Sustaining library makerspaces: Perspectives on participation, expertise, and embeddedness

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Abstract

As the novelty of makerspaces in libraries slowly is fading, this study sets out to uncover how participation, expertise and embeddedness in the library organization and surrounding community is sustained in library makerspaces. Based on interviews with makerspace practitioners in thirteen libraries, practices of maintaining, scaling, replicating and evolving library makerspaces are analyzed. The findings propose a variety of practices and tensions concerning sharing of ownership with user communities, scaling and prolonging users’ participation, building expertise by documentation, repetition and sharing, collaborating with local community partners and embedding makerspace practices into existing library practices, resources and values. The results inform a discussion of participation, expertise and embeddedness that is distilled into three guiding principles that can help libraries reflect and address the sustainability of their makerspace in the long run.
Introduction

Libraries, among other cultural institutions, have implemented makerspaces for almost a decade now. This development supports that tools such as 3D-printing, laser cutting, electronