of practice. When making activities are adopted by a public library, this community changes, and this is where this thesis is focused. The following section presents

how public library making connects to the maker movement and research on how pedagogy in makerspaces has been discussed in public library research.

2.3. Makerspaces in public libraries

Public libraries as a home for makerspaces was first suggested in *Make Magazine* in 2011, nothing that: *"If the only public space where 3D printers, laser cutters, and learning electronics happens is in fee/membership-based spaces (TechShops, hackerspaces), that will leave out a segment of the population, who will never have access"* (Hamilton & Schmidt, 2014). Lauren Smedley took up his request and started the first US public library makerspace in the Fayetteville Free Library the same year (Watters, 2011). Public library making soon became a worldwide trend. Makerspaces are now frequently included in public libraries to further strategic plans, shifting from being content providers to supporting participation in content production in performative spaces (Britton, 2012; Jochumsen et al., 2017; Nicholson, 2019; Slatter & Howard, 2013).

Public library makerspaces have been following the maker movement in the belief that democratising access to fabrication tools will generate entrepreneurship and mobilise citizens (Diaz et al., 2021). In the early days of public library making, Britton (2012) described the Fayetteville Free Library makerspace as a natural extension of library work. The librarian's role has been to support knowledge creation by *providing access to space and tools and facilitating opportunity*, not necessarily by being the expert in every field. However, the new tools require knowledge and ways of scaffolding the users towards participation, as the space does not necessarily encourage new users to engage (Dreessen & Schepers 2018; Einarsson & Hertzum, 2020; Taylor et al., 2016). In addition, professional librarians reported challenges in creating and sustaining library makerspaces (Koh & Abbas, 2015)

Libraries have met these challenges by training staff (LaConte et al., 2022; Moorefield-Lang, 2015), hiring staff with expertise in organising makerspaces, specialising in specific activities and sharing complete packages of tools and PowerPoints that are easy to use (Einarsson, 2021). However, an increasing focus on formal learning in library makerspaces means that a public library might lack the expertise, knowledge or technical skills to do all the programming themselves. Partnerships with local museums, organisations (Nicholson, 2019) or makerspaces (Williams & Willett, 2019) are, therefore, a way to meet the new role as educators, as well as to include experts and hobbyists from the local community in the library (Slatter & Howard, 2013). Partnerships are described as a way to expand the collection to include people and social resources from *communities of practice* outside the library (A. Lakind

et al., 2019), as well as enabling the library to provide makerspace activities on a low budget (Bartlett & Bos, 2018; Slatter & Howard, 2013).

Learning in library makerspaces may be divided into formal educational activities connected to school visits, non-formal learning courses provided at the library and informal self-directed learning in the makerspace (Einarsson & Hertzum, 2020). From interviews with nine library makerspace practitioners in six different libraries in Denmark, Einarsson & Herzum (2020) found that formal learning activities typically had pre-defined learning objectives, limited time, and pre-planned instructions and were mandatory for the students. In formal makerspace learning, librarians typically introduce technology by dictating how to make simple things. Examples are making digital dice using *micro:bit*, making a marble race track using tape, cardboard, paper and other objects (Bartlett & Bos, 2018), recreating lunar phases using frosted sandwich cookies and using everyday materials to make a "lunar lander" (LaConte et al., 2022). Experiencing a topic differently by making something, for example, building a scene from a book using freely chosen tools and materials is also frequent activity (Einarsson & Hertzum, 2020).

Examples of support for informal learning include providing materials for families to make a specific object, lecturing on technical skills, and practising with tools (Einarsson & Hertzum, 2020). Mixing instruction, exploration, and teaching concepts, such as amperage and conductivity when needed, is also frequently seen (Willett, 2018). Interviews with librarians support these findings and show that *teaching* making was described as a method of being taught, told or shown a skill, and enabling users to turn ideas that "pop up" from the mind into a reality. However, librarians emphasise *excitement* and *co-creation*, *discovering*, *exploring* and *collaborating* when talking about learning (Lakind, 2018). This shows a remarkable gap between how librarians speak about learning and how they describe their actual teaching. Moreover, library educators in the Denmark study report school/library collaboration as a novel task which requires them to plan teaching sessions, and express concern about whether the extensive focus on formal education will be at the cost of fostering civic engagement in the community (Einarsson & Hertzum, 2020).

The studies above show how public libraries struggle to work out what it means to learn in a public library makerspace. Einarsson (2021) therefore calls for new ways to integrate makerspaces with the public library as a cultural-historical system. Grounded in the activity theory of Engeström and his conceptions of tensions in activity systems, one of the questions Einarsson asks is how *tensions and adaption can inform development toward more sustainable models of library makerspaces over time* (Einarsson, 2021, p. 175). Based on semi-structured

interviews with practitioners who have experience in makerspaces in 13 libraries, Einarsson found that in order to sustain the day-to-day tasks and host the makerspace, the coordinators reported three models for staffing – hiring individuals, working with volunteers and developing competencies in staff member teams that originate from different sections of the library. The model involving volunteers was found to be challenging in that the coordinators reported unease with the volunteers taking too much ownership of the makerspace, as though the workshop was a "closed club", difficult for outsiders to enter. Einarsson (2021) commented that ownership was, in that sense, at the cost of inclusion. Moreover, participation in the club required a great deal of self-initiation, and the librarians commented that without this skill, "you don`t fit too well in here". This finding was not further analysed as a productive tension in the article. The author concludes by suggesting activities that could help public library makerspaces become more integrated into existing library practice. Examples are *developing activities to liven stories and information stored in collections, teaching critical literacy for construction (e.g., information seeking and project planning), fostering engagement and interaction among diverse actors in the local community, and actively seeking to involve marginalized users who are underserved in other types of makerspaces* (p. 185). Several studies take a similar approach to library making by suggesting teaching critical literacy in makerspaces (Fourie & Meyer, 2015; LaConte et al., 2022). However, there is little research on how critical literacy should be taught.

Willet (2018) argues that the lack of a clear approach to learning and teaching is also a strength, as libraries have the opportunity to experiment with this role without the constraints of a curriculum, and discuss the ways learning in public library makerspaces is framed in the socio-political landscape. However, the question has been raised whether a *Living Lab* methodology fits library values better than the makerspace-model, because *Living Labs* invite citisens to solve concrete social challenges in the community (Hernández-Pérez et al., 2022). Libraries using the *Living Lab* methodology typically engage citisens in designing the services at the library (Hernández-Pérez et al., 2022; V. Miettinen, 2018; Moorefield-Lang, 2019), as in the example in Barcelona that ended in citisen science projects such as identifying and documenting animals in the neighbourhood, diagnosing the ecological status of a river or selecting what unpublished poems should be included in the digital literature collection of the library (Hernández-Pérez et al., 2022).

Interviews with librarians show that community engagement is emphasised as the most positive impact of housing a makerspace in the library (Slatter & Howard, 2013). Interestingly, community building has also been used as an approach to library making. For example,

Williams & Willett (2019) explain how librarians in a system-wide makerspace project known as “The Bubbler” could be described as social coordinators, aiming to get to know their neighbourhood and figure out who people are and how their knowledge might fit in with the makerspace. It has also been underscored that providing social contacts is crucial for underserved communities, because they might not lack the tools but rather the experience needed to use them in meaningful production (Lakind et al., 2019). Furthermore, community building is emphasised as a way to develop maker identities, equally important for democratisation as the typical access to tools and maker activities (Willett, 2018). However, attempts to design communities of practice through community building have been found to be challenging, and questions have been raised about whether a Community of Practice (CoP) model is applicable to libraries.

Willet (2018) found that out of 18 expert-led art-in-residence programmes aiming to cultivate a CoP of makers, none of them evolved as communities of practice. In cases where library users seemed to experience a sense of empowerment, the library provided tools for production, such as music recording, but the actual knowledge of music was learned elsewhere. However, some experts presented novices to communities outside the library, and it is therefore suggested that making in libraries has value as an introductory “on-ramp” to making.

Summing up this review on public library making, makerspaces are frequently included in library services to further strategic plans emphasising empowerment and creativity, also referred to as the *performative turn.* Furthermore, the maker movement and public libraries share the view that access to tools facilitates learning. Implementing makerspaces in public libraries has been challenging, and the reasons reported are visitors' lack of knowledge or self-initiation needed to participate. Strengthened attention to pedagogy in the form of formal teaching is a frequent but yet contested solution. Formal teaching is described as opposed to the library's values, and there is a call for exploring makerspace practices following the public library's values, where one study suggests a cultural-historical approach. I follow this call by suggesting that public library making is closely connected to a historical transformation of public libraries as we know them, and argue that this transformation has not been studied enough in relation to what making becomes in libraries. This thesis fills this gap by introducing a cultural-historical approach to studying this new way of working in public libraries, and how pedagogy for making is collectively constructed within this site. The next chapter explains the theoretical concepts used to explain this phenomenon.

3. Theoretical framework

3.1. Cultural-historical theory as an approach to learning

This chapter concerns the perspective and the theoretical concepts used in this thesis and the three articles. The first part of this chapter concentrates on the cultural-historical approach used for this thesis and in article three and therefore focuses on the system perspective. Then follows a section on distributed creativity and imagination and a section on participation.

The present study adopts a view close to Cultural Historical Activity Theory (CHAT), where understanding society as fundamental to human consciousness is central (Roth, 2014). Further, the concept of *expansive learning* is central to article three and to the discussion in this thesis (Engeström, 2015). The theory of expansive learning has been used in settings ranging from post offices and factories to schools, hospitals and newsrooms, and research utilising the approach typically looks at an activity system facing a significant transformation, similar to the case of this Norwegian public library. Expansive learning is a theory and a methodology for understanding learning in situations where one needs to form a desirable culture instead of acquiring an existing one (Engeström, 2015). Further, the potential for change lies in the local activities carried out by concrete people *and* the contradictions within socioeconomic structures. In this thesis, the theory is used to analyse contradictions within the Norwegian public library system and how the contradictions drive change on the plane of politics and the practical plane in planning and organising children`s making.

3.1.1. Object-oriented and multi-layered activity

Exploring the introduction of creative making in public libraries through the lens of cultural-historical theory requires going beyond what individual librarians or library users have learned or think. The approach includes multiple layers of analysis relevant to determining the societal system individuals constitute. Determining change efforts in the activity requires three analysis levels: the *object-historical, the theory-historical and the actual-empirical level* (Engeström, 2015), and the methods section focuses on the procedures for data collection.

The theoretical ground for the three levels of analysis is the multiple layers characteristic of activity: 1. the collective, object-oriented activity directed by motives, 2. actions directed by more short-term goals and operations at the action level, 3. using the tools at hand (Leontev, 1978). In the present case, article three discusses the historically emerging contradictions in the collective activity at the system level and concrete efforts in adopting making in the library.

Articles one and two discuss the practical use of the makerspace at the level of interaction. The following text explains these levels and the relationships between them.

From the perspective of cultural-historical theory, institutional change is *object-oriented* and emerges in a dialectic relationship between the individual and *collective activity systems* (Arnseth, 2008; Engeström, 2015; Miettinen, 1999). The *object-orientedness* of human behaviour does not mean that materiality affects us. Still, all actions have a material ingredient – the moment we change our environment, we change our way of thinking simultaneously (Leontev, 1978). Everything we produce to maintain life as we imagine it involves using, producing or manipulating objects. Consequently, material changes such as building a new library and implementing a makerspace mediate how actors negotiate making and public library practice.

Individual actors contributing to the production of things constitute a *collective activity system* (Engeström, 2015). Accordingly, individual change is social, as the activity of producing ourselves is a collective endeavour. In other words, there would be no joint activity without individual action and vice versa, as the whole system is one unit under constant *dialectical* construction (Leontev, 1978). Hence, individual change is not an exchange between two entities – the social and the individual. Change emerges by being this social organism, and concepts such as creativity, agency, and identity have to be understood in these terms (Roth, 2014). Roth (2014) suggests participation is always change-producing, and society is, in that sense, a *self-moving entity* orienting to transformation to meet a *generalised collective need*. An example of an activity from the current case is book lending free of charge, which is realised by the public library where the librarians perform their daily work. The activity makes sense on a societal level, in that book lending is a way to include underrepresented citisens in learning and culture production, countering the unfair distribution of power in society. Understanding the relationships between these aspects of activity *dialectically* means that the activity on the action level in day-to-day practice carries the societal motive equalising the distribution of power. In this study, the collective activity system refers to the Norwegian public library institution and the nodes of connected systems. These are the school, the maker movement, a science museum and interest organisations profiling STEM field learning. At the same time, the day-to-day practice of implementing and re-configuring children's making represents the action level of this study, while the negotiations on the floor during making activities, such as deviating from the task, represent tool use.

Lemke explains the dialectical relationship between levels as heterochrony: a lamination of horisontal layers of actions and semiotic meanings operating on different time scales (Lemke,

2000). On the interaction level, characteristic timescales in processes and interaction events define the situation as recognisable, such as school-going. Heterochrony may also occur in meaning inscribed material objects used in education, such as policy documents, moving bodies or the architecture of a room. For example, classroom talk often has particular sequences and timing, such as posing questions and answers and evaluating answers. The sequence defines what comes first and what comes next, and also what is evaluated as appropriate behaviour in specific episodes of interaction. The current study shows examples of interaction events typical for schooling, such as question-and-answer structures. Events typical for the children's library department appeared as co-constructing narratives in dialogue with children. This lamination of interaction events was enacted simultaneously, and the concept *framing* (Goffman, 1974) was used in determining these structures in article one. In article two, the concept of *positioning* (Holland et al., 1998) was used to explain how the children negotiated what was appropriate behaviour. Hence, the focus has been on the negotiation of interaction events. Following Engeström's notion of *expansive learning* (Engeström, 2015), these negotiations are typical when one seeks to change practice, because many activity systems are in play and contradictions appear. These contradictions exist at the system level and the interaction level. The next section outlines the concepts of contradiction and its potential for expanding a practice.

3.1.2. Expansive learning

According to Engeström, a contradiction in activity systems is a potentially productive source for expanding practices (Engeström, 2015). Studying institutional change using the notion of expansive learning means defining contradictions, how contradictions work as a motor in activity transformation and how tensions suggest likely changes for the future (Foot & Groleau, 2011). Hence, contradictions are the source of the ZPD of activity systems (Engeström, 2015). It is vital to understand that Engeström's theory of expansive learning explains contradiction in line with the dialectics of activity theory, and cannot be understood as simply opposite opinions (Engeström & Sannino, 2011). Contradictions are multi-layered and therefore exist within culturally developed habits of how to do, for example, schooling or librarianship and in day-to-day practice. The contradiction may manifest in conflicts and tensions, but is not equal to these tensions (Engeström & Sannino, 2011). Contradictions have a systemic ground and often end in trying to make sense of, reformulating, or constructing new practices (Engeström & Sannino, 2011). For example, in article three, questioning a copy practice prompts change efforts in the

process of re-constructing making for children. This process is understood as an effort to resolve a contradiction inherent in the system.

Based on the Marxist idea of independence and subordination, day-to-day attempts to solve contradictions carry a basic polarity in human society (Engeström, 2015). This polarity is *primary* to all the contradictions in a system, and arises from the division of labour (Engeström, 2015). For example, in pre-capitalist societies, subordination was visible as asymmetric relationships between landlord and farmer. Hence, collaborating on creative tasks will reflect negotiations of independence and subordination. However, the actions do not rigidly follow all definitions of social order, but are a changing unit of contradiction moving the activity forward (Engeström & Sannino, 2011). Looking at one example from Engeström's research, polarity in balancing independence and subordination is revealed in how an elderly man in healthcare changes the practice of standing up from his chair to resolve a contradiction between safety and autonomy. His fear of falling, the consequent use of supporting furniture, and the need to move, conflicted with his need to use his muscles and be autonomous. This polarity drove the innovation of standing-up techniques (Engeström et al., 2012). In the current case, independence and subordination were premises for the *primary contradiction* between self-driven education and the centrally governed policies of including all citisens in such activity.

Primary contradictions are inherent in central practices and invisible to participants because a *primary artefact* creates tacit representations or images of the task. Using a primary artefact is a repetitive part of the practice, and modes of thinking and habits are followed but hidden from reflection (Engeström, 2015). This is what Engeström terms the *need state* of the activity. The need state is hidden until a *secondary contradiction* brings it to the fore. A *secondary contradiction* appears as an awareness of one's habits, typically at the moment when multiple practices meet. Furthermore, secondary contradictions make the ZPD of activity systems come to the surface. Engeström defines ZPD for activity systems as follows:

> *The distance between the present everyday actions of the individuals and the historically new form of the societal activity that can be collectively generated as a solution to the double bind potentially embedded in the everyday actions* (Engeström, 2015, p. 138).

In the light of contrary ways of doing and thinking, the taken–for–granted appears contradictory and impossible to continue. As activity are object-related, the pressing need for change always has a *secondary instrument*, often borrowed from other practices. Secondary instruments differ

from *primary instruments*. They are not used as a tacit part of the central activity but result from a conscious struggle with contradictions and aims to model new solutions. In this case, the makerspace pilot and the innovation course for children are understood as secondary instruments. From this perspective, staff in the library can be understood as *historical actors* (Gutiérrez et al., 2019) negotiating everyday dilemmas by re-purposing tools towards new ends or, in this case, re-constructing children's making towards new ends. Re-construction ideally ends in a new shared object, as illustrated in the model below (Figure 1).

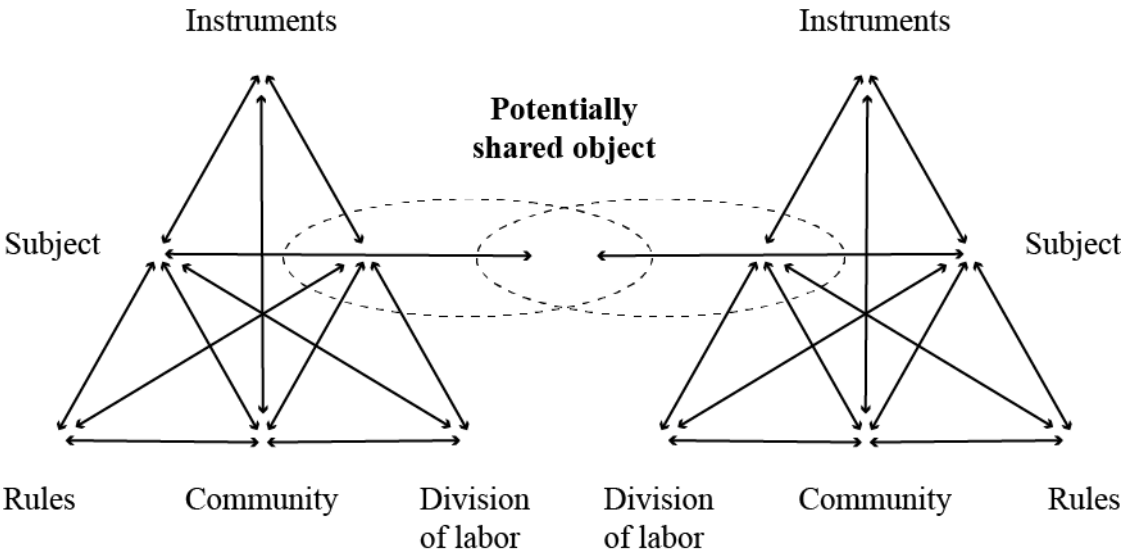

Figure 1. Two activity systems and a potentially shared object. More than two systems may be part of the picture.

Preferably, the new object is a third way – a qualitatively new way of doing children's making in public libraries that does not conflict with the other corners of the central activity system (Engeström, 2015). To obtain this "thirdness" of the new solution, a *tertiary instrument* and an overall methodology for making and using the secondary instruments are needed for the new object to be sustained. This methodology is that of expansion – the dialectical social process of *reconstructing both the central activity and the secondary instruments*. This process is usually guided by interventions such as double stimulation practices (Sannino & Engeström, 2017), and often the researcher has been invited by an organisation seeking intervention (Foot & Groleau, 2011). Foot and Groleau (2011) argue that when the study does not include intervention, power relationships manifested in the division of labour determine whether the new object changes

the central activity. As we see, secondary instruments do not automatically solve contradictions, but may point to new possible directions for the activity. The next sections zoom in on concepts used to explain participants' efforts in overcoming the contradictions.

3.2. Creativity and distributed imagination from a cultural-historical perspective

Following the cultural-historical approach, I understand creativity as distributed across participants (Sawyer & DeZutter, 2009) and mediated in the material world (Hutchins, 2005) within historically emerging activity systems. Thus, creativity from a cultural-historical perspective differs from the individualist paradigm in that creativity is a collective and cultural phenomenon and, therefore, something learned (Sannino & Ellis, 2014). Cognitive efforts are also understood as distributed over participants and time within this approach (Cole & Engeström, 1993). Vygotsky writes in "Imagination and Creativity in Childhood" that *an enormous percentage of what has been created by humanity is a product of the anonymous collective creative work of unknown inventors* (Vygotsky, 2004, p.10-11). Hence, being creative is not so much about being a genius, but one of these unknown inventors who take the collective further (the last paragraph in this section explains concepts used to understand how creativity distributes across participants). Creativity also distributes across time in that the ways of doing a specific activity emerge historically (Cole & Engeström, 1993). Hence, appropriate participation in an activity such as the inventor course will be defined by the diverse experiences among members and, at the same time, be emergently defined. The structure and sequence of collaboration will therefore be constantly negotiated, particularly when a new practice has been introduced (Engeström, 2015).

The way creative collaboration is acted out may also be domain-specific (Lymer, 2009). For example, a good argument among architects may not be verbal, but activate models of buildings and imaginary plans by connecting gestures to the model. Creativity may also appear within a varying degree of constraint. For example, a jazz band shares conventions on the sound of jazz, but is nevertheless expected to improvise. Playing in a symphony orchestra is more predictable and guided by a conductor (Sawyer & DeZutter, 2009). When many conventions for how to do creative work meet, children likely have to interpret and negotiate how the structure and sequence of creative work should be done. Moreover, creative tasks might be particularly demanding in a school context because the "script" for how to approach the task deviates from the sequential organisation of a teacher or a textbook (Kajamaa & Kumpulainen, 2019). On such occasions where problems are novel, creative work might require the participants to recontextualise or transform procedures in their work. From a cultural-historical

point of view, these types of deviations from the given script are valued as a *transformative agency* (Kajamaa & Kumpulainen, 2019). For example, in a study of children's making in a school context, Kajamaa & Kumpulainen (2019) found that the children deviated from the structured tasks by changing them to be more interest-driven, and that such deviations might pave the way for new perspectives on learning in makerspaces in the school setting. Deviations can also appear as deviations from the sequential interaction and talk structure, and are inherently power-related (R. Engeström, 1995). The following paragraph explains the concepts I used to analyse the sequence and process of imagination in articles one and two.

I understand imagination as distributed, in that ideas are *mediated* by culturally produced tools (Hutchins, 2005), which in articles one and two means the Little Bits, feathers, paper cups and straws. Understanding mediation dialectically (Roth, 2014), the material environment works as imaginary material anchors (Hutchins, 2005) for ideas, and re-configurations of things further provide new anchors and widen and blend resources for new ideas. Material anchors are, therefore, not merely signs that allow abstract symbols to be manipulated. Anchors are given meaning by their use and thus become during the action. Hence, there is no causal connection between imagination and the anchor, as the meaning of the anchor is constructed by the meaning maker(s). For example, seeing people standing in a line is not seeing a queue until the concept of a queue is suggested by the sequential order being "first in line", which blends with the sensory experience. Or, as in this case, a platform with wheels was given a new aspect by spinning in circles, but was meaningless until blended with the concept "cat toy". Connecting concepts and material anchors in creative collaboration, participants do not necessarily "reason", but sensory features of the material trigger interest, for example, by feeling the air from a fan, a cord in the hand or a synthesised sound (Pierroux & Rudi, 2020). Although not a central discussion of this thesis, I acknowledge the embodied and emotional aspects of interest triggers, and understand expressive moments as potential linking of ideas (Vass et al., 2014) and as a source in the process of activating imaginative material anchors (Hutchins, 2005).

Creative tasks are typically ill-defined, turning the conversation towards finding the problems rather than solving them (Sawyer, 2017). In the cases used in articles one and two, the task also asked for problem-finding, leading the focus particularly in that direction. To explain how the participants in the two cases found problems, we adopted narrative meaning-making (Bruner, 1991) as a concept that is complementary to imaginary anchoring. The first sensory exploring of material anchors typically leads to "as if" ideas, such as the spinning wheel platform behaving as if it was a cat toy. However, what problems in the world can the cat toy

solve? Narratives allow for interpretation and understanding of the world, and narrating why, for whom, and where a product works helps elaborate on the initiated idea, giving it a place in "the real world" where problems occur.

The perspective on imagination and the importance of emotion in creative work ground my approach to collaborative creativity. When collaboration is not rooted in reason and logic but in sensory and affect-based linking, utterances may seem to go against common sense, unrelated and bizarre (Vass et al., 2014). But yet, cohesion may still be achieved through shared experiences, emotions and mutual trust. Vass et al. (2014) term this kind of collaboration *collective pooling*. Collective pooling is a collaborative strategy for generating content that is seemingly random and unrelated, and is characterised by a high degree of emotion-based connectivity, overlaps, speedy exchanges and interruptions. This parallel production of ideas works as a collective in that all participants contribute to the shared pool.

Due to the random character, ideas are often conflicting, where one becomes dominant. Therefore, it is of great importance to understand ideas as intermediate products when the creative work is in a preliminary state. Treating ideas as intermediate may hinder conflict, and dominant ideas can merge with other ideas or become something new. Hence, in collective pooling, ideas are not owned by one individual (Sawyer & DeZutter, 2009). Sawyer & DeZutter describe this kind of relationship as an emerging collaboration, particularly evident in situations where the expected outcome is ill-defined and unpredictable, such as in jazz, improvisational theatre and dance. Although this way of collaborating is described as the most successful in my observations, it is not necessarily how children are expected to work on collaborative tasks at school or in the library. The next sections explain concepts used in the project to explain how diverse ideas about inventing and collaboration are acted out and negotiated.

3.3. Negotiating participation

3.3.1. Framing and positioning

Understanding institutional change as multi-levelled requires studying short-term goals at the level of actions (Leontev, 1978). In article two, I used the concept of *framing* in order to describe this aspect of activity (Goffman, 1974), and in article three, I used the term *positioning* (Holland et al., 1998) to describe the underground negotiation of what was regarded in and out of frame in collaborative creative work. Framing will be presented first, and positioning follows in the last section.

Framing is a concept that allows for analysing the different understandings of what it means to innovate by focusing on social interaction and how participants negotiate what counts. I am aware that Goffman's ideas can be in conflict with an activity theoretical view (Holland et al., 1998). Nevertheless, the concept has been useful and has many similarities to activity theory. The theory of framing takes departure in collectively organised social activity, and does not explain the organisation of activity as happening only in mind, but also *in* activity (Goffman, 1974). The term focuses on the underground negotiation of "what we are doing here" and the ongoing change and cultural construction of activity, which in this case was "what we are doing when inventing". I believe the concept can be used to study how participants potentially *expand* the activity system at the level of concrete actions (Engeström, 2015). However, taking an activity theoretical stance on the concept of framing, some considerations have to be made. I will discuss these briefly after presenting the concept.

Framing an activity is, as Goffman explains, the action itself (Goffman, 1974), not only people talking "about" what we do. The activity is defined through "staging" the sequential order and pattern in how to do things. Staging is simulation of practice and typically appears in the form of demonstrations, task trials, rehearsals and planning, that are distinguished from "the real practice" and decoupled from the simulated practice's consequentiality. Goffman uses the term *script* to describe this patterning. For example, the script for sequences in the act of reading and spoken narration is linear. Further, lectures and talks are likely to be sequenced in specific ways, containing both an aspect of entertaining at a stage and instruction, suggesting this particular way of talking in future lectures in this category. Hence, scripting is also suggested during interaction in sequences of talking, gestures and kinetic moves, and staging innovation suggests what innovation is and is not.

A problem that occurs in relation to activity theory is the assumption of a primary frame representing "the real thing" – an "unstaged reality" one wants to copy, which for example, can be the activity of innovating things. This idea of a static model activity is problematic in CHAT terms, as change is a primary ontological assumption, not allowing for exchange between two entities (Roth, 2014). However, Goffman also emphasises that representations of a primary practice will never be the same as the primary practice itself, and the mere copying of new practices is regarded as impossible (Goffman, 1974). Change is, thus, an important aspect of the frame concept. When copying a primary practice, a representation or a new frame is *laminated* to the primary practice. For example, when the "primary practice" of innovating is presented, it is "staged" using the frame for lecturing and storytelling. Many frames may be laminated during efforts of copying, and this term seems compatible with the idea of

heterochrony in activity theory, emphasising the horisontal and dialectical relationship between the three levels of activity (Lemke, 2000; Leontev, 1978; Roth, 2014). I find the term lamination very relevant for theorising the negotiation of framing at the level of interaction, as laminations of frames exist simultaneously, and the relationship between frames is not understood as causal (Goffman, 1974). Moreover, the "staged" frame may differ considerably from the framing acted out during interaction by other participants, and open up for variability. However, laminated frames can potentially disturb events by framing the activity in ways that are found inappropriate. Goffman suggests that individuals acting out of frame will be disorganised, *flooding in and out* of the activity or changing the activity by suggesting a new frame (p. 358). In article three, one such case is described by adopting the term *positioning* (Holland et al., 1998).

The concept of *positioning* aligns with an activity theoretical view on identity, considering consciousness as embedded in the social world (Holland et al., 1998; Roth, 2014). Holland argues that explaining identity as either habituated culture or individually constructed fails. They call for an understanding of agency that accounts for both cultural constraints and the human capacity to improvise. Even in situations where asymmetrical power relations grossly constrict participation, actors have the potential to improvise in the situation in a way that overcomes the constraints. Holland et al. suggests that the authoring of identity is situated in "games peculiar to themselves" (p. 287) and has the potential to *expand* and become new groupings, creating a new currency for participation. Nevertheless, this kind of play is also regarded as a collective endeavour in that culture is habituated. The above concepts explain how I have taken into consideration that making can be framed in diverse ways and provide different opportunities for participation. The next section describes the concepts used to explain these negotiations with a more fine-grained focus on interaction.

3.3.2. Influence in collaborative making

At the beginning of this chapter, I explained my take on creativity as distributed across participants (Sawyer & DeZutter, 2009), mediated in the material world (Hutchins, 2005) and embedded in historically emerging activity systems. From this perspective, appropriate participation is emergently defined among members in framing (Goffman, 1974) the task, positioning (Holland et al., 1998) peers as in frame or out of frame. At the same time, agentive improvisation and expansion of the situation may occur. In a collaborative creative task, the ways ideas are proposed and taken up in group interaction will vary, and Engle et al. propose a

model for studying influence in persuasive discussions that have been useful in describing participation at the interaction level (Engle et al., 2014).

I argue that this take on participation is in line with Holland et al.s (1998) concept of positioning, in that participation is regarded not only as a culturally defined currency of what is in frame, but also as the social negotiation of influence. Hence, the participant's level of influence in creative collaboration may not be equivalent to the person's *merit* in producing ideas, but emerge out of the social negotiation of influence itself. Undue influence in creative, collaborative work may therefore occur, raising issues both of the quality of the collaboration and the creative outcome and equity in participation. Students who deserve to be influential may not be acknowledged, with consequences for how they are viewed by others, by themselves and for opportunities to identify as innovators. Students who have high status in the group have more access to the *conversational floor*. This status is not to be understood as a characteristic of individuals, but as *authority* resulting from local negotiations of who are regarded as credible contributors. Access to the conversational floor may also be negotiated as a *spatial privilege*, for example, having tools available or being physically oriented to peers in gaze or body orientation. Pierroux et al. (2022) have recently expanded on the model of influence in persuasive discussion to develop *creative influence* as a concept for studying adolescent group collaboration. In their findings from the study of adolescents' creative collaboration on an architecture task, having equal access to the conversational floor by proposing ideas that peers expanded upon fostered a sense of shared authority and creative influence.

4. Research setting and methods

4.1. Defining the project

I introduced this chapter by explaining how the research focus changed at the project's *initial state* and how the focus on children's participation in an inventor course came about as my core data corpus on the *actual empirical level* of analysis, and how an *expansive learning* design was chosen for the project (Engeström, 2015). The next section describes the participants and the setting, followed by an overview of the empirical material, a description of the inventor course and finally, a section explaining how I have approached the analytic process.

The following excerpt from my notes demonstrates my impression of the makerspace and how children's making was in a state of change during the early stages of my research project.

Asgeir is giving a tour of the makerspace. We walk together through the skylight room and into a side room with bookshelves along the walls and sofas in the middle of the room. Many visitors are sitting there reading. It is quiet. An almost ordinary morning. Winter holiday. The table where Tirill and Iver (my children) decorated nets at the maker festival is now a place for reading. Do you no longer use the ground floor for making? No, Asgeir answers. Only when we have courses. You can use the second floor whenever you want, but you must book. You know - there was a lot of noise. We cannot hammer here. No. I look beyond the rows of shelves and the people sitting there concentrating on their books. We have some advanced equipment here as well that is easily destroyed. We have found that we cannot be completely open. Children use the Creator Lab. Asgeir goes up the stairs to the mezzanine. Along the walls are desks. Two 3D printers. A small heat press machine for vinyl transfer. Some people come here to make t-shirts, Asgeir says. In a side room is a large format printer. Many also come to print posters. Today the room is tidy. The room shows no sign of anything being made. No products to promote.

As this extract from my field notes indicates, the library was obviously in a state of change, struggling with sustaining activity in the makerspace. For this reason, I selected a theoretical perspective that could provide insight into institutional and organisational change, specifically that of expansive learning (Engeström, 2015), for my research design. My research design choice was also informed by previous research on the challenges institutions face when adopting practices from other fields, which underscore that a complete copying of practices is undoable (Crook, 2012). Therefore, the preliminary research question formulated for the project was:

What happens when a public library aims to adopt makerspace practices?

The process of gradually narrowing the focus has not been linear but came about over time, during my pre-studies and later through interviews, informal participation in diverse maker-related activities in the library, and pre-study observations of the inventor course. The question "what is happening here" was, in that sense, the guiding research question for a long time. "Children's making" was the first narrowing of the project. The selection of this case was purposive and informed (Silverman, 2000) by the theory of expansive learning (Engeström, 2015), as it was clear there was tension related to children's use of the makerspace, as the library

decided to move children's making to the children's department. Most of the maker activities were structured as school or kinder garden collaboration, so my focus went to one of the courses provided for schools called the inventor course. This course was chosen because there was a discussion in the children's department concerning creativity in the use of 3D printers. One of my respondents expressed a need to change the 3D printing practice to be more in line with the inventor course, because it was "more creative". Through the window of the inventor course, I was allowed to study how creative making was being framed in the actual course activity, how the children were positioned and positioned as makers in collaborative work, and to explore the particularities of creative collaboration focusing on making things. However, designing a study based on the theory of expansive learning requires data collection on three levels: The object-historical, the theory-historical and the actual-empirical levels (Engeström, 2015). The following sections describe the participants and the data collected for the study, followed by a description of the analytic approach.

4.2. Participants and settings

The children following the inventor course were between 10 and 12 years old, the library's recommended age group. The selection of groups for filming was made by the respective class teachers based on the students' submission of formal parental consent forms supplied by the researchers before the visit. In sum, ten groups of three to four children were filmed in 2018 and 2019, with about 17 hours of video recordings (see the table in Figure 2).

Children from five school classes in four different schools registered for the course. As the course was organised as a school trip, participating in the inventor course was mandatory, and their teachers followed them to the course, participating in various ways. Four librarians working in the children's department alternated as course leaders and assistant facilitators, two at a time. The same librarians were frequently working in the library during my informal visits. One central staff member involved in the inventor course was working at the children's department in the initial state of the study but did not facilitate the course at the time I filmed the courses. As I was doing partly participative observations to provide rich descriptions of my case, many visitors and other staff members were observed and may appear in my notes. In addition to staff in the children's department, the head of the makerspace, the former head of the makerspace and three staff members in leading positions participated.

4.3. Empirical material

The empirical material for this thesis consists of ethnographic notes, documents, video recordings from the observed inventor courses and interviews. I decided to video record the courses because video is especially suitable for studying details in the use of material and space arrangements (Jordan & Henderson, 1995). Video data was also used to explore how participants unintentionally tried to solve systemic contradictions, as discussed in this thesis. The analytic take on video data is more fully described below. I observed activities in the makerspace and the children's makerspace during the daytime and in the afternoon. The video recordings were mainly conducted by me, except for one day when one of my supervisors assisted (researcher 2) and one day when an assistant (researcher 3) was recording alone and writing field notes. The recording setup did not focus directly on interaction this day, so I mainly used the field report from researcher 3. I used 2 or 3 GoPro cameras on a stand with a wide-angle at the tables where the children were working, one camera for each group (Figure 3).

The number of cameras varied, as there was some variation in how many children I was allowed to film. One child in each filmed group wore a remote mic to ensure the sound quality. In addition, one video camera was positioned on a stand in a corner to get an overview of both the whole table and the overall setting. This setup produced high-quality data, allowing for a detailed analysis of the interactions in the groups. An overview of the video material is given in Figure 2, and Figure 3 shows an overview of the areas covered in the library setting.

Date	Recorded groups	Minutes	School	Researchers	Device
16.11.2018	2 groups	51/58/48	School 3	Researcher 1	2 GoPro. Main camera
30.11.2018	No specific group	64	School 4	Researcher 3	1 GoPro moving
07.12.2018	2 groups	87/45/71	School 1	Researcher 1	2 GoPro. Main camera
11.06.2019	2 groups	86/82/60	School 2	Researcher 1+2	2 GoPro. Main camera
18.06.2019	3 groups	77/86/73/87	School 2	Researcher 1	3 GoPro. Main camera

Figure 2. Overview of video material

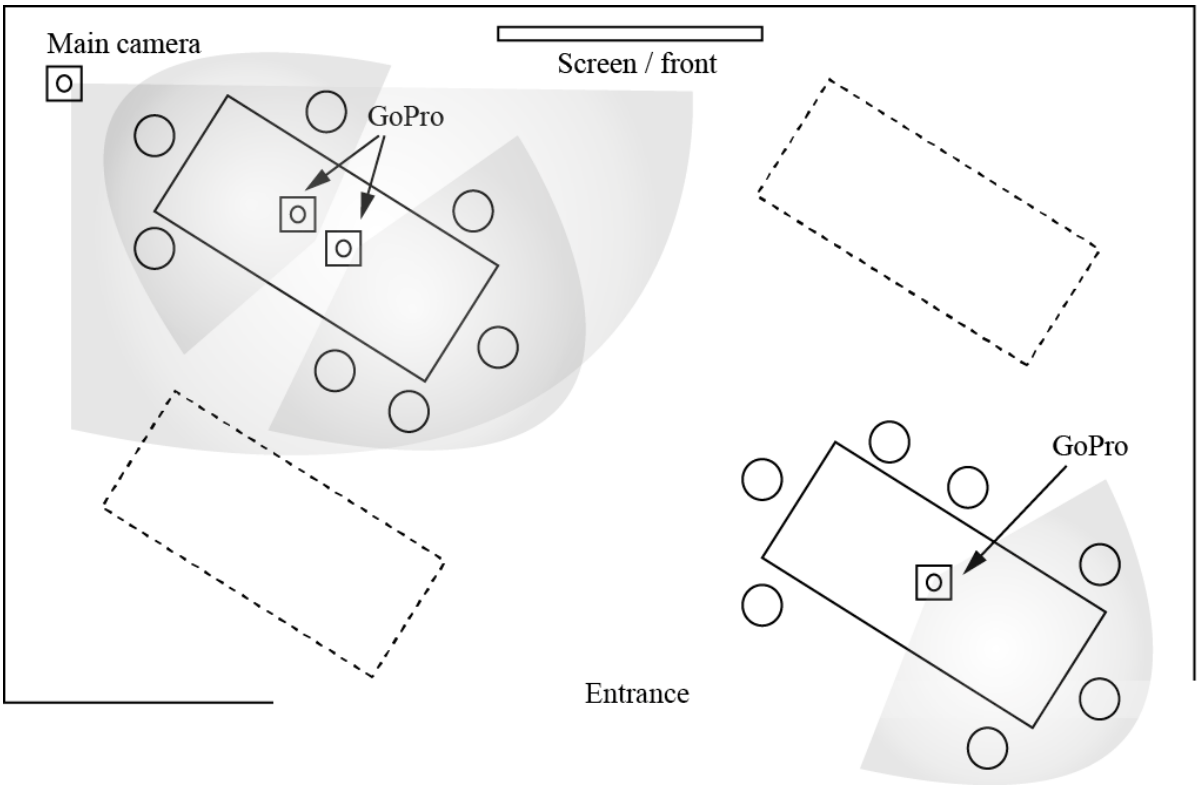

Figure 3. Overview of the room showing a typical setup. The organisation of tables, the position of the main camera and the number of GoPros varied (see the table in Figure 2).

In addition to video recordings of the inventor courses, the data collected from studies of library activities include ethnographic notes and pictures stemming from 34 hours of partial participatory observation. I participated in a diverse range of situations, for example, the Oslo Maker Faire, the Girl-Tech festival, the Wednesday Club, a 3D design course, bringing my circuit kit to the makerspace in the evening to make a lighting bracelet, and an internal course in soldering. I also dropped by occasionally or hung around, chatting with staff in the children's department and the makerspace. Ethnographic data provided an initial understanding of what was happening and a sense of the tensions connected to the makerspace. Further, ethnographic data was used to select the inventor course as a case and fill in the blanks in the sequential transformation (Engeström, 2015) of making in this library, as discussed in article three. The method of following sequences is discussed more fully below.

Official Norwegian policy documents and reports were analysed from the time span 1935 to 2019, as were library policies stemming from before 1935 and secondary literature included in the children's library education curriculum. The purpose of the document analysis was to determine the library's *primary contradiction* and *need state* discussed in article three

and this thesis (Engeström, 2015). The analytic take on the documents is more fully described below.

I also conducted nine semi-structured interviews of approximately 1-hour's duration with key staff (researcher 1). The topics covered in the interviews were "a normal day at work", "making activities", "organisation", "the new library", and "background". Audio recordings of the interviews were made. The purpose of the interview data was to detect the system components of this particular library and to trace the historical sequences in the changing object of library making. The interviews were particularly important for analysing the changes in the inventor course discussed in article three and this thesis. The analytic take on the interviews is discussed more fully below.

4.4. Description of the inventor course

In article three, the inventor course was analysed as a secondary artefact that was re-constructing children's making in the library. Hence, the description given here is the version used at the time of filming for this project, that is, the final version of the course. The course was based on the use of a technological toy named Little Bits, and the marketing of the product typically addresses children's aspirations to engage in the STEM fields and develop as changemakers. One merchandiser writes on their web page:

Our magnetic "bits" snap together to turn ideas into inventions, transforming the way kids learn about electronics so they can grow up to be the creators of tomorrow (https://sphero.com/pages/littlebits).

The Little Bits kits contain easy-to-use parts for making electronic circuits, such as batteries, switches, lightbulbs, a fan, a temperature sensor, an electronic axle and wheels. The pieces are marked with colours indicating where they must be placed to work in the circuit, and magnets ensure that the parts "click" together in the correct position. Figure 4 shows an example of a combination using wheels. In the inventor course, the children were provided with material to use in combination with the Little Bits: pipe cleaners, straws, paper cups and plates, feathers, tape, scissors and tissue paper. Figure 5 shows an example of how the boys from the case in article one combined the Little Bits fan, temperature sensor and a sound buzzer with paper cups. The invention was named "The Rescuer" and contained an air rinser and a morse-code machine.

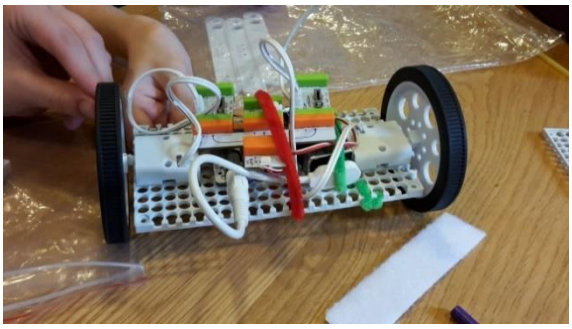

Figure 4. Little Bits circuit with wheels

Figure 5. The Rescuer

The duration of the course was approximately two hours, with an inventing part lasting about 40 minutes. The course had a fixed design, organised into five consecutive parts, where the first three were orchestrated by a librarian (Figure 6). The first part was an orchestrated dialogue on the topic of inventions that can be described as a whole class question and answer dialogue led by the librarian asking, "what does invention mean?" A definition from the encyclopaedia followed the session: "Invention. A practical solution to a technical problem using natural materials and or energy. The invention may be a product or process." The children were asked to suggest inventions they know, and a standard question followed: "what kind of problem do you think this invention has solved?" Next, the librarian told a story about a Norwegian invention, for example, one about the brewer who invented the principle of bottle recycling to solve his problem of not having enough bottles.

The second section was an informative introduction to the Little Bits shown on a screen, and the librarian pointed to the different colours explaining the functions of the various parts. The section concluded with a video showing three products: a spin roller, a drawing machine and a walking paper figurine. The third section was instructions guiding the children on how to make electrical circuits. The children connected different parts to a battery, such as a lightbulb, temperature sensor, fan, on/off switch, or wheels and a motor-driven wheel axle.

Figure 6. A librarian orchestrated the first three sections. The picture shows children sitting in groups around tables with the librarian in front.

The inventing task was the fourth section, where the children were expected to invent something using the Little Bits. The task had the following formulation:

- Make your own invention in groups.
- The invention should solve a problem.
- The invention should have a name.

Both teachers and librarians facilitated the children's work, but as the cases used in the articles indicate, groups of children could be left alone for long periods. The last section assigned the groups to present their inventions, where the librarian also discussed the vision with the children.

4.5. Expansive learning as research design and analytic approach

This section first introduces the analytic take and the data used for each level of analysis and closes with a description of how I proceeded to analyse interviews, documents, video and ethnographic notes. The purpose of the study is to contribute insights into libraries adopting making, and I pursue that aim by adopting a cultural-historical approach. Cultural-historical

studies approach individual learning as embedded in the changing cultural-historical, material, and social context. Understanding how actors in this library learn to 'make' therefore implies a study of historical efforts in changing the public library system, the emergence of the current makerspace and making activities, and how the non-planned actions in an inventor course point forward to change and future learning.

The data collection was inspired by Engeström's (2015) methodology of *expansive learning* circles, which encompasses multiple levels of analysis. Analysis at the historical level concerns the development phases of ideas connected to central cultural artefacts, for example, the *access* policy that guides 'book lending' and the contradictions driving the current changes toward a *performative* turn. The analysis was conducted as a historical periodisation of changes in the institution before the makerspace was introduced and also included a periodisation of the planning and implementation of activities after the introduction. Documents, interviews and ethnographic notes have been used as data for analysing this level.

Analysis at the actual-empirical level focuses on how ideas and practices concerning creative, collaborative making are acted out and unintentionally changed during the inventor course sessions. Video data and ethnographic notes are the main sources for this analysis. Articles one and two focus mainly on the actual empirical level, and article three focuses on the historical level, although there is some overlap between the articles.

This extended abstract discusses findings across all three articles and focuses on how the participants' efforts change the maker practice and how the children's behaviour during making is grounded in the cultural-historical context in which they find themselves. *Transformative action* is used as a concept in this discussion to describe how participants transform the context of making (Gutiérrez et al., 2019; Kajamaa & Kumpulainen, 2019), but was introduced here only after writing all of the articles. The following sections explain in more detail how I approached data analysis.

4.5.1. Analysing interviews

The interviews have been used to analyse the changing object of library making and to detect the system components of this particular library. This analysis is presented in article three and shows how the library and making changes, and how these changes connect to contradictions. Engeström underscores that contradictions cannot be observed directly but must be identified through their manifestations (Engeström & Sannino, 2011). Manifestations of contradictions typically appear as pressing and equally unacceptable alternatives in an activity system, leading to making sense of, re-formulating and examining existing objects or constructing new objects

(Engeström & Sannino, 2011). I approached the analysis by detecting situations where either library practice in general or makerspace practices change.

The first approach to the data was to transcribe the interviews in full, using a simplified version of the Jeffersonian transcription notation that I found most relevant. After transcription, I organised the interviews' content schematically according to themes (Thagaard, 2009), such as *a typical day at work, making activities, organisation, the new library and background.*

The third step in the analysis was describing the library's sequential structure of significant transitions (Engeström, 2015). I organised the transitions in a schema, a technique inspired by Engeström. Ethnographic notes and documents were used to support interview data and fill in the blanks in the narrative about the becoming of the makerspace and the inventor course. This was a task spanning over months, as the story existed in several versions and included many stakeholders. Nevertheless, it was possible to construct a narrative of the trajectory of making in this library by weaving the threads together.

While describing periods of transition, I was iteratively tracing the secondary contradictions connected to the instruments. Secondary contradictions are not conflicts between persons or wrongdoing, but tensions between the corners of the activity system. One example is the situation where the children were moved from the main makerspace to the children's department. This transition was connected to the use of the 3D printer and tension concerning children's agency to find meaningful ways to use the 3D printer. The secondary contradiction connected to this problem was that the 3D printers were treated as the object of change itself rather than as an instrument that afforded opportunities for change. Hence, explained in terms of the activity system model, the contradiction was between the corners object and the instrument. Such contradictions typically appear when two or more systems meet (Engeström, 2015). In this case, it was taken for granted that the ways of the maker movement were transferable to the library. Figure 1 (p. 20) in the theory section shows an example of two activity systems and the corners of the systems. In article three, we suggested that the space of opportunities resting in this contradiction is the ZPD of public library making.

4.5.2. Analysing documents

Policy documents have been used to determine the *need state* of this library (Engeström, 2015). This approach to document analysis takes the idea that social systems are inherently contradictory as a point of departure (Engeström, 1996). Policy documents will therefore be polar and contain manifestations of contradictions, both as a textual product and as a document in practical use; in project planning, talking and material change (Prior, 2003).

The goal of analysing documents was to define a *primary contradiction* and *need state* of public library practice (Engeström, 2015), and my reading focused on how subordination and independence appeared in public library policy. My reading of documents focused on how library policy has changed, the tensions driving the changes, as well as how policies and ideas were connected to objects, for example, architecture and interior. The material was extensive and thus narrowed down to what I understood as the most significant changes in policy and legislation and how independence and subordination were treated during transitions. This iterative narrowing of the data revealed a pattern concerning independence and subordination, and this pattern was analysed as the need state of the library fuelling current changes. By focusing on independence and subordination, I was able to trace how the inherent power relations in human society (Engeström, 2015) manifested in the tensions reported in the documents.

Including policy documents in the analysis is not to say that actors internalise policies and act thereafter. Following Prior, documents are both containers of content and performatives (Prior, 2003). For example, "The public libraries should be an independent social space and arena for public debate" is performative, as the sentence promises to "do" things for the public in specific ways that also suggest how library visitors should act and learn in the library. At the same time, ideas about what it means to learn in a library makerspace may be "performed" or "framed" in diverse ways (Goffman, 1974; Prior, 2003). For example, the given task in the inventor course suggests a theory of how creative ideas are developed. The analytic take in this thesis is to use findings from interview data and document data to understand the findings at the actual empirical level.

4.5.3. Analysing interaction

Video has served as data for the analysis at the level of interaction. Interaction analysis (Jordan & Henderson, 1995; Goodwin, 1997) of participants' trajectories during the inventor course has been in focus. My first intention with the data collection meant for covering the actual empirical level was to explore very broadly what happened on the floor. Inspired by Engeström & Escalante (1995), I was also expecting to find deviations from the ideas about making that had been expressed by staff and formulated in documents, but at the time video recording was conducted, interviews and documents had not yet been analysed. I was, therefore, unaware of the importance of the inventor course for how making was understood and changed in the children`s department at the time. The course was chosen because it stood out from the activity (or inactivity) in the makerspace and focused on creativity. During the analysis, I learned that

this way of selecting a view into activity was fruitful, as a change in institutional activity can indicate contradictions (Engeström, 2015).

My first approach to the video data was sorting the recordings of all groups according to structure and sequence of the course activities, accompanied by detailed notes on interactions within each group during each sequence. Through this process of structuring the data, the patterns, regularities, and "breaks" in interactions within and across groups became visible (Stake, 1995). The use of materials and types of teacher facilitation are examples of distinguishable features from each phase of the activity. Recordings of group interaction used in articles one and two were transcribed in full length, attending to talk, bodily orientations, gestures and use of material.

I was particularly interested in multimodal aspects of children's collaborative making, and my approach to this problem was inspired by multimodal interaction analysis (Goodwin, 1997). In order to include multimodal aspects of interaction analysis, periods of action without talk are included in the sequences, and specific to my study was the inclusion of touching, manipulating and moving objects, as well as the gaze, gesture and body orientation. Including these aspects of interaction in the analysis has consequences for how sequences in a conversation are understood, in that utterances may stretch over a more extended period. For example, connecting a battery takes more time than a verbal utterance. Moreover, inspired by Goodwin (1997), I was interested in the sequences of the conversations in creative, collaborative work and how materials were given a role in the social distribution of sense-making.

The research focus for articles one and two guided the selection of cases. For the first article – which has a research focus on how the task of being an inventor was communicated, facilitated and enacted using the resources in this particular makerspace context – the trajectory of a group of three ten-year-old boys was selected. The selection was also informed by a research interest in the educational role of librarians and their professional knowledge practices. Analytical concepts were tentatively introduced after the first round of data selection, including the general idea of *framing* as an analytical perspective (Goffman, 1974). Four extracts were then selected as episodes for detailed analysis.

The second article has a research focus on creative collaboration and opportunities for participation. Following Susan Leigh Star (2010), interactions standing out as anomalies guided the selection of the case (Leigh Star, 2010). Changing groups within the regular class structure were one such anomaly, affording a window into negotiations of creative, collaborative work and expectations for how to proceed. Further, four episodes were chosen to represent

meaningful units of interaction. Concepts were iteratively introduced after the first round of data selection, including the idea of positioning (Engle et al., 2014; Holland et al., 1998).

4.6. Research credibility

4.6.1. Generalisation

The external validity of research concerns how findings can be generalised across settings, persons and time (Kleven, 2008) and thereby be relevant to the future analysis of children's making. A cultural-historical stance in line with Ilyenkov and Engeström means taking a *transactional* view on ontology (Stetsenko, 2005). That is, changing environments change people, and this process of change is everlasting, non-static and non-linear. That means cultural-historical research observes *change* (Jornet et al., 2019), not defining categories. Furthermore, taking a departure from Marxist views on power (Engeström, 1999) and the inherent contradiction in social systems, how making is "acted out" will always be negotiated within a cultural-historical landscape. From this standpoint, it is assumed ontological stability in that power negotiation exists (my comment). Nevertheless, this negotiation may look very different, changing setting, persons and time. Therefore, findings in my research may not directly apply in future studies but have to be re-explored in the light of the specific cultural landscape. However, although the interaction pattern I found in the video data will vary across settings, I understand findings generalisable in its multitude (Peräkylä, 1997). Thereby, I can claim that the invention frame, exploration frame and narrative frame can appear in different constellations and that different constellations of framing inventing most likely produce different outcomes. Nevertheless, the concept of framing (Goffman, 1974) seems general enough to include new cultural landscapes and different constellations of people in cultural-historical studies. Similar considerations can be taken for the findings in article two, where I discuss positioning related to two different genres of collaborative work. Under different cultural-historical circumstances, the behaviour of anchoring ideas in the material could have been the "proper" way. Nevertheless, I do claim that ways of collaborating exist that are rhetorical and/or defined by collective pooling and that styles of collaborating are inherently power related.

4.6.2. Reflexivity

Internal validity in quantitative research concerns controlling effect (Kleven, 2008), but in qualitative research, internal validity concerns the researcher's reflexivity (Lincoln & Guba,

2011). That means, in addition to focusing on data, the reflexive researcher observes herself in how she carries out the research, and control of effect and bias will be replaced by conscientious descriptions of observations. However, through the lens of cultural-historical activity theory, the researcher will always be a part of the context (Stetsenko, 2005). In that sense, all human activity can be seen as a transformation of the world, research included, as the researcher is "doing science" to change the world. Hence, when there is no clear destination in findings that has to be controlled, the question of internal validity has less relevance (my comment). Some researchers taking this stance choose to include their contribution to the research in their reports. For example, Jornet et al. (2019) included the researcher's voice in their article reporting on a researcher-practitioner collaboration on making in kindergartens and museums: *At that point, the question was raised, "what would be the required criteria for this to be a makerspace activity?" (researcher, WP1).* (Jornet et al., 2019). However, this was an intervention study, in contrast to my project, which has been exploratory.

My "agentive" stance has not been as visible as in the example case, and this may be a reason for critique. I did reflect on this problem before starting video recordings of the inventor course and considered wearing Go-Pro cameras and filming my conversation with the children during their making. However, I needed to observe more than one group at a time, and I decided to place cameras on the tables instead, but kept the idea of bringing a camera with me and wandering around to talk to the children. This researcher's role resonates with the ontological assumptions in CHAT (at least in some interpretations of CHAT), but nevertheless, I felt that my view was too narrow, missing what was happening in the room. I therefore changed my role and acted as the "cameraman". From there, I was able to observe the whole room live as well as details in the camera, and I believe this strategy gave a richer picture of what was happening. For example, I was able to observe the situation where Frida, in the case from article 3, was changing groups. After watching the video data, I also noticed how the group Frida attended talked directly to the researcher through the camera. This situation was included in the analysis. In that sense, I was also a participant.

4.6.3. Reliability

In order to ensure findings are not observed as a coincidence (Jordan & Henderson, 1995), the researcher needs good quality or *reliable* data. The data produced in this project include field notes, interviews, video recordings and public documents. Using diverse types of data strengthens the reliability of qualitative research in providing thick descriptions of the phenomena (Geertz, 2000). Conversely, reporting qualitative research shows only a small

selection of the data, leaving few opportunities for the reader to re-interpret the material (Silverman, 2000). Data should therefore be treated in a way that gives access to the works of the subjects, independent of the researcher's interpretations if possible.

My ethnographic notes primarily served as the initial study to define and narrow the project and "fill in the blanks" in the historical trajectory of making in the library (Engeström, 1999) and ensure the reliability of the additional data (Jordan & Henderson, 1995). Notes were written in a narrative and descriptive style (Fangen, 2010) the day after my visits. For example, *Today, the large table in the Creator Lab is covered with laptops and booklets showing some of the functions in Tinkercad, and three-dimensional letters are used as an example in the booklet. Asgeir and another man are helpers on the course, and they are walking around – it is a "drop-in" course.*

Concerning the documents used for analysing the need state of the library, these documents are publicly available. Nevertheless, analysing text depends on narrowing the data and choosing a clearly defined approach (Silverman, 2000). My reading of documents was informed by the theory of expansive learning. I was therefore interested in how library policy has changed, the tensions happening before the changes, and how policies and ideas were connected to objects, for example, architecture. The first narrowing of the material was written with references to the original documents and was shared with my supervisors, allowing for several interpretations of the material, but the last narrative presented was without the references. Considering the reliability of the document data, this might be a reason for critique. The material was extensive and was narrowed down to what I understood as the most significant changes in policy and legislation and how independence and subordination were treated.

Selecting cases from the video data follows the procedures recommended by Jordan & Henderson (Jordan & Henderson, 1995). I started with sorting video recordings from all groups in *ethnographic chunks* according to the structure and sequence of the course activities. This work was accompanied by detailed notes on interactions within each group as well as the facilitator's moves during each sequence. All the notes were organised in a content log, noting the time stamps in the video to ease retrieval of the sequences for re-inspection. Through this process of structuring the data, patterns, regularities and occurrences of "trouble" in interactions within and across groups became visible. I selected short sequences for collaborative viewing with my supervisors to avoid confirming my preconceptions (Jordan & Henderson, 1995). The material was then considerably narrowed.

The core video material for the project is based on three groups of children in their trajectory during the two-hour course. Article 2 focused on how the task of being an inventor

was communicated, facilitated and enacted. The groups were purposefully selected (Silverman, 2000) based on a research interest in the educational role of the librarians and their professional knowledge practices. Following Leigh Star (2010), interaction standing out as anomalies was used as a methodological heuristic for selecting the case for article 3, because anomalies have the potential to reveal social expectations within a practice (Leigh Star, 2010). Changing groups within the regular class structure was an anomaly giving insight into social expectations and negotiations of creative, collaborative work. Further, four episodes were chosen to represent meaningful units of interaction. The analytic concepts used in the articles were iteratively introduced. The video material of the selected groups was transcribed in full length according to a modified version of Jeffersonian transcription notation, including multimodal aspects of the interaction (Mondada, 2018).

I used the interviews to get an overview of the *activity system* and the *central activity* and to trace the *object historical* narrative of how the makerspace came about and the hesitations prompting changes (Engeström, 1999). All the interview data was first transcribed in full length using a simplified version of Jeffersonian transcription notation I found most relevant for my use. Then I made a descriptive form (Thagaard, 2009), organising the themes taken up in the interviews *a typical day at work, making activities, organisation, the new library and background.* By organising the content in this way, I was able to describe the activity system and its changing object.

4.7. Ethical considerations

The Norwegian Social Science Data Services (NSD) has authorised the project, and data treatment is in line with the GDPR rules. I have followed an approach to ethics concerning both the legal aspects and the pragmatics in ethics requiring understanding by the participants (Elster, 2013). That means that information sent to participants took into consideration that "information overload" is a problem when collecting consent, a situation that did appear in my project. Although children under the age of 18 do not have the competence to consent in a juridical sense (NESH, 2016), children's personal integrity should always be protected . I therefore provided one age-specific information and consent form for the children and one for their caretakers. The consent forms were sent to the teachers, who distributed the forms.

My good intentions resulted in receiving consent only from the children, except for a small group whose caretakers also signed. The situation was resolved by isolating children with consent from caregivers on one side of the room, to avoid filming someone without consent. Because of this situation, I decided to change the forms and provide only one for caretakers and

included a recommendation to ask their children before signing. All participants were informed about the opportunity to withdraw from the project.

I collected informed consent from library staff participating on a regular basis. As the site was a public space and more peripheral members of staff were coming and going, I also had to consider whether informed consent was needed in all cases, as consent in public spaces can be difficult to obtain. In general, the more public the space, the less the need for informed consent (Fangen, 2010). Nevertheless, some of the occasions included children. In those cases, I wore a button saying "researcher", and information about the purpose of the study was provided in a letter. I did not record sound or visuals of children during my ethnographic work, and was open about my role when talking with the children. I did not ask for their names or any other personal data. I followed the same routine in cases when older youths (over 14 years old) were participating in the makerspace, although some participants were photographed after informal consent at the site.

The youth I had conversations with over a longer period gave informed consent. Transcriptions of video recordings were anonymised, and names replaced with pseudonyms. All the audiovisual data and transcription material have been stored on a secured device only accessible to me, and video has not been shown outside the research community.

5. Introduction to the three articles

Together, the three texts provide broad insight into the trajectory of making in this library and how the changes connect to the political and historical context. Article one focuses on how staff and children frame what they do when doing innovation, and article two focuses on how the children negotiate participation in collaborative creative work. The third article focuses on the cultural-historical aspects of what making for children becomes at this library and how staff re-construct making for children. The article applies the expansive learning concept and suggests a zone of proximal development for children`s making in this library. Research using the concept of expansive learning typically uses findings from the actual empirical level to make the habits of participants visible and uses them to provoke change, but I underscore that the findings in this project serve as a basis for discussion only.

5.1. Article 1

Skåland, G., Arnseth, H. C., & Pierroux, P. (2020). Doing Inventing in the Library. Analysing the Narrative Framing of Making in a Public Library Context. *Education sciences*, 10(6), 158. doi:10.3390/educsci10060158.

Article one explores how the idea of being an inventor is enacted by children and librarians during an inventor course session. The role of the article in the thesis is to offer a window into how public library policies encompassing culture production were enacted in practical work with children's making, and how possible futures for library making are negotiated during the inventor course. The research questions asked *how do children and library educators frame the concept of inventing in a makerspace activity? How and through what means do children create in the collaborative making? In which ways do storytelling practices in libraries merge with practices of inventing in makerspaces, and what is the pedagogical value of this merging?* Video recordings of one inventor course session comprise the primary data in the analysis, supplemented with ethnographic notes. The analysis is a close interaction study that follows the structure of the course and how teaching making and doing making are framed during five consecutive parts of the course, following the trajectory of one group of children. Goffman's concept of framing was applied in order to study the participants' understanding of what was going on, and what activities that are judged as "out of frame" or "proper frame". Frame analysis was particularly useful for this case, as the concept allows for studying the negotiation in play, when formal and informal learning intersect, which in this case was the public library and a primary school class. Moreover, we were particularly interested in mode use and storytelling, as the enactment of how making should be done was assumed to connect with the habits of the participants performed implicitly during the interaction.

Imagination was understood as mediated by socio-material features such as objects, texts, interactions, talk or sounds, functioning as "imaginary material anchors". We used these concepts in the analysis of the children`s imagining process and collaborative construction of being an inventor. Findings show that the course had a tight structure organised into five parts. The first is an orchestrated dialogue about what invention means, known inventions and what kind of problems these inventions are intended to solve, completed by a storytelling session about the brewer who invented bottle return. The second part was a video informing about the Little Bits and demonstrating examples. The third part was an instruction session on making electrical circuits using the Little Bits. The fourth and main part of the course was an inventing

task expecting the children to collaborate in finding a problem to solve using the Little Bits. Finally, the fifth part was a group presentation for the class orchestrated by a librarian.

The interaction analysis shows how expectations in the course structure and task description were negotiated as three ways of framing making, typified as inventing as invention, inventing as exploration and inventing as narrative. The article concludes that although the inventor course was situated in a public library setting, the framing of making had school-like features emphasising information and tool instruction. The inventing as invention frame was part of this picture, as the focus in the introductory parts of the course was on the product and the problem, suggesting a linear process of design starting with a known problem, generating ideas and finally, materialising the idea.

We found that the children struggled to align with this approach to creative collaboration but were more successful in generating ideas by exploring the material features of their environment. Ideas were typically surprising and triggered by sensory play with the material. Exploring the material generated the children's ideas for things to make, but these were loosely connected to a problem. Framing inventing as narrative, the librarians implicitly introduced a new didactic approach supporting meaning-making, where a product was given a role in a dramatic real-world plot. In that sense, the narrative approach looks upstream, connecting children`s making to notions of empowerment and participation in cultural change. In relation to the overall aim of the thesis, frame analysis allows for a window into the blend of activity systems in play at the level of action when making is introduced in new settings.

5.2. Article 2

Skåland, G. (2022). I hate little bits: The collaborative construction of children's creative making in a public library makerspace. In K. Kumpulainen, A. Kajamaa, O. Erstad, Å. Mäkitalo, K. Drotner, & S. Jakobsdóttir (Eds.), *Nordic Childhoods in the Digital Age: Insights into contemporary research on communication, learning and education* (pp.154-167). Routledge.

Text number two focuses on creative collaboration. The aim of focusing on collaboration in children`s making was to explore the tradition of democratic socialisation in Nordic education, emphasising collaboration as education towards community building and democratic habits of mind at a micro level. Moreover, I was also interested in the fruitfulness of collaborating on the

inventor task and how ideas were collectively produced. The role of the text in the thesis is to serve as a window into the upstream notions of empowerment in public library values.

The research questions asked were *what role does material play in children`s collaborative problem exploration, and how are children positioned and position themselves as collaborative makers?*

Video recordings of one sequence of the inventor course served as data for the analysis, and the selected case consists of four units of detailed interaction from the trajectory of one girl who changed groups. In line with the findings in article 2, I continued to approach creative work as anchored in material surroundings. Further, two concepts were iteratively applied in the analysis of the dialogue; persuasive dialogue and collective pooling. In combination with positioning, these concepts were helpful in describing the different opportunities to contribute to a shared conversational floor the girl experiences during her trajectory. Findings show how the children demonstrated joint problem finding by anchoring narratives of possible problems to seemingly meaningless things. Furthermore, turn-taking in collective pooling followed a different sequential structure than expected in verbal turn-taking. Messing around with things in parallel allowed for multiple utterances to be produced. For example, fiddling with an LED light was taken up by peers and continued as an anchor for new ideas. I conclude that this finding has implications for how the sequence of utterances in turn-taking may be analysed in future studies on collaborative making.

The case shows how the girl was active in producing material utterances for the group but was deemed non-collaborative in a group dominated by persuasive verbal discussion. In the group dominated by persuasive discussion, the focus was on finding one joint idea to work on. The winning argument was not connected to joint idea generation, but was dominated by unequal distribution of authority and undue influence. By changing the group, the girl found a climate of collaboration evolving towards collective pooling, where she managed to re-position as a contributor in collaborative work.

I conclude that the findings concern core library values of democratisation. Working in groups and allowing children to find a problem of their own do not automatically support children`s opportunities for participation and empowerment in making, as expectations for how to collaborate might be multiple and favour one way over another.

5.3. Article 3

Skåland, G., Arnseth, H. C., (submitted 2023). Making the library of the future. Toward the zone of proximal development for a Norwegian public library makerspace. Submitted to *Mind, Culture and Activity*.

The third article is a cultural-historical analysis (Engeström, 2015) of one public library makerspace. The role of the article for this thesis is to provide insight into the public library as a system and how contradictions at the system level are implicit in everyday actions and plans in the library. The research questions asked are *1. How do the historically developed practices of libraries impact how making is realised in a library context?2. What tensions occur during implementation, and what are the contradictions manifest in these tensions? 3. What is the ZPD for future development in this public library makerspace?*

The analysis was based on documents, interviews and ethnographic notes. The analysis focused on historical changes in Norwegian public library policy, how this library became a host for a makerspace pilot project, why children`s making was moved to the children`s department, and how an inventor course for primary school children was iteratively changed in the children`s department. By combining an analytical focus on three levels, we were able to trace this library's *primary contradiction* and *need state*, and how these implicitly grounded current *secondary contradictions* driving iterations on the inventor course.

The *primary contradiction* found was between self-driven education and the centrally governed policies of including all citizens in such activity. By this, we defined the need state as the *search for strategies ensuring citizens are able to benefit from having access to the collection*. That is, a solution had to go beyond merely access orientation to digital tools, helping visitors in using them in meaningful ways. By analysing the emergence of the makerspace pilot and the inventor course, we found that making in this library underwent three waves of object formation grounded in the need state. During the first wave, a contradiction arose between expectations for children to be self-driven in finding meaningful and personal 3D projects, and the principle of access to tools and technical guidance as an instrument. The contradiction led to further re-configurations of the main makerspace to be more library-like by introducing a booking system to ensure access, and children`s making was moved to the children`s department. Hence, the contradiction remained during second-wave iterations and continued to cause trouble under the surface of change efforts. During the third wave of object construction, the social constellation of staff and the new organisation focusing on fiction and storytelling in the children`s department was of importance for how the inventor course was changed.

The course changed from instructed problem-solving to creative and collaborative problem-finding, emphasising real-world problems. However, the pedagogy was still tool oriented and school-like and ended in a presentation for the class. The problem was, in that sense, not "real" in that it was not expected to have any impact in the real world. The article concludes that the need state of supporting children in being self-driven in using tools in meaningful ways is unresolved but, at the same time, represents a *zone of proximal development* for this public library. Moreover, we suggest further studies to discuss pedagogies aligning more with core library values of inclusion, citizenship and change through making. The empirical level of analysis in articles one and two taps into these questions by looking at children's efforts in solving the task. Articles one and two showed how new and valuable practices emerged, underscoring how the re-configuration of making in the library is a continuous process evident in day-to-day practice. The discussion in the next chapter follows this line.

6. Contributions and discussion

6.1. Empirical contributions

This chapter discusses findings across the three articles produced during the project and comprises discussions on the empirical, theoretical, and methodological contributions. This thesis has aimed to explore in what direction the participants collectively re-construct making activities in the library. The guiding objectives are to explore how pedagogies supporting creative making are re-constructed and to discuss how the re-constructions suggest changes for public library institutions. I have applied a cultural-historical approach to learning to explore these objectives. By using Engeström's notion of expansive learning (Engeström, 2015), this thesis has focused on challenges in changing institutions as possibilities rather than as failures. This chapter aims to discuss the findings from the three articles as a process of change, namely expansive learning.

The emergence of public library makerspaces closely connects to the Maker movement, emphasising that access to tools will generate entrepreneurship and mobilise citisens (Diaz et al., 2021). The movement embraces constructionist learning principles such as creative tinkering (Petrich et al., 2013) and a learner-centred approach requiring self-driven participation (Dougherty, 2012; Sheridan et al., 2014). Providing opportunities to improvise and fail and supporting creativity and motivation are at the core of how learning in makerspaces is advocated.

These learning environments require a great deal of self-direction in learning (Blikstein, 2013). Although self-directed learning is a central value for public libraries (Williams & Willet, 2019), making in libraries has moved towards formal learning (Nicholson, 2019; Einarsson & Hertzum, 2020), and attempts to establish communities of practices within the library have not been successful (Willet, 2018). However, instead of evaluating whether learning in library makerspace environments happens or fails according to ideas adopted from the Maker movement, there is a call to explore new ways to understand learning in makerspaces that align with public library values (Einarsson, 2021; Willet, 2018). It is therefore critical to examine how pedagogy can support novices in creative making and how pedagogies relate to the specific institution in question.

The analysis conducted in the three articles adds to this discussion by showing how participants negotiate how to do creative, collaborative innovation and how the course they participated in was questioned and re-constructed based on a cultural-historical context. In cultural-historical terms, this type of learning is a demonstration of transformative agency that can re-construct the practice at the level of interaction (Kumpulainen, Kajamaa & Rajala, 2018; Engeström & Sannino, 2021). Transformative actions typically deviate from the given script of procedures in work (Kajamaa & Kumpulainen, 2019). Together, the findings from the three articles show how participants on the floor have the potential to contribute to new pedagogies, and how the cultural-historical evolution of the institution is visible in their change efforts. By analysing children's making through this lens, this work is relevant for public library making and informs institutional adoption of makerspaces. The following section describes how the practice of inventing was transformed by multiple participants connected to the makerspace in this public library.

6.1.1. From problem-solving to collaborative problem-finding

In article one, we found that many frames for how to do inventing existed simultaneously, and the participants constantly negotiated what the appropriate one was. The structure of the course suggested that knowledge about what an invention is, and the technical knowledge in using the Little Bits, was self-sufficient to support creativity. This lack of facilitation in finding a project left the children alone in working out how to approach the task. The frames analysed in the article were termed *inventing as invention, inventing as exploration and inventing as narrative*.

The inventing as invention frame was demonstrated during the introductory part of the course as question and answer sessions focusing on a product and a problem. The sequence in this conversation suggested a linear workflow in having a problem to be solved by an invention,

but the children struggled to follow this sequence as they did not have a clear problem. Defining the problem was the most challenging part of the task. Finding a project was more successful when inventing was framed as an exploration of the material environment. Sensory play typically generated ideas by surprise, for example, how a sound triggered one child to repeatedly push the button, making a rhythmic sound. This action generated the idea of a Morse code signaller. The finding is interesting in terms of how their process was similar to tinkering but yet different.

Tinkering is described as a playful mindset or improvisation with problem-solving in mind (Martinez & Stager, 2013; Petrich et al., 2013). However, the finding in the current case is typical of creative tasks where the problem is ill-defined (Sawyer, 2017). The conversation turns to finding a problem rather than solving one. Moreover, the process of exploring the material was joint work and triggered by emotions. For example, the sequence in the idea generation for the Morse code signaller started with boy one picking up a random piece that happened to be a sound distorter. Boy two connected an on-and-off button to the piece, and the sudden sound emotionally triggered all the boys in the group. The sound distorter was placed back in the box but was made relevant again when boy two connected a lightbulb to the switch, making a rhythmic flashing light. This was the moment when boy three came up with the idea to make Morse code signals using the sound distorter. A similar sequence in exploring the potential of the material was found in article two. The timescale of sequences in idea generation varied. In some cases, like the one mentioned above, touching a piece triggered ideas.

In other cases, one child may explore and make seemingly irrelevant things for a longer period of time. For example, in article two, playing with a straw and a feather and creating a seemingly nonsense thing turned out to be a driving cat toy as a final invention. One important aspect of this finding is that what matters as contributions to joint creativity may be difficult to observe in the chaos of children's making. A critical factor for facilitators in this regard is to value children's touching, tweaking and chaotic play. Although their actions may seem disconnected from their peers, their behaviour might be central in producing intermediate ideas or triggers for imagination.

The process of exploring ideas for products explained above was productive in that their work resulted in something to present to the class. However, what problem the thing should solve remained unanswered. Research suggests that when making becomes institutionalised, children need “onboarding” to reach a self-driven style of learning (Blikstein, 2013). The findings above show how technical guidance and information were insufficient in supporting children's self-driven innovation, in that they struggled to find a meaningful purpose for their

innovations. Nevertheless, they did find ways to collectively create products in a manner that can inform future pedagogy, and that collective play with material, embracing surprise, emotion, and chaos are essential ingredients.

A third framing of inventing found in the study showed that the librarians brought their storytelling habits into the course. The narrative framing was helping the children come closer to a real-world problem their product could solve. The librarians were not explicit about using narratives, and their use of narratives as a didactic approach was, therefore, invisible to the participants. Nevertheless, their habit of being in dialogue with children`s imagination during loud reading sessions was a new and fruitful contribution to facilitating children's imaginative thinking in the makerspace.

Although the narrative in the introductory part of the course described the inventing process as linear, helping the children locate seemingly meaningless inventions within a dramatic plot did support problem-finding. By asking questions concerning the plot (such as who is this made for? where and when is it supposed to be used?) the librarian imagined a series of events and problems during dialogue with the children, modelling how their invention might have a role in the real world. In the case from article one, the narratives were clearly connected to a professional sphere for adults, suggesting the "Morse-code-and-air-rinser-thing" to solve problems in volcano research. Children's making was, in that sense, disconnected from the community of practitioners in this case – the children.

Article two shows one example of children using a narrative approach on their own, where the process of finding a problem was connected to cats and experiences of having an urge to run. The case from article two deviates from the adult perspective of inventing and suggests narratives relating to children`s interests and experiences. Considering public library values of empowerment (Britton, 2012; H. Jochumsen et al., 2017; Nicholson, 2019; Slatter & Howard, 2013), children's making should align with real-life problems relevant to the children participating and connect to real-world changes (Mackey & Jacobson, 2011).

Narrative as pedagogy in problem finding might have the potential to facilitate children in finding real projects that are meaningful to them where their contributions matter. However, in this case, the course had time constraints typical to school, and the Little Bits had to be put back in the box before leaving the course. The products made during the course were therefore limited to being meaningful within this time frame. This section presented how the children found ways to approach the task of finding a problem. However, this way of working may not be valued as proper in all settings, as the dominant frame may differ. The following section presents how participation was negotiated during the inventor course.

6.1.2. Negotiating participation

Previous research on making in the primary school setting suggests that tinkering together as a participant structure can foster equitable learning environments (DiGiacomo & Gutièrrez, 2016). Equity is also central to public library making in that democratisation is the grounds for giving access to digital tools (Diaz et al., 2021). This thesis defines equity as the opportunity to shape an identity as an innovator. This take on democratisation is in line with an empowerment approach where participation means having a voice (Pawley, 2003). In line with Willet (2018), this take emphasises identity as equally crucial for democratisation as the typical access to tools and maker activities. Willet further suggests social contacts as essential for including underserved communities in making and emphasises community building through partnerships as one way to reach this goal.

In the current study, I follow Willet in that the social aspects of participation in making need closer attention. The current study approached identity as emergently defined among members in the inventor course, focusing on how the participants negotiated appropriate participation.

In article one, all three boys contributed to making The Rescuer but in different ways. Boys one and two dominated in the physical exploration of the Little Bits, and boy three contributed by verbally suggesting Morse code signalling. The situation demonstrated how physically exploring the Little Bits was the dominating frame of inventing in the group, giving the frame rhetorical power in deciding the material aspects of the invention. That is to say, a voice in this situation was connected to the dominating frame of exploration. Similarly, presenting the innovation as a coherent narrative was the dominating frame during the presentation. In article two, this phenomenon was given closer attention.

Findings from article two show how the dominant frame of persuasive talk defined the exploration frame as off-task, positioning one girl in opposition to her group. This situation occurred because the Little Bits pieces were getting a symbolic function, as the opposition argued against in a discussion. Their argumentation was, to a great extent, non-verbal signals such as moving objects, gaze and space arrangements difficult for an outsider to notice. The result was that influence in creative collaboration was undue on many occasions, resulting in the teacher treating the girl who wanted to explore as a non-collaborative child and dismissing her.

Accelerating negotiation is typical when a new practice has been introduced (Engeström 2015) and may be particularly evident when creative tasks meet school, because the script for

how to approach the task deviates from the sequential order of a teacher or a textbook (Kajamaa & Kumpulainen, 2019). On such occasions, creative work might require participants to transform the procedures in their work. The situation from the case above is one example in that the dismissed girl did not align with the persuasive style in her group but re-positioned herself as a contributor by switching to a different group. There she continued enacting an explorative approach and succeeded in participating. In the second group, creative collaboration was in line with the collective problem-finding framing explained in the previous section, where joint exploration and narrative problem finding laminated. Hence, in her deviation from the persuasive frame, the girl suggests collective problem-finding to support equity and creative work.

The findings from the cases raise issues of the quality of creative collaboration, the creative outcome, and equity in participation, supporting previous research suggesting that tinkering together can foster equitable learning environments (DiGiacomo & Gutièrrez, 2016). At the same time, there is a need to broaden the perspective on empowerment in makerspaces to include how the framing in collaborative creativity defines what creative collaboration is and is not. Moreover, the participant's level of influence in creative collaboration may not be equivalent to their merit in producing ideas, but emerge out of the social negotiation. The social negotiation of participation in making underscores that we cannot take the democratising potential of makerspaces for granted, as the dominant framing of appropriate participation seems to vary considerably. It is also possible that the variation in framing is domain-specific (Lymer, 2009) and has to be understood as part of the systems involved in the situation. The next section discusses the institutional aspects of the inventor course and how the course was part of changing library practice.

6.1.3. Policy, plans and contradictions – changing making in the library

Article three gives a deeper understanding of the implicit factors grounding what making for children becomes in this library. The findings above show how the participants deviated from the script, doing creative work and collaborating in both productive and unproductive ways. Accelerating negotiation is typical when a new practice has been introduced (Engeström 2015) and indicates contradictions at the system level. *Empowerment* is a central value connected to changing library activity at the system level, also discussed as *the performative turn* in public libraries emphasising participation, user-driven innovation and co-creation (Jochumsen et al., 2017), collaborative learning, relevance to identities and interests, experimentation and meaningful play (Nicholson, 2019).

Article three adopts the notion of *expansive learning* as a lens to understand public library making. From this view, changes in how to do making in day-to-day practice are driven by the same contradictions as in the system (Engeström 2015). Article three discusses how the staff re-constructed making for children in the library, and how systemic contradictions drove the iterations of the inventor course. The study defines the need state triggering changes in children`s making as the *search for strategies ensuring citizens can benefit from having access to the collection*. The solution had to go beyond an access orientation to digital tools and support children in using the tools in meaningful ways.

Three waves of change efforts concerning children`s making were found. The first wave was access oriented, in that children`s making was moved from the makerspace to the children`s department because children occupied the 3D printers, giving less access to adult users. A similar situation was found in the Denmark study (Einarsson, 2021), where librarians reported difficulties recruiting, as the ordinary library visitors did not have the necessary self-initiation. The visible tension in both cases was hesitations concerning the behaviour of the visitors. In the study from article three, the conflict was solved by changing the site for children`s making to the children`s department. However, when analysed in terms of expansive learning, a visible conflict is the symptom of a systemic problem, not the tension itself (Engeström & Sannino, 2011). Findings from article three show that the contradiction was inherent when children used 3D printers too much. As the children did not know how to find a meaningful project and work on it over time, they occupied the printer, making pre-designed toys or cell phone covers. The situation continued the same tensions this library faced before when the tools were literature.

Inherent in the system is the enlightenment philosophy, advocating that access to literature is self-sufficient in enabling citizens to transform society (Pawley, 2003). For example, one assumption grounding the idea was that the working class could benefit from having access to the literature. However, a substantial amount of the group could not read. Using the old situation as a metaphor – the children in the makerspace could not read the 3D printer as expected. This finding suggests that solving problems in public library makerspaces with varying access-oriented solutions may reproduce contradictions. However, research discussing inclusion in makerspaces typically takes its departure in access.

One study suggests expanding access to tools to include access to people (Lakind et al., 2019). Other studies criticise makerspaces for providing access to tools and materials that are more appealing for boys than girls, or excluding some types of making, such as sewing or visual arts (Keune & Peppler, 2019; Vossoughi et al., 2016; Willet, 2018). There are good reasons for these suggestions. Research on informal makerspaces has shown that a diverse collection of

digital and non-digital tools often leads children not interested in tech to try digital tools on their non-digital project, for example, making a light for a doll's bed (Sheridan, 2014). However, the findings in my case concern the transferability of creative practices when access to the tools, material and technical operation is the guiding principle for inclusion. The children in the current institutional setting seem to struggle to find a project in the first place. The findings suggest that research needs to explore how to help children use the makerspace in meaningful ways.

When children`s making was moved to the children`s department, the problem continued as an explicit discussion among staff members about whether the children should be allowed to copy. The social constellation in the children`s department and changing the organisation of staff were important factors in how the discussion turned towards creativity. The group was organised in the library as the "storytellers" and posited creative backgrounds and/or interests, and the inventor course set an example for how a "more creative" 3D printing task might look. The first version of the course was an instructed task in making a coffee cooler with the Little Bits fan, which was adopted from a science museum makerspace. When this course met the children`s department, it was re-constructed, giving clear expectations for the children to find their own problems to solve, giving connotations both to the expectations of self-direction within informal makerspaces (Dougherty, 2012; Sheridan et al., 2014) and to the new library policy of empowerment in performative spaces (Jochumsen et al., 2017). However, the contradiction in how to support self-directed creative work continued, as the pedagogy following was structured as a school-like environment with its time constraints and tool orientation.

There was an implicit suggestion in the course design that having the technical skills in using the Little Bits and the knowledge about what an invention is was self-sufficient to facilitate children's problem-finding. The micro-level actions where the children and the facilitators in the course were negotiating inventing procedures were indications of how the participants struggled to overcome the contradiction. Anchoring ideas in the materials and giving silly things a role within coherent narratives were attempts to meet the contradiction – how to use the Little Bits in meaningful ways. At the same time, inclusion was negotiated at the micro level as having a voice in the group, and the strongest voice represented the dominating frame of inventing. Moreover, when school, the library and the maker movement intersect, the dominant frame of making is not necessarily in line with expectations in the task design. These findings suggest that micro-level interactions are where public libraries should look for changes. The micro-level interactions and the analysis of the evolving object of the

library system in concert suggest a possible new shared object. The model below illustrates the possible shared object and the difference between the central library activity (left) and the re-configurations suggested by the participants (right) (Figure 8).

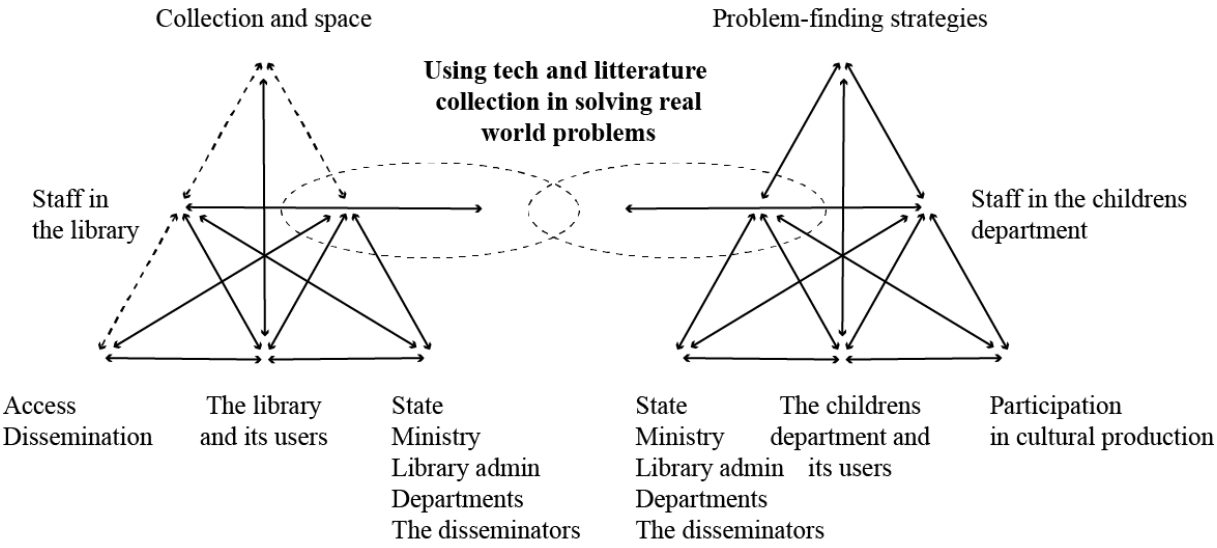

Figure 8. The central activity and the new activity with a possibly shared object.

The modelled systems shows how the collection of books, tools and other material in the library is still regarded as artefacts that can empower citizens, while my studies of the participants suggests problem-finding strategies as a new approach. The findings from the micro-analysis were not shared with the staff during my project. The staff engaged with the inventor course believed the course design focusing on teaching the affordances in the Little Bits was the reason for the creative outcome, with the result that the contradiction remained invisible for reflection and further change. Future research may therefore focus on unpacking contradictions, making new opportunities visible, for example, by the principle of double stimulation (Sannino & Engeström, 2017).

6.1.4. Implications of the empirical findings

The described empirical findings draw on previous research on informal makerspaces and efforts to adopt similar learning environments in public libraries. My findings add to this research by exploring how a cultural-historical approach can provide new insights into makerspaces in institutional settings. The empirical findings show how the cultural-historical approach affords methods for zooming in and out between individual actions and institutional

contradictions, and therefore stands out as a very relevant lens for implementing makerspaces in line with existing values within the institution in question. One of the main ideas behind the concept of expansive learning, which is discussed in this thesis, is that in order to maintain and improve both the makerspace and the library, they must undergo change and adaptation. Findings from the three articles suggest that extensive micro studies of participant interaction in the makerspace are central to finding new pedagogies, as these actions are efforts to overcome systemic contradiction. As we see from the model presented in the previous section, the participants in the inventor course suggested by their actions problem-finding strategies as a new instrument, aligning with the new object of solving real-world problems. The model also suggests solving real-world problems as a shared new object aligned with public library values of empowerment.

6.2. Theoretical contribution

The articles produced in this project include concepts belonging to CHAT (Engeström, 2015). The project puts a great deal of focus on the deviant operations of the children and the librarians in their efforts to overcome systemic contradiction, and in that sense, contributes to a discussion around the fourth generation of CHAT (Engeström, 2021). I am aware of the differing opinions on separating approaches to CHAT into generations. CHAT has been in continuous change since its beginning, and the current approaches in use are not necessarily convergent (Stetsenko, 2021). Considering the emergent character of CHAT, I suggest additional concepts used to theorise the agentive transformation of making in the library can be of interest to future research. Strengthening the focus on participant agency was suggested by Engeström in an article in Mind, Culture and Activity in 2021.

In this thesis, I have understood agentive transformation as a step in expansive learning, inspired by cultural-historical research focusing on participants' agency to transform the context (Kumpulainen et al., 2018). Focusing on transformations at the level of interaction contributes to the discussion by showing an example of how agentive transformation can apply to the expansive learning concept. By exploring the unplanned actions of children and librarians participating in the inventor course in detail, I not only defined deviating operations but also introduced additional theoretical concepts useful for understanding the practices that participants introduced. These concepts can be used in the future cultural-historical analysis of creative, collaborative work, inclusion in such practices and opportunities to identify as a maker.

Article one introduces Goffman's (1974) concept of *framing*, including his understanding of frames as laminated. This concept is thoroughly presented and discussed in the theory chapter. The concept of laminated frames can be useful for analysing cases where the object of activity is in a state of transition. Typical for these situations is an increasing level of negotiation (Engeström, 2015), and analysing laminations of frames can identify the multiple voices apparent in such situations. The concept, therefore, explains how different ways of doing connect to diverse practices known to the participants, for example, collaborative work at school or reading aloud. At the same time, actors do not necessarily act according to a defined frame but may improvise, suggesting new frames. Moreover, one finding from article one shows how multiple frames acted out simultaneously may merge into new frames. This improvisational approach to frames can be understood as an example of transformative agency and align with current CHAT discussions. Referring to Holland et al. (1998), these deviations may produce new currencies for participation and opportunities for re-positioning.

Both articles one and two describe in detail the diverse sequences of talk and material/space arrangements in play during the inventor course. The concepts together form analytic tools for understanding dialogues in collaborative creative work, and how authority and influence are formed in group work. These concepts are *material anchoring*, *narrative meaning-making*, *collective pooling and the conversational floor*. The theory chapter presents these concepts in detail. Current discussions underscore how the focus on agency in activity theory needs to avoid the traps of individualism (Hopwood, 2022). The concepts used in this project have been used in a way that can inform CHAT by suggesting concepts for creativity and collaboration situated in social and material interaction. This contribution also has methodological implications for how dialogue is analysed, and the next section presents this take.

6.3. Methodological contribution

In this thesis, I have shown examples of how agentive transformation can be seen as a step in expansive learning. The methodology for this part of the analysis has been inspired by interaction analysis (Jordan & Henderson, 1995) with focus on the material aspects of interaction inspired by Goodwin (1997). I argue this is a contribution to research grounded in cultural-historical theory and, in particular, in studies of dialogues in a makerspace setting.

In line with Goodwin (1997), action without talk was analysed as an utterance in turn-taking in articles one and two. Types of actions comprise touching, manipulating and moving objects, gaze, gesture and body orientation. Including these aspects of the conversation changes

how sequences appear in that utterances stretch over an extended period. The methodology, therefore, had significant consequences for my analysis in that what appeared as chaos at first nevertheless had features of a conversation. The transcript below is one example taken from article two. Text in double parenthesis comprises non-verbal utterances.

1.	Ada:	it's bo:::ring::: ((holding a bit in her hand, looking at it))
2.	Ida:	a:::::::::h I'm so tired of this falling apart and I mean it if this doesn't work I give up
3.	Frida:	I take scotch tape ((pulling out tape)) lots of scotch tape
4.	Ada:	((picks up a straw and a stick and puts the stick into the straw. Then she turns a pipe cleaner around the end of it))
5.	Frida:	loo:::k I have scotch ((holding scotch tape in front of the scratcher and Ida and Frida start to fasten the fan on to the scratcher))
6.	Ada:	((grabs a feather and attaches it to the straw under the pipe cleaner)) tata::: ((holding the feather-straw in front of her))
7.	Iris:	((smiles and look at the feather-straw)) nice ((walking over to Ada's place))
8.	Frida:	((looking at the straw thing)) you can make a eh: yesyesyes↑ ((walks over to Ada, grabs the straw and puts it into one of the holes in the wheel platform)) yes↑ we can have this on and kind of ((bowing over the feather making it tickle under her chin)) so if one's a bit bored so eh:: one can run after
9.	Ada:	that one ((pointing at the feather with a stick)) a cat toy for the cat
10.	Frida:	yes↑ ((turning towards Ida and Iris)) cat toy↑ we can try to make a cat toy if that one doesn't work ((looking at the scratcher))
11.	Ida:	it works
12.	Ada:	we can call it the catapult

What is striking about this conversation is that the participants do not seem to talk together by taking turns and elaborating on each other's utterances. Their style is more similar to parallel play. However, this picture changes by understanding play with the material as part of the conversation. I adopted the concept of *collective pooling* from Vass et al. (2014) to define this kind of conversation.

I argue that the term collective pooling is both a methodological concept and a theoretical concept explaining collaborative creativity. It is a methodological concept in that it changes how one analyses a conversation. The term originates from dialogic studies of children collaborating in writing poetry, but it has been useful in understanding material dialogues.

When utterances are understood as participation in collective pooling, parallel production of material works as a collective in that all the participants contribute to the shared pool. A similar understanding of creative collaboration has been termed *emerging collaboration* by Sawyer and DeZutter (2009). They argue that one individual does not own ideas in emerging collaboration. Hence, the discussion is not about the end point of the production, but the product emerges during collaboration. Taking an example from the excerpt above, putting a stick in a straw is a seemingly random exploration of the material, not part of the conversation, but a contribution to the collective pooling. Hence, the term collective pooling changes what we understand as a sequence in conversation.

The methodology contributes to research grounded in cultural-historical theory in that a sequence is understood as emerging in social and historical contexts. For example, a jazz band shares conventions for the sound of jazz but is nevertheless expected to improvise (Sawyer & DeZutter, 2009). Moreover, a sequence in conversations defines what comes first and what comes next, and also what is evaluated as appropriate behaviour in specific episodes of interaction (R. Engeström, 1995). Other examples of sequences in conversations are the question–response–evaluation typical for the classroom or sequence in a persuasive conversation. Hence, the methodology suggested here can be used to analyse what kind of sequence is expected in talk within professions or, as in this thesis, to analyse diverse expectations of sequences and how sequences are negotiated and changed.

7. Concluding remarks

I introduced this extended abstract by arguing that tensions in knowledge institutions adopting making can inform new pedagogies within the system in question. The aim of the thesis has been to explore *in what direction the participants collectively re-construct making in this public library*, and two objectives guided my work. How pedagogies supporting creative work are re-constructed, and how the re-constructions suggest changes for public library institutions. This thesis has substantiated these questions by zooming in and out of micro-interactions in the inventor course and the systemic contradictions driving actions at the micro level. Accordingly, this extended abstract allowed me to broaden my perspective on the three articles produced during the project, as I have sought to understand the three texts in dialectical relation to each other. By zooming out, I have shown how findings from articles one and two were driven by a systemic motivation to find ways to support visitors in using the library collection of books, technology and other material in meaningful ways. By zooming in from article three, I have

been able to discuss how the longer term threads of the history of public libraries made the particular interactions in articles one and two possible. In this way, I have been able to reflect on how participants actions suggest future approaches to makerspace pedagogy in public libraries that also meet institutional needs. Research applying the concept of expansive learning is often based on intervention studies that present results of an analysis as stimulation for reflection and further change. My project did not include such an intervention, but in the aftermath of the study, I have concluded that the contributions of the participants in changing ways to do making were substantial. Future research approaches that include interventions therefore seems promising.

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Doing Inventing in the Library. Analyzing the Narrative Framing of Making in a Public Library Context

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Abstract: In this article, we examine how creative making is framed in a public library setting. We pursue this topic by focusing on the trajectory of a group participating in "The Inventor Course" during a school trip to a library. Video recordings of the maker activity comprise the primary data for analysis, supplemented by ethnographic notes. Analysis of the group's interactions shows how different frames for inventing are acted out and intersect during the activity. We describe these frames as inventing as invention, inventing as exploration and inventing as narrative. Findings indicate that a narrative frame is a fruitful approach to making in a library setting and that narratives performed in dialogue with children help them to make sense of their explorations.

Keywords: libraries and other cultural institutions; makerspaces; education and pedagogy

1. Introduction

In the Norwegian welfare state, public libraries have been important institutions for providing free access to a variety of media for all citizens. In recent decades, libraries in Norway have followed international developments, with the introduction of new activities and architectural spaces to accommodate societal change and novel forms of digital media. The introduction of makerspaces in libraries is one such change in existing practices, with "making" written into policy aims and plans to reinvent the library and give it new purpose in the current mediascape [1]. The rationale for providing makerspaces in libraries is usually taken from either do-it-yourself ethics (DIY) or neoliberal ideologies of innovation and competition, or a combination of the two [1,2]. DIY ethics focus on the possibilities of the individual to participate in cultural change, with activities often focused on finding solutions to local problems [2]. Innovation rationales, on the other hand, are more concerned with libraries providing public access to facilities that people can use to educate themselves for future job markets [1]. Makerspaces in public libraries, in this sense, serve national strategies for innovation and competitiveness.

In this study, we examine a making activity in a public library in Oslo that had the aim of introducing children to a future role in society as "inventors". The makerspace was a relatively new practice in this library, as was the course, which invited school classes (grades 4–7) to visit and participate in an activity specifically designed to foster children's creativity and innovation skills. Within the context of public library policy, this inventor course may be seen as a tool for empowerment, that is, that children should be given opportunities to practice skills and tools they need to participate in society [3,4]. More concretely, the pedagogical design of the activity, as described below, asks children to identify a problem they can solve by making an invention using Little Bits and other materials.

We examine in detail how the idea of being an inventor is enacted in interactions between the children and between the children and the library educators. We are interested in how the activity is

framed for the children in terms of what is expected of them, what they are supposed to do, and with what tools. Further, we explore how library educators support the children's creative making processes in a relatively new makerspace practice, particularly how they use narrative, or storytelling, as a resource to frame the activity in particular ways. To investigate this topic, we address the following research questions:

- How do children and library educators frame the concept of inventing in a makerspace activity?
- How and through what means do children create in collaborative making?
- In which ways do storytelling practices in libraries merge with practices of inventing in makerspaces, and what is the pedagogical value of this merging?

2. Making in Public Libraries

Public libraries have been highlighted as well-suited for makerspaces because the maker movement and the library share some of the same core values [2,5]. Libraries have a long history of providing public access to information, with access to tools for digital production included in a broad understanding of this democratic principle [1,6]. In a study of how librarians talked about access and freedom of expression in relation to their library's maker practice, Barniskis interviewed nine librarians responsible for makerspaces [3]. One finding was that the librarians viewed "access to tools of production and creative expression" an important instrument for reducing socioeconomic and digital divides. This understanding of the library mission has been referred to as a performative turn, encompassing activities related to culture production [1] and the fundamental idea of the maker movement as a revolutionary shift from consuming to making things [3].

An ethnographic study of public library makerspaces in the Nordic countries explored how such performative activities are connected to different rationales [1]. The study found that "making" was a category of its own, grounded in economic argumentation and focused on the library as producer of tomorrow's entrepreneurs. Rationales for including performing arts or DIY projects in the library, however, were not the same. Instead, access as democratization and empowerment was a rationale for art programs, which typically were designed to foster artistic expression and civic engagement by strengthening personal or group identity. The conclusion argues for a democratization and empowerment rationale for library makerspaces, leaving the innovation rationale to other actors. While this conclusion is rather typical for researchers in this field, it also underscores how creativity and invention become linked with ideals of democratization and empowerment [2].

In a discourse analysis of research articles and blogposts spanning from 2012 to 2014, Willet found mostly references to DIY ethics. The possibility to bypass governments, institutions and other gatekeepers in production is understood as one of the main rationales for having a makerspace. Making as DIY ethics concerns providing alternatives to mainstream modes of production, finding solutions to local problems and giving voice to those otherwise not heard. The pedagogical framing of making in the reviewed articles also typically contrasted makerspaces with learning in school. While formal learning in schools was often framed as a teacher controlled instructional pedagogy with little connection to the real world, library making was described as an opportunity to expand formal STEM education to include real-world problems [2]. As informal learning activities, then, making in libraries may be conceptualized as affinity spaces where people with shared interests meet [7], learning through participation [8] and from being situated in a shared practice. These perspectives also align with constructionist views on participants as self-directed learners, tinkering with technology while inventing and developing prototypes [2]. An important tenet of constructionism is this concept of tinkering, a bottom-up approach to learning where the goals for making emerge during play [9]. Learning in constructionism-inspired environments is thus described as a dialogue with artefacts [10]. Children's thinking is represented in material form and revising thoughts becomes a matter of changing the external artefact [11].

While the above-mentioned aspects of learning in makerspaces are assumed to be realized through open access to tools or courses [4], there are few studies of how policies of access may affect patrons'

making activities. A study by Barniskis [3] found that the social function of makerspaces was more apparent than actual innovative or creative work, and that librarians had difficulties facilitating creativity and prototyping. In particular, the use of 3D printers was described as a non-creative tool, as most of the 3D printing used existing models downloaded from the internet. The study concluded that tool access alone did not ensure the use of library makerspaces for creative endeavors, pointing to the need for research on the role of the librarian as a learning facilitator [3] and on what actually happens in these spaces [2].

Distinctions between learning theory and practice were also apparent in the study by Willett [4], which first interviewed and then observed librarians from different libraries participating in the same maker project. In the interviews, their references to the project emphasized terms such as "learning by doing", "exploratory", "experiential", "playful" and "hands on", suggesting constructionist perspectives on learning [4]. Observations of the science education project for children on circuitry, however, showed the librarians used of a combination of formal styles of teaching, such as showing the basic, and self-driven explorations. Willet concluded that there is a mismatch between what librarians think they do, and the actual pedagogy practiced. This finding is in keeping with previous research on informal makerspaces, which shows widely diverse practices [11]. Building on these findings, this study focuses on what children, teachers and librarians do in a making activity, considering the particularities of the public library setting.

3. Analytic Concepts

3.1. Imagination, Creativity and Inventing

Sociocultural approaches entail the study of how ideal and material tools mediate human activity [12]; in this case, how library educators and children use semiotic means to imagine, create and make meaning of their actions and what they produce "as inventing". For the purposes of this study, creativity is defined as "whenever a person imagines, combines, alters, and creates something new" ([13], p. 10). Further, imagination is understood as a dynamic and mediated process [14] that may be "triggered" by curiosity, interest and the sociomaterial features of a particular setting [15–17]. A generally accepted definition of interest is a liking, preference, or engagement with content in a context, at a specific point in time, both individually and in groups [17,18]. Examples of sociomaterial features that may trigger interest include objects, texts, interactions, talk or even sounds. Any kind of recorded or synthesized sound, for example, may trigger an imagination space to explore symbolic or conceptual relationships [19]. To explain how different kinds of resources become blended with concepts, such as "inventing", Hutchins [20] proposed the notion of "imaginary material anchors", whereby the imagination is mediated by cultural forms (e.g., materials, gestures and social interactions) during ongoing activity [20]. We draw on these concepts to analyze how features of the library makerspace mediate the children's imagining processes and their creative collaborative work as "inventors".

3.2. Framing

Organized as a school field trip to a library makerspace, both formal and informal learning practices intersect in the inventor course [21]. Accordingly, different institutional practices—in schools and in public libraries—play a role in how the participants frame the activity; that is, how the activity makes sense for the participants and the consequences this has for their participation. For Goffman, "frames" is a concept for understanding how activities and actions are organized and possibly structure people's interpretations and perceptions of them [22]. Framing describes a process that helps people understand what is going on in a situation by organizing experiences into meaningful units, which, in this case, are defined by the library as part of an inventing activity.

In informal learning research, framing has been a useful concept for studying children and young people's meaning making in exhibitions, workshops, and creative activities in science, history and art museums [23,24]. In these settings, children may break frames that educators introduce; for example,

when determining whether to approach an activity as "educational" or not, or whether an object is an "invention" or not. As in the inventor course, which straddles formal and informal learning contexts, a lamination of frames may exist simultaneously [22]. Lamination refers to how different frames overlap and intersect in interaction. In such situations, one participant may take on a "definer" role, rendering one action "out of frame" and another a "proper frame". An outermost frame determines the status of frames. In this case, the outermost frame tells the participants that what is happening is inventing, during a school visit to the library. Violations of expected behavior in a situation may be rejected as inappropriate, or be perceived as confusing, and participants may become uncertain as to the applicable rules. In the context of "making," organized as a school trip to the library, expectations may be unclear for the students, and we use the concept of framing to analyze the frames participants perform in their efforts to figure out what the rules are. Importantly, negotiations of what constitutes a relevant frame are not necessarily performed verbally; framing may be negotiated tacitly, through ways of doing things and the habitual practices each participant brings to the situation [22]. Frames are also rhetorical tools in negotiations, where verbal and embodied means represent different opportunities for persuasion [25]. This study draws on the concept of framing to explore how established practices by librarians in this branch of the library—habituated frames—are made relevant during the inventor course activities, as well as how students frame their own activities. Storytelling, for example, is a frame that was noted during ethnographic observations of the librarians' educational practices, apart from the inventor course. In the analytical approach, we were thus sensitive to the use of narrative as a way of framing the activity. We analyze how participants use narratives to construe frames that function as resources for meaning making. Bruner suggests that the interpretative quality of narrative meaning making allows for negotiating our understanding of the world [26]. Together, these concepts constitute the analytical framework for our investigation of how participants "do inventing" in a library makerspace.

4. Data Collection, Methods and Analytic Approach

The research design was focused on collecting data for the analysis of participants' verbal, embodied and collaborative interactions during a two-hour making activity, an "inventor" course in a public library in Oslo, Norway [27,28]. To capture participants' interactions, video recordings, supplemented by ethnographic notes [29], were made of five school classes from four different schools that had registered for the course. Ethnographic notes from approximately 34 h of participant observation inform the study, but the video recordings serve as primary data for this analysis. The participants were between ten and twelve years old, the library's recommended age group. The selection of groups for filming was made by the respective class teachers, based on the students' submission of formal parental consent forms that had been supplied by the researchers prior to the visit. In sum, ten groups of three to four children were filmed over a period of several months in 2018 and 2019, about 20 h of video recordings.

The analysis first sorted video recordings from all groups according to the structure and sequence of the course acitivites, accompanied by detailed notes on interactions within each group during each sequence. Through this process of structuring the data, patterns, regularities and "breaks" in interactions within and across groups became visible [30]. Patterns in the collaborative flow of student groups, in their use of materials, and in types of teacher facilitation, are examples of distinguishable features from each phase of the activity. For this study, which has a research focus on how the task of being an inventor was communicated, facilitated and enacted using the resources in this particular makerspace context, it was decided to follow the trajectory of a group of three ten-year-old boys as a case study [30]. The selection of the group was also informed by a research interest in the educational role of the librarians and their professional knowledge practices.

These children attended the course with their class, their teacher and two teacher assistants. Two librarians were present, one with main responsibility for the activity and the other in an assistant role. Librarians in this library alternated in teaching the course. On this day, the participating librarians

were from the children's literature department, defined as the "storyteller's division" in policy and practice. The two librarians most frequently teaching the inventor course had a background as professional storytellers, although the librarian in charge on this day did not.

Recordings of the group's interactions during instruction, inventing, and presentation activities were transcribed in full length, attending to the boys' talk, bodily orientations, gestures and use of materials. Concepts were tentatively introduced after the first round of data selection, including the general idea of framing as an analytical perspective [22]. Four extracts were then selected as episodes for detailed analysis. The interaction analysis method, as well as procedures for selecting and transcribing extracts and episodes, are adopted from approaches established by Jordan and Henderson, and Goodwin [28,31].

5. Analysis

5.1. Description of the Activity

This city library provides a makerspace for their visitors, with one open makerspace for youth and adults and an annual inventor course offered for primary school children. The course lasts for approximately two hours, with an inventing part that lasts about 40 min. The course has a fixed design, organized in five consecutive parts. First, there is orchestrated dialogue on the topic of inventions. This session can be described as a teacher-led, whole-class question and answer dialogue. Kira (pseudonym), the librarian in charge of the course, introduced the course with a question directed to the children, "what does invention mean?" Following suggestions by the children, Kira read a definition of invention from a Norwegian encyclopedia that was also shown on a slide presentation at the front of the room (Figure 1). The following definition was given: "Invention. A Practical solution of a technical problem using natural materials and or energy. The invention may be a product or process." The children were asked to suggest inventions they know about, and a standard question followed every suggestion: "what kind of problem do you think this invention has solved?" This was repeated throughout the dialogue session; every invention has a connected problem. Usually, the librarians have prepared a story about a Norwegian invention and on this day, Kira told the children about a brewer who had a problem of having enough bottles and invented the principle of bottle return. Second, an informative introduction to how Little Bits works is shown on the screen, along with examples. Kira pointed to different colors and explained their different functions. The section concludes with a video provided by the Little Bits company, showing three products made with Little Bits: a spin roller, a drawing machine and a walking paper figurine. Third, an instruction session guides the children in how to make an electrical circuit from a selection of Little Bits. The session was led by Kira, and the children were expected to try one piece at a time in concert with her. The bits introduced in the whole-class instruction are a battery, a lightbulb, a temperature sensor, a fan, an on/off switch, wheels and a motor-driven wheel axle. Fourth, the main inventing task takes place and the children are expected to invent something using Little Bits. The task is formulated on the screen: "Make your own invention in groups. The invention should solve a problem. The invention should have a name." The resources provided for each group are a large box of Little Bits and arts and crafts materials: paper cups and plates, feathers, tape, scissors and tissue paper. The crafts materials are handed out at the start of inventor section. Both teachers and librarians facilitate the children's work during the inventing task, but the group in this case is left alone for long periods. Finally, the fifth part is group presentations in front of the class, with the librarian orchestrating the session. The episodes below are extracted from transcripts of the last three parts: instruction, inventing task and group presentation.

Figure 1. Makerspace setting for inventor course, with librarian standing.

5.2. Episode 1. Instruction Session: Playing 'off Task'

The children were told to find a light bulb from the Little Bits box and follow the librarian's instructions on the screen at the front of the room. Abdi had just picked up a battery and Rufus and Abdi quickly mount the light bulb to the battery. Then Abdi picks up a piece from the box that is not included in the task instruction and Rufus asks him to stop, insisting on following the rules and working on the official task. Abdi listens to him and puts the piece back in the box. Rufus picks up the piece discarded by Abdi only a few seconds earlier and from this point on their activity changes (Table 1). They follow the librarian's instructions while also exploring the pieces in the box.

Table 1. Excerpt of dialogue: Playing off task.

1.	Rufus:	(grabbing a piece from box. turning it around) what is this
2.	Kalle:	(bowing forward towards piece) sound distorter
3.	Rufus:	so if we place it (reaching for the piece in direction of the circuit)
4.	Abdi:	(reaching out hand. touches the piece while Rufus is holding it)
5.	Rufus:	(putting back piece)
6.	Abdi:	(picking up the same piece from the box) it says plus
7.	Rufus:	yeah, it shows where you should place it
8.	Abdi:	(placing piece in circuit) biiiiiiip (jumps back, looking at Rufus, smiling, both hands on circuit)
9.	Kalle:	(opens mouth, leaning over table, looking at circuit)
10.	Rufus:	(touches circuit, smiles)
11.	Abdi:	it made a sound (smiling, looking toward teacher)
12.	Kalle:	can I try (puts finger in mouth, smiling, looks at circuit)
13.	Rufus:	(takes a piece from box, aligns it with circuit, puts it back)
14.	Abdi:	(takes switch piece from box, puts it at end of circuit. no light, switches places for the pieces, holding circuit with both hands)
15.	Rufus:	(pushes button, lights up)
16	Kalle:	(index finger points to circuit close to it on the table) cool cool we must have it we must have it. we can make Morse from it we can make Morse from it
17.	Rufus:	yeah (tapping index finger on table)
18.	Kalle:	we can Morse code
19.	Rufus:	we can make Morse from it

Rufus finds a random bit and asks, "what is this?" (1). Kalle, who had attended a similar course with his friend and mother, knows the function of the bit and says the piece is a sound distorter (2). Rufus places the bit back into the box (3), but Abdi picks it up again (6) saying the bit has a plus sign on it. Rufus concludes the plus sign is showing where to place the bit (7). Abdi places the bit into the circuit, and the sound distorter reacts immediately. The sound makes him jump in his chair, and he smiles in the direction of Rufus (8). Kalle's reaction is to lean his torso closer to the circuit, and his

mouth is wide open (9). Rufus reacts by touching the circuit and smiles (10). "It made a sound", Abdi says, and he looks in the direction of one of the teachers (11). Then Kalle asks to try the circuit (12), but none of the boys respond to his request. Abdi continues to explore the bits. He takes a switch piece from the box and mounts it to the end of the circuit. Nothing happens this time. Then he switches the places of two of the bits in the circuit (14). Now, when Rufus pushes the button, the bulb emits a rhythmic flashing (15). Kalle raises his voice the moment the button shows the potential of turning the light on and off, repeating each utterance: "cool cool, we have to use this, we have to use this. We can make a Morse code out of it, we can make a Morse code out of it" (16). Rufus confirms the idea with a "yes" and a rhythmic tapping on the table with his index finger (17). Kalle elaborates that they could make codes with the Morse code (18), and Rufus acknowledges that, repeating that they can make a Morse code (19).

Laminating Frames

There is a conflict in the beginning of this excerpt in terms of how two of the boys frame the activity. The task instructs them to follow a procedure but Abdi chooses to explore, picking up a piece in the box. Rufus disagrees with Abdi's frame breaking at first, but then follows Abdi's example only seconds later. In the ensuing collaboration, we witness how a lamination of frames is performed [22]. Abdi and Rufus continue to explore the Little Bits as a sidetrack to ongoing instruction, challenging the frame established by the course pedagogy. Instead, the activity has an inventing as exploration frame. To start tinkering and exploring with the bits and pieces is unproblematic for the children. We might also argue that it is not particularly surprising that they want to explore things that are laid out before them immediately, rather than waiting for the educator to tell them when to do what. They take out the pieces as instructed, but also many more, and they put them together in different ways to see how the pieces work at a tempo much faster than the instruction. Their dialogue is often non-verbal; for example, when Rufus touches the button and the light turns on and off. The touching of pieces defines what their dialogue is about, that is, their touching has a rhetorical function during their exploring activity [20,25].

Sound becomes a material anchor for Kalle's imagination when he suggests that the button functions as a Morse code, and a third frame for the activity is introduced. There are two interesting aspects of this event. First, it shows that their activity is about following instructions, exploring Little Bits, and about making an invention—an inventing as invention frame. The exploring frame established in the group is now oriented toward searching for ideas for what the pieces might be, as if they were making a real invention. This is a role Kalle assumes during the entire session, and the excerpt above is a typical example of this frame. His suggestions for what the Little Bits might be align with the whole class dialogue about invention, where the focus is on invention as a product and the stories connected to these products.

Zooming in, a second interesting aspect of this excerpt is the process by which a new idea emerged. Through play with the multimodal Little Bits pieces, the sound and light triggered an imagination space [19]. The sudden squeaky sound and rhythmic flashes of light appeared when Rufus turned the switch on and off and these modalities triggered Kalle's associations with Morse code; the pieces assumed new semantic and referential properties and the materials were re-contextualized from Little Bits pieces to a Morse code signal system. Moreover, this imagination space could be further developed and shared by all the participants. Although their talk may not indicate that Rufus, Abdi and Kalle are collaborating while exploring, they nonetheless occupy this shared imagination space. Their engagement is signaled through signs of emotions, such as gazing and smiling towards the teacher; shows of surprise, such as open mouths and repeating each other's utterances in verbal and gestural modes (tapping finger on table in a Morse-code rhythm); and shouts of joy when accidentally discovering that they could make Morse code, underscoring the important role of interest and emotion in triggering imagination and creative processes [17,18].

5.3. Episode 2. Inventing Task: What Counts as an Invention

The next two excerpts take place during the inventing task. Earlier, when Kira led a whole-class discussion on what constitutes an invention, two points were emphasized: an invention is something new and an invention solves a practical problem. Kira explained this using a narrative about a car: "Why do we need a car? Because we need to move heavy things from one side to the other—from IKEA to the house. Suddenly you have a car, and the problem is solved." The excerpt below starts as the boys are discussing what qualities an invention should have (Table 2).

Table 2. Excerpt of dialogue: What Counts as an Invention.

1.	Kalle:	we can't make sound because that is already invented (flat hand in front of Rufus)
2.	Rufus:	no but we can try to make a: a new type ↑ of Morse code (gazing up and away from Kalle)
3.	Kira:	then let's say you have forty minutes to work
4.	Kalle:	hhh so little time (turning head rapidly towards Rufus)
5.	Rufus:	ka—(taking a piece from the box) I want to make something first (takes cord with battery from Abdi's hand as they are holding the fan together. attaches a piece to the cord, takes it off again) then we need this (takes another piece from the box and attaches it to the end of the fan) like that↑ (attaching a piece) like that
6.	Kalle:	why can't we make something that serves (hands folded at the table)
7.	Rufus:	biip biip bipbiiiip (pushes the button on the buzzer piece he attached to the end of the fan, leans back smiling and places his hands on the table. Abdi is holding at the other end)

Kalle starts out by stating that they must invent something other than sound because sound is already invented (1). Rufus argues that while they cannot invent sound, they can try making a new type of Morse code (2). At this point, Kira informs the whole class about the limit of forty minutes for the inventor task, and Kalle reacts with rapid breathing to show that this is too little time (4). In the next line (5), Rufus takes a piece from the Little Bits box. He says he wants to make something first, taking the battery from Abdi's hand. Abdi continues to hold the circuit together with Rufus while Rufus tries to attach one piece after the other (Figure 2). Kalle watches while keeping his hands on the table, suggesting making something that "serves" (6). Rufus responds by pushing the button on the pieces he just assembled, demonstrating the beep with a smile (7).

Negotiating Inventing as Invention

Episode 2 shows how Rufus and Kalle have different ideas about what it means to invent something. Kalle states that an invention must be something completely new, something that does not exist here and now. Rufus, on the other hand, argues that working further on something that already exists, like the Morse code, counts as an invention if they find a new tweak on it. Understanding an invention as something never seen before seems to hinder Kalle's imagination process, as does the challenge of working with Little Bits as an imaginary material anchor [20]. In other words, it seems difficult for Kalle to reconcile the idea of a new invention with the material imagination space in which they are working [19]. Following the inventing as invention frame, he then suggests making something that "serves", expanding the imagination space with a new idea. This idea is connected to the cups and plates and other materials on the table and is thus triggered by materials in the same way as the Morse code invention. However, his idea and argument about the need for something new is ignored by Abdi and Rufus. One reason may be that the two boys are engaged in different modes of communication during this interaction [25]. Kalle uses a verbal mode to argue his understanding of an invention as something "new", and this seems to keep him from participating in the inventing process going on. His suggestion is disconnected from the mode of practical experimentation with physical objects that Rufus and Abdi are engaged in, the activity of making, and he is thus outside the material imagination space they share [19]. Further, his verbal approach has consequences for the impact of his rhetorical argument [25], as the materials Kalle refers to are not yet activated within this space.

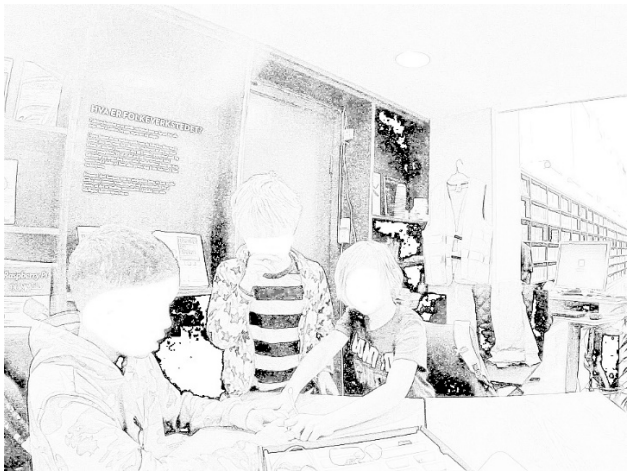

Figure 2. Group of boys collaborating on inventing.

5.4. Episode 3. Inventing Task: Identifying a Problem

The inventing task asks the children to define a real-world problem to solve with an invention made of Little Bits and crafts materials. However, finding a problem that their invention can solve is a difficult task for the children to solve on their own. In many ways this activity is similar to doing school, where the focus is on making something that can be assessed. This contrasts with the maker ethos which is more focused on creative exploration. Having said that, as we demonstrated above, the institutional framing does not determine what the children do and how. During iterations of their invention, the Morse code idea has grown into a platform containing several elements. These include a paper cup with a fan at the bottom that provides an air substitute in case of poisonous air; a temperature sensor and a lightbulb with no explanation of their function; and the Morse code signaler. The boys are tapping into ideas for possible problems their invention could solve, but why and when one might need a Morse code signaler or an alternative air supply has not yet been discussed. In this excerpt, Merete (class teacher) has just arrived at the table to talk to the group (Table 3).

Table 3. Excerpt of dialogue: Identifying a Problem.

1.	Merete:	what have you guys made? (walking towards the end of the table)
2.	Kalle:	Morse code (gazing towards teacher)
3.	Rufus:	(looks toward teacher, smiling, and shifts his gaze the circuit)
4.	Merete:	what ↑
5.	Kalle:	a Morse code thing (pointing towards the circuit)
6.	Merete:	a Morse code thing ↑
7.	Rufus:	(pushing the button) biiip biiiiip
8.	Merete:	okay (1.) but when do you use a Morse code ↑
9.	Rufus:	when you are at sea and need emergency

In this excerpt, the teacher asks the boys what they have made (1) and Kalle responds that they have made a Morse code (2). Rufus smiles and looks at Merete and then shifts his gaze toward the circuit (3). Merete does not recognize what is said (4) and Kalle nearly repeats his first answer, but now says "a Morse-code-thing" (5). Merete repeats this with a high intonation in her voice (6), while Rufus is pushing the button (7). Then Merete asks them when one might need a Morse-code-thing (8), and Rufus answers, "when you are at sea and need emergency".

Problem Solving Backwards: Narrating Inventions

The excerpt shows an attempt by the teacher to introduce a narrative frame that can facilitate the group's thinking about how what they have made is related to a problem that needs solving. The boys

do not participate in adult "real world" practices, and do not have such problems to solve. What they have are many possible solutions from which a problem must be derived. The teacher helps the boys tap into possible real-world problems by introducing a narrative frame, shifting from problem solving to storytelling. She asks them to imagine when Morse code might be used. This question invites answers about the objectives of a potential user of Morse code, a possible cause for the need of such a tool, and what obstacles the user may be facing. Rufus answers that the place might be the sea and the need is unspecified emergency. This episode describes the invention through dramatization, in the same way as the librarian when telling the story of the brewer in the introduction. However, the teacher does not elaborate further on their narrative. Except for a name, the story contains what is required from the task: a problem and an invention that solves the problem.

As the time for group presentations approaches, Kira reminds the children to find a name for their inventions. She underscores that there is no need to stress about finishing—it is the idea that counts. The boys have called the invention different names during this last period of making: *Emergency Situation*, *Emergency Situations*, *Save*, *The Emergency Situation*, *Emergency Sit*, *Emergency Sit Where You Are*, *Rescue Spaceship*, *Wall Machine*, *Rescue Rescue*, and *Problem Problem.* When the time runs out, the three boys are first to present.

5.5. Episode 4. Presentation: Kira Gives The Rescuer a Dramatic Role

The last part of the program for the inventor course has the groups present their inventions to the class (Table 4). The three boys stand at the end of the table: Rufus in the middle, Abdi to his left and Kalle behind the two. The rest of the class serve as an audience from their respective places in the room. Kira oversees the presentation session and starts the conversation. The teacher, Merete, also comments during the session.

Table 4. Excerpt of dialogue: Kira Gives the Rescuer a Dramatic Role.

1.	Kira:	what's the name of your invention
2.	Abdi:	the rescuer
3.	Kalle:	e:h the rescuer
4.	Rufus:	the rescuer
5.	Kira:	the rescuer (1.) the rescuer and who or what do the rescuer rescue
6.	Rufus:	e:h (looking at the rescuer)
7.	Kira:	what kind of problem does it solve
8.	Rufus:	many
9.	Kira:	many problems
10.	Rufus:	because when you turn it on (turns on the invention and looks toward Kira) then it is (.) if it is a place with poisonous air
11.	Kira:	right
12.	Rufus:	and then you can (lifting paper cup) rinse the air with this (puts cup down again and continues to look at the rescuer)
13.	Kira:	right
14.	Rufus:	and (pointing at the rescuer) here (.) this is a temperature sensor (.) this one (moving slider button back and forth) vir (.) makes the sound also (pushing button) piippiip here it is (piiip) sound
15.	Merete:	what did you call the sound earlier today Rufus
16.	Rufus:	(leans away from the rescuer at the table, looks up) I don't remember
17.	Merete:	a code
18.	Rufus:	(looking at Abdi and Kalle)
19.	Kalle:	the Morse code
20.	Merete:	Morse code is what you called it earlier
21.	Kira:	a:h exactly
22.	Rufus:	biiip biiiip (pushing button)
23.	Kira:	fantastic (.) I think something like this would fit researchers working with volcanos (1.) then the air is poisonous (.) so one can e:h rinse the air there and measure temperature and it shouldn´t be too hot to come close to the volcano (.) and then one could if it is necessary call for help then one can use Morse code (1.) I am sending a message help (1.) great the rescuer (1) thanks to the rescuer (clapping)

This episode shows the librarian opening the presentation by asking for the name of the invention, and the three boys answer, "The Rescuer" (1–4). Kira confirms the name twice and continues by asking who or what the rescuer is rescuing (5). Rufus is silent, looking at The Rescuer, and Kira reformulates by asking what kind of problem the rescuer solves (6–7). Rufus answers that The Rescuer solves many problems and Kira repeats this (8–9). Rufus explains that when turned on, The Rescuer will rinse poisonous air, lifting the fan-cup and turning on the machine (10–12). Kira confirms his explanation, and Rufus continues to explain that The Rescuer also includes a temperature sensor and a sound, demonstrating this by touching the sensor and sliding the button to make the machine beep (13–14). The teacher intervenes, asking for the name of the sound and reminding Rufus that he had referred to it earlier (15). However, when Rufus says that he cannot remember (16), the teacher prompts him by saying it was something with the word code (17). Rufus turns around to look at Abdi and Kalle, and Kalle says Morse code (18–19). Merete confirms, saying that Morse code was what Rufus had mentioned (20). Kira says "a: h", confirming that she understands the idea of the Morse code (21). Rufus replies by pushing the button (22). Kira uses the word "fantastic" about the invention, and then she suggests an alternative use of The Rescuer: it can be used by volcano researchers who need tools to measure temperature, rinse the air from poison and signal in Morse code in case of emergency (23).

Implicit Expectations of Storytelling

This episode shows how the task is linked with implicit expectations connected to the practice of telling stories, and how a narrative frame invites a certain casting, or emplotment, for stories about inventions [22]. Kira opens the presentation by following the expectations stated in the task, asking for the name of the invention. When the boys answer "The Rescuer", Kira asks questions about who or what The Rescuer is rescuing. Who are the characters in the story about The Rescuer and what is happening; what is the plot? None of the boys respond to this question, but Rufus explains that the problem is poisonous air and that the invention will clean the air if you are in a place where the air is poisoned. This is a problem the boys came up with during their making activity, after having mounted a fan in the bottom of a cup. As such, the problem of poisonous air and their solution addresses the task presented to the children; they have a problem, an invention to solve the problem, and a name for the invention. However, this episode shows that what is implicitly expected from the children is a story about the problem and how it was solved, in a manner not unlike everyday practices of telling stories [22].

During their presentation, Kira asks questions that guide them toward a coherent story about The Rescuer. When Rufus says that The Rescuer will clean the air if you are in a place where the air is poisoned, the story is still incomplete, not least because The Rescuer has many functions and only one has been explained. The character using the fan-cup is "you", having experienced the poisoned air, but it could also be me or someone else. The place is loosely defined as "a place" where the air is poisoned, and a cause is missing. However, a plot is emerging. We have a consequence, poisoned air, but its cause is unclear. Kira elaborates on the consequence in the plot by introducing volcanoes as a cause for the poisonous air, and she also suggests characters. The Rescuer is imagined to be used by volcano researchers and in the plot they experience poisonous air and extreme heat that will potentially lead to a crisis. The researchers need the tool invented by the boys; the temperature sensor helps the researchers avoid the heat and the fan helps rinse the air. In case of a breakdown, the Morse code device will be of good use. In this episode, The Rescuer has been given a central role in a drama featuring researchers as the main characters. The story establishes a place, characters and a dramatic plot. In this narrative, the characters are adults with high expertise within a profession.

6. Discussion

The research questions for this study ask how children and educators frame the practice of "making" in libraries, and in which ways the library setting may distinguish this makerspace context. We also wanted to understand the resources children draw on to creatively collaborate in an inventor

course offered by the library. We explored these questions from a sociocultural lens, using Goffman's concept of framing [22]. By focusing on the trajectory of one group of children during the inventor course, we identified frames that the children and the library educators used to make sense of the overall frame of inventing. In the introductory part of the course, the children were not presented with a model of how inventors actually work. Rather, the library educator talked about inventing in terms of an invention, a finished product. We term this frame inventing as invention, a narrative about what has been made and not the process of making. The frame inventing as invention suggests that a process of design follows a linear structure, starting with ideas and ending in a re-presented material form [32]. This frame is typical of schooling where students are required to present a product for evaluation. We found that when following instructions, the boys in the group initially struggled to align their approaches with creative collaboration. This changed through a playful, exploratory approach to the materials, which we called an inventing as exploration frame. This frame is similar to the tinkering concept [11], but emphasizes the social, multisensory and affective aspects of exploring materials [17,18]. Moreover, we found that the multimodal properties of Little Bits triggered the children's interest and imagination, fostering the creative process. The inventing as exploration frame was driven toward ideas because of surprising sensory triggers evoked through play with the materials, which served as anchors for their imagination [17,18,20]. On a more aggregated level, we find the overall frame of inventing in this activity unclear [22], which may be one reason "doing inventing" was framed in such diverse ways. Furthermore, when children are trying to decode expectations of behavior in institutional practices of making, a dominant frame may be given more rhetorical power [25].

However, looking at the pedagogical value of different frames, we also identified the library educator's use of a narrative frame and its significance as a resource for the children in the making activity, using storytelling as a didactic approach to help them make sense of their inventions. Storytelling is part of everyday practice in the library and an established way of engaging in dialogue with children. According to Bruner, narratives are fundamental to human learning and have great pedagogical potential as a meaning-making tool [26]. There was an implicit expectation that the children in the course would present their inventions in the form of a coherent narrative, emphasizing the rhetorical power of storytelling as a skill to be mastered and perhaps more important than the actual making process and product [25]. In this case, the library educator's story about the group's invention illustrated for the children how narrative could be used to make sense of inventing activities as connected to solutions for real world problems. However, this pedagogical approach to storytelling also reflects the librarian's power to shape the narrative of the children's work from an adult perspective. Purposefully eliciting narratives from children that are related to problems closer to their worlds would likely resonate more powerfully, fostering a sense of ownership and identities among children as problem solvers. In this sense, although situated at a micro level of interaction, this study also looks upstream to connect to DIY rationales for library makerspaces based on notions of empowerment [3] and participation in cultural change.

7. Conclusions

We identified three different frames in the inventor course: the invention frame, exploration frame and narrative frame. These frames may appear in different constellations and have different outcomes for children. Whether they are seen as productive or not must be assessed in relation to what the participants want to achieve—including the institutional goals structuring the activity. Even though the course was situated in a library setting, it had school-like features. There might be several reasons for this, one being that the educational programs need to be seen as relevant to schools, and, by the same token, that the library needs to pay careful attention to curricular goals and objectives. Having said that, an interesting feature of the activity we observed concerns how library educators are able to draw on their storytelling expertise to support the children's meaning making.

To conclude, we propose the fruitfulness of using frames as a theoretical lens for studying making in institutional settings such as the library. This approach enables examining in detail how participants

understand what is going on, which frames become dominant resources for sense–making, and how opportunities appear for children to exert agency and pursue lines of action that go against dominant institutional frames. We mentioned in the introduction that an important rationale for the public library is to offer access to making for all children and young people. While this library also had an open makerspace for people to pursue their projects, the inventor course was targeted at schools, to provide activities that children do not necessarily have access to in a school setting. However, as we have demonstrated, there is a risk that such activities may become too much like school and that the creative and exploratory characteristics of the maker mindset may become lost. From a social equity perspective, it is crucial that public institutions like the library offer opportunities for imagining through creative exploration, with materials that young people may not have access to at home. How libraries might become places for such activities is still in the making.

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ARTICLE II

II

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Chapter 14

I hate little bits

The collaborative construction of children's creative making in a public library makerspace

Gro Skåland

Situating the case

The value of creativity and collaboration is increasingly emphasised in public library policies, and the maker movement has found a home in libraries as part of this change (Lakind et al., 2019). In 2021, the Norway Makers counted eight Norwegian public libraries offering makerspaces for their visitors (Norway Makers, 2021), and 84 makerspaces were registered in schools, museums, libraries, universities, workplaces, and independent start-ups. Norway makers have had a vital role in introducing makerspaces in Norwegian public libraries and museums and in being partners in start-ups and co-producing events. The agenda is to front the Maker Movement towards education, science, politics, and entrepreneurs and align their rationale with national economic objectives.

Despite the interest in making in Norwegian public libraries, the aims and underlying rationales of makerspaces are not clear since makerspaces are not explicitly discussed in policy papers. When producing data for this study, the ruling policy in Norway was in line with an international trend emphasising performative space. Visitors in performative spaces are producers and not consumers of culture (Jochumsen et al., 2017). This policy aligns with the maker ethos – that making democratises STEAM subjects (Science, Technology, Engineering, Art, Math) (Hatch, 2013), by providing a do-it-yourself arena. Democratisation explained in these terms emphasises individual freedom and the opportunity to participate in STEAM fields. At the same time, Nordic education has long traditions for democratic socialisation, emphasising collaboration as education towards democratic habits of mind and building a sense of community at a micro-level (Oftedal-Telhaug et al., 2006). In that respect, the maker ethos, including do-it-with-others (Lakind et al., 2019), reflects a Nordic understanding of democratisation. Moreover, collaboration seems to enhance creativity (Chappell & Craft, 2011; Littleton & Mercer, 2013), making collaborative creativity a vital topic both in terms of democratic socialisation and as a method of creative work. The present study focuses on participation and collective creativity understood as two aspects of democratic socialisation in children's making.

The children in this study participate in a two-hour-long collaborative makerspace-inspired task as part of a school trip to a Norwegian Public Library. The case

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presented follows one primary school student (Frida) in her trajectory between groups and how she authors herself as a maker (Holland, 1998). The children collaborate in finding a problem to solve using a tool called Little Bits, feathers, adhesive tape, wooden sticks, pipe cleaners, and straws (Figure 14.1).

The Little Bits is a circuitry set providing parts with functions such as LED lights, switches, temperature sensors and wheels, and the pieces are easy to click together. The tool is inspired by a constructionist view on learning (Papert, 1993) and is assumed to enhance creativity because the focus on the construction process is inherent in the pedagogy of the tools (Moore & Adair, 2015).

Maker projects for children often afford creative challenges inspired by the design disciplines that usually take a departure in a design problem (Kumpulainen & Kajamaa, 2020). Early design-thinking research described the process of solving design problems as linear and logical (Lawson, 2005), but current research uses the term problem space. A problem space is the iterative exploration of a problem as it changes along with emerging solutions (Cremin et al., 2006). Research focusing on children's design thinking finds that explicit instruction in problem exploration helps children work in similar ways as professional designers and develop collaborative competencies (Hughes et al., 2019; Riikonen et al., 2020). A problem space also seems to be fuller described if many voices contribute (Schultz & Geithner, 2014), and it is, therefore, creative potential in group work.

In a school context, collaboration through verbal dialogue is found to enhance both content-specific learning (Wegerif et al., 1999) and creative outcomes (Chappell & Craft, 2011; Littleton & Mercer, 2013). However, children often work in groups without scaffolding to work effectively, and sometimes even the cleverest children fail on collaborative tasks (Barron, 2003). For that reason, it is essential to know more about how children collaborate. As collaborative work is relational, Barron (2003) finds joint attention to be a necessary factor for collaborative problem-solving. Joint attention makes individual thinking visible for evaluation and reasoning. Furthermore, relating proposals to a shared topic helped

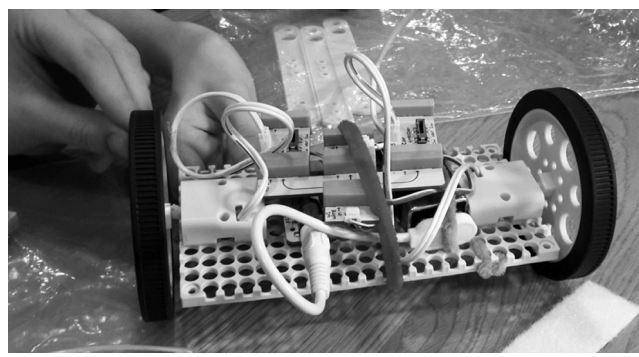

Figure 14.1 The Little Bits set offers a mounting board, wheels, and components easy to click together into circuits for driving motors, light, and sound.

children to avoid polarised debates. Following this line of research with a focus on sharing, Riikonen et al. (2020) have recently found that seventh graders sharing epistemic objects such as a prototype collaborated fruitfully in the making, and the object supported them in staying on task. Moreover, research shows that shared leadership is a condition for the possibility of allowing multiple perspectives to emerge in collaborative making (Leskinen et al., 2020). Groups of children with dominant leaders had more conflicts, few ideas, and asymmetrical opportunities to participate, while groups sharing leadership included multiple ideas inviting for co-construction.

More implicit factors of collaboration in makerspaces have also been under study. Halverson et al. (2018) find that children's innovations distribute across participants because peers replicate each other's inventions and blur ownership (Halverson et al., 2018). The researchers suggest the term collaborative emergence for this type of collaboration.

Another implicit factor concerns the ecology of materials in play. Intentions to engage children in improvisation using computer programs can be overruled by user manuals or task descriptions suggesting procedural and more school-like ways of learning (Kumpulainen & Kajamaa, 2020).

This study builds on these findings, exploring both implicit and group aspects of children's creative collaboration. The following research questions guided the study:

- What role does material play in children's collaborative problem exploration?
- How are children positioned and position themselves as collaborative makers?

Theory

In sociocultural perspectives, problem finding is mediated by cultural and symbolical tools (Vygotsky, 2004). More specifically, material anchors can trigger new ideas (Hutchins, 2005; Skåland et al., 2020), and because making means to change material surroundings, new products may also become anchors for imagination (Hutchins, 2005).

This study focuses on how different ways of collaborating provide diverse opportunities for children to socially position themselves (Holland, 1998) as contributors in creative collaboration. The study defines the social position as interactively achieved and, the position may therefore be contested by the participants as re-positioning (Davies & Harré, 1990). The groups are analysed using two approaches to dialogue in collaborative work; persuasive dialogue and collective pooling.

The art of persuasion means rhetorical argumentation. Uneven distribution of authority is therefore inherent in the persuasive discussion. When one participant increases their authority, the position of their peers will be affected (Engle et al., 2014). That is, this study approaches rhetoric as social dominance rather than rational argumentation, looking at the social negotiation of who is counted as credible contributors to the conversational floor (Engle et al., 2014). According to

Engle et al. (2014), several components interact when access to the conversational floor is negotiated. What counts as a merit of quality may be undue influence based on the social authority and giving more access. A discussant can also come into position through his/her spatial privilege demonstrated by gaze and physical orientation between peers or access to the material.

Collective pooling (Vass et al., 2014) connects to dialogic views on creativity, underscoring the distributed character of creative thinking and authority. In line with our take on persuasive discussions, collective pooling is understood as more than talk, including affective aspects of interaction such as laughter. Vass et al. (2014) explain how participation in collective pooling is grounded in mutual trust, often displayed in laughter and how trust opens for a willingness to explore the unknown with someone else. Collaboration characterised by collective pooling shows as messy interaction dominated by overlaps, interruptions, and speedy exchanges, and ideas are often unrelated, bizarre, meaningless, and intermediate (Vass et al., 2014). Nevertheless, cohesion may still be achieved implicitly in the joint crafting of stepping stones for new ideas or by fusing multiple ideas.

Methods

The research design focused on collecting data for interaction analysis of participants' verbal, embodied and collaborative interactions during a two-hour making activity in a public library in Oslo, Norway (Jordan & Henderson, 1995). Following a sociocultural research tradition, my study considers creativity embedded within these social and material practices (Säljö, 2009). Video recordings of one sequence from an inventor course serve as primary data for this analysis. The presented case is selected from a dataset recording five school classes from four different schools registered for the course. The participants were between 10 and 12 years old, the library's recommended age group. The selection of groups for filming was made by the respective class teachers, based on the students' submission of formal parental consent forms supplied by the researchers prior to the visit. In sum, ten groups of three to four children were filmed over a period of several months in 2018 and 2019, with about 20 hours of video recordings.

Following Susan Leigh Star (2010), interaction standing out as anomalies has been used as a methodological heuristic selecting this case. Anomalies have the potential to reveal social expectations within a practice (Leigh Star, 2010). Changing groups within the regular class structure were one such anomaly that affords a scope into negotiations of creative, collaborative work. After selection, recordings of the two groups were transcribed in total length, attending to talk, bodily orientations, gestures, and use of materials. Further, four episodes were chosen to represent meaningful units of interaction. Concepts were iteratively introduced after the first round of data selection, including the idea of positioning (Engle et al., 2014; Holland, 1998) as an analytic perspective. The narrative presented follows Frida during her trajectory from being positioned as a non-collaborative child in one group and how she re-position as a productive contributor in another.

Analysis

The first group uses a persuasive style of collaborating. Guro, Victoria, Tomas, and Frida approach the task by first agreeing on a problem to solve and then using Little Bits to make an invention that solves this problem. This approach corresponds to the task. In addition to the Little Bits, feathers, straws, tape, paper cups, pipe cleaners, and wooden sticks are on the table, but out of reach for Frida, and the librarian asks them to place the Little Bits box at the centre of the table to ensure access for everyone. With this message, the librarian supports and strengthens Frida's access to the conversational floor, which has both a verbal and a material character in this setting. In the following episode, Frida uses the position given to her through the librarian's support in a persuasive discussion concerning ownership and access to the Little Bits.

Episode 1. Negotiating uneven distribution of authority and position

1. Guro:	where are the buckets (.) victoria did you take these buckets
2. Frida:	((reaches for the ice cups and puts them in front of herself. takes a foam ball from the cup and throws it in the air))
3. Guro:	((takes the cups)) you put it in there ((gazing towards frida))
4. Frida:	no ((gazing towards Guro. continues to throw the ball))
5. Guro:	but it's not yours
6. Frida:	( ) I have to be allowed to (1) and by the way ((leaning towards little bits box)) we have to bring it to the middle (.) ((move feathers, straws and pipe cleaners into the centre)) we have to keep it here ((reaching for the box and lean back again, lifting the wheels)) we at least take something that can dri::ve ((gazing towards Victoria))
7. Victoria:	((smiling, gazing towards Frida))
8. Guro:	Victoria do you have an idea ((gazing towards Victoria))
9. Frida:	((grabbing the box and place it in the middle. looking at Victoria and Guro)) we can keep them he↑re then:::::: ((leaning back throwing the ball again))
10. Victoria:	((turning head away from the group))
11. Tomas:	grabbing a piece from the box
12. Guro:	Victoria do you have any ideas
13. Victoria:	no ((gazing away from the group))

Frida demonstrates access given to her by the librarian. She moves the cups to her side of the table, and in that way, she also strengthens her spatial privilege. Being in control of the material gives her attention from Guro, who is gazing at Frida. However, Guro is restricting Frida's access and authority by opposing Frida to herself. She takes the paper cups back, saying it isn't 'yours', but Frida continues to argue for her access to the Little Bits saying they have to place the Little Bits at the centre of the table. Access to the Little Bits and spatial privilege allow Frida to start a process of anchoring, and she suggests they should make 'something that can drive in any case.

However, access and spatial privilege do not give her authority. None of the participants in the group elaborates on her suggestion, and Guro starts treating Victoria as an authority, asking her if she has any ideas. Hence, although Frida has spatial privilege and access, her social position in the group restricts the value of her merit. Victoria, on her side, determines the spatial privilege of her group as a whole, repeatedly turning her torso and gazing away.

Frida continues to have access to material and spatial privilege in her relation to Guro, and together they are anchoring several ideas from their approximate environment. Among the suggestions stated by Guro and Frida is a drawing robot that can talk, a sound recorder, and a sound recorder on a driving robot. However, Guro repeatedly faces Victoria for confirmation by gaze, and she rejects their ideas by staring at the table. The rejections are accepted, and Frida continues searching for pieces in the Little Bits box. At one point, she is messing around with a LED light bulb, and suddenly Victoria moves her gaze up from the table, stating she has 'an excellent idea'.

Episode 2. Group 1: How a persuasive dialogue positions Frida as opposition and marks her as a non-collaborator

The idea fronted by Victoria anchors in the LED light activated by Frida and the library they are situated in – a book light. Guro immediately takes up the idea, and Frida follows with practical elaborations. However, she continues to demand access to the conversational floor, suggesting merging the book light with the wheels.

1. Frida:	but we can have a rolling book light ((looks at the other two))
2. Victoria:	eh::::: ((gaze towards Guro, then down at the table))
3. Guro:	((gaze towards Frida)) it's a little weird
4. Frida:	no it's going to be cool
5. Guro:	but why can't we have just a regular book li↑ght ((looking sideways at Victoria's hands))
6. Frida:	yes↑ and then we can put wheels on it

7. Victoria:	((gaze down at the table. keeping pipe-cleaner in her hand. persistent))
8. Guro:	((sits down)) okey (.) we can vote then
9. Frida:	so that if you are hyper you can run around while reading and sort of chase it
10. Victoria:	((looks at Tomas)) Tomas↑ shall we have a regular book - ((looks at Frida))
11. Frida:	((bends over the table)) we can make a ( ) toy ↑ (1) with wheels eh: ( ) can chase
12. Victoria:	yes but if it gets hold of it gets a shock (3) so that will not work ((shaking her head looking at Frida. Keeping pipe-cleaner in her hand))
13. Guro:	Tomas↓ (1) do you want kind of regular reading lamp with wheels or without wheels
14. Tomas:	i want wheels ((looking at Guro))
15. Frida:	with wheels ((move gaze from Tomas to Guro and Victoria))
16. Victoria:	okay two against two

This excerpt shows how Frida initiates collective pooling, suggesting merging two unrelated ideas. Victoria rejects her contribution by gazing down, and Guro strengthens Victoria's position by saying Frida's statement 'is weird'. Frida is further positioned as the other side of the debate concerning 'wheels are strange versus wheels are cool'. Her position as an opponent is materialised in the wheels. That is, the polar structure of their debate makes Frida stuck in the wheel argument. At the same time, it is clear that their social position in the group determines the relative importance of their opinions. Victoria is in a position to reject ideas by silently gazing at the table. Frida counters, giving task-specific statements, narrating that chasing the driving book light would solve the problem of 'being hyper and wanting to read simultaneously'. Describing possible problems is a relevant and possibly meriting argument, but Frida's merit is cut off from further elaboration. Frida's argumentation is finally stopped when Guro introduces voting as a second way to come to an agreement.

The vote ends in a tie, and Guro persuades them to play by chance instead. Guro and Victoria end up winning the game, and they start preparing the book light. However, Frida does not abide by the results of the game and states she wants to make an invention of her own. This side-track is evaluated as discoordination by the teacher. He insists on her collaborating with the group in terms of working on the same object. Frida is now positioned as a student in discoordination with the group's way of doing things; namely, consensus defined as the power of the majority. The episode ends with Frida being dismissed because she is not able to collaborate with her group.

Episode 3. Group 2 alters the distribution of authority with humour, and Frida becomes a collaborator

This episode shows how Frida re-positions herself by moving to Group 2. Changing groups would typically be a discoordination bypassed or suppressed in a school setting, but in this case, neither the teacher nor the librarian seems to notice what is happening.

1. Ada:	but you are in their group
2. Frida:	no i don`t care ((looking at Ada og Ida)) so you can exercise while reading (2)
3. Ida:	exercise ↑
4. Frida:	if you like reading and don't have time to exercise you can exercise while you are reading
5. Ida:	((gazing towards Frida)) but how can you do that ((keeps a paper plate in her hand)) wi:th that ((nodding in the direction of the wheel platform))
6. Frida:	you know it drives (1) then you can run after it while you read
7. Ada:	we could make it ((tapping at the wheel platform with a stick)) we don't have anything anyhow so ((palms pointing up)) it's better than nothing
8. Frida:	((looking in the direction of her former group)) yes↑ (1) that's true↑ (2) okay ((grabbing a finished circuit from the table))
9. Ida:	((leaning over the table closer to the central working space and the circuit, gazing towards Frida)) that (1) we tried to make like a light machine but eh: it was a bit defective cause eh:
10. Ada:	hhh ((gazing towards Frida))
11. Ida:	yes (1) we didn't make it work properly and the others made one too ((picking up researchers mic from the table)) here's a microphone so they hear everything we say
12. Ada:	((leaning head towards mic)) i hate little bits
13. Ida:	we said we hate little bits and such (hhh)
14. Frida:	okay but eh:
15. Ada:	okay (1) a driving light what do we need for that then
16. Frida:	I've no idea (2) but eh: we just have to improvise (2) eh: we need light

In this episode, Frida brings a wheeled platform, and in that sense, she is getting access. Her suggestion to 'read while you exercise' is taken up by Ida, who invites further elaboration, saying 'exercise' with a high intonation in her voice. Hence, Frida both has access to material, spatial privilege, and access to the conversational floor. Ida's question also invites Frida into a dialogue without being in defence of the wheels. Frida is lucky with the timing when it comes to changing group. Group 2 is in a state of 'hating' Little Bits, and by questioning the task, they let loose – laughing about their own mistakes and talking to the researcher's camera. Within this scene, Frida is accepted on the premise that 'anything goes because they do not have anything anyhow'. In the moment of giving up – they build mutual trust in a shared joke about their shortcomings and the stupid research project, and at the same time, they even out the distribution of authority. Research does not matter, failing does not matter, and the rules for working in groups at school are broken. Simultaneously, the jokes are directed to Frida by gaze and body, inviting her to share. Frida does not take up the joke immediately, so Ada asks her what they might need for making the wheeled platform, acknowledging Frida as an authority on the subject. However, Frida does not take the role of an expert but invites her fellow participants to improvise. Within this collaborative atmosphere of mutual trust and humour, Frida re-positions herself and becomes a collaborator in the group.

Episode 4. Tata::::! connecting silly things and rejected ideas

In the following episode, the group are pressed for time to actually have an invention to present, and the transcript shows how collective pooling helps them come up with their final invention.

1. Ada:	it's bo:::ring::: ((holding a bit in her hand, looking at it))
2. Ida:	a:::::::::h I'm so tired of this falling apart and I mean it if this doesn't work I give up
3. Frida:	I take scotch tape ((pulling out tape)) lots of scotch tape
4. Ada:	((picking up a straw and a stick and puts the stick into the straw. Then she turns a pipe cleaner around the end of it))
5. Frida:	lo:::k I have scotch ((holding scotch in front of the scratcher and Ida and Frida starts to fasten the fan on to the scratcher))
6. Ada:	((grabs a feather and mount it on the straw under the pipe cleaner)) tata::: ((holding the feather-straw in front of her))
7. Iris:	((smiles and look at the feather-straw)) nice ((walking over to Ada's place))
8. Frida:	((looking at the straw thing)) you can make a eh: yesyesyes↑ ((walking over to Ada, grabs the straw and puts it into one of the holes in the wheel platform)) yes↑ we can have this on and kind of ((bowing over the feather making it tickle under her chin)) so if one's a bit bored so eh:: one can run after

9. Ada:	that one ((pointing at the feather with a stick)) a cat toy for the cat
10. Frida:	yes↑ ((turning towards Ida and Iris)) cat toy↑ we can try to make a cat toy if that one doesn't work ((looking at the scratcher))
11. Ida:	it works
12. Ada:	we can call it the catapult

The group continues collectively pooling material anchors in their subsequent work. Ada modifies a stick by turning a pipe cleaner around the end of it. The pipe cleaner stick emerges in parallel to the driving book-light project, and nobody seems to notice, except Iris, who is picking it up and continuing to modify it, putting the stick into a straw. Because collective pooling is the ruling practice, Frida has time to explore the wheels, and later she finally rejects the wheels on her own initiative. As authority and access are not directly connected with the wheels anymore, leaving the wheels does not reduce Frida's rank as an acknowledged contributor.

This episode is characterised by collective pooling as the situation appears as chaotic and seemingly unrelated unplanned actions. Ada is placing a feather under the pipe cleaner. Then she bursts out: 'tata:::' Her emotional expression connects with Frida, who bursts out 'yesyesyes!' She puts the feather stick into a hole in the wheel platform in front of her, where it fits perfectly. This combination of two products results in a new material anchor for a problem. Frida suggests running after the driving feather in cases when you are bored. Then Ada anchors the feather platform as a toy for the cat and names it The Catapult.

Their work continues, discussing alternative names for the catapult. Frida turns the cat toy on, and it starts to spin around within a small radius. Ida imagines the cat is running after it. Frida continues by anchoring a narrative in the spinning, suggesting the toy moves in small circles because it is for lazy cats. Later, the invention 'Lazy Cats' is presented to the class as a cat toy solving lazy cats' low capacity to run.

Discussion

Analysing this case, I asked what role material plays in children's collaborative problem exploration. Further, I asked how they position and are positioned as collaborative makers. Findings concerning material in joint problem exploration show that material (such as feathers) anchors children's imagination about what kind of meaningful problems they might solve (Hutchins, 2005). Simultaneously, the imaginative process distributes across participants (Halverson et al., 2018) and time. This finding resonates with the collaborative emergence found by Halverson et al. (2018), where inventions wander from child to child and work as an implicit collaboration. In the present case, children activate material anchors for imagination in a similar implicit way. Messing around with the LED, for example, was

essential for the book light to emerge. This finding has implications for what it means to stay on task in collaborative creative work. Seemingly non-collaborative off-task actions seem essential in collective creativity because children take up each other's mess (Vass et al., 2014). This finding invites a continued discussion on what we talk about when we talk about creative collaboration. In this case, messing around together rather than shared attention oriented group dynamics (Barron, 2003; Riikonen et al., 2020) facilitates joint production of anchors for imagination. Further, things made, such as the stick inside a straw, have potential as anchors for children's imagination (Hutchins, 2005) over time. Anchors may be taken up by peers a long time after being created. Hence, this finding has implications for how turn-taking in material conversations is analysed.

Moving on to the design challenge, none of the groups takes departure in a problem. Before reaching a problem, objects are activated in their proximate environment (Hutchins, 2005) and later work as anchors for imagining problems (Skåland et al., 2020). For example, the cat-toy spinning on the floor triggered the story about a lazy cat. And by this, the following problem emerged: how to make lazy cats run. Hence, both groups work within a problem space to some extent, defining problems in concert with emerging solutions (Cremin et al., 2006). However, this task is more open than design tasks usually are. At least a purpose of some kind usually initiates the design, for example, 'how can we improve the quality of life for people living with a chronic illness?' (Sanders & Stappers, 2008). In that regard, findings from this case may align more with participation in informal makerspaces, where there is no pre-defined problem (Sheridan et al., 2014). Hence, approaching problem exploration with an explicit departure in available material and narration may be a suitable way to help children find a meaningful project. However, this study also shows how the social situation in collaborative work may hinder anchor production.

Finally, attention turns to positioning in collaborative making and the opportunities to identify with making emerging within the two groups. Group one was dominated by persuasive discussion. Within the persuasive climate (Engle et al., 2014), the wheels get a symbolic function as the opposition. This situation has two consequences. First, Frida cannot reject the wheels without giving up her position as an acknowledged contributor. Hence, she continues to demand a position in the group by insisting on the wheels. Second, the teacher treats this behaviour as non-collaborative. However, the underlying problem in this group is not Frida's low social competence but the hidden demonstrations of authority fuelling the polar debate. The strongest arguments in this group are based on undue influence (Engle et al., 2014) acted out as embodied signs difficult for outsiders to notice. The social negotiation of participation going on underscores that we cannot take the democratising potential of makerspaces for granted (Lakind et al., 2019). The Little Bits do not themselves spark a creative process, as suggested in previous research (Moore & Adair, 2015) because the social situation must open up to this possibility. We see from this example that Frida is willing to explore and tinker with the wheels, but her position in the persuasive discussion does not allow tinkering. Moreover, situations like this may hinder a child from identifying as a maker

(Holland, 1998), making the makerspace to be a less democratic place. Nordic education has a strong tradition in democratic socialisation that values collaboration and community building (Oftedal-Telhaug et al., 2006). However, as Barron (2003) pointed out in her research, being placed together in groups does not necessarily work out as planned, and the same can be said about the current case. The group that succeeded the most was breaking the institutional rules for collaboration, not following them.

Hence, policy plans for inclusion in library makerspaces need to be followed up by pedagogical practice taking departure in the unique character of collaboration where the dialogue is material. My observations of Frida in group two may inspire future research in that regard. The wheels are not talked about in a debate. When material in action becomes the conversation, multiple opportunities to participate emerge simultaneously and increase creative outcomes. At the same time, findings suggest positioning oneself as a maker might be challenging for children who take the initiative to start material dialogues, as this genre may collide with existing expectations for how group work should be done.

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ARTICLE III

III

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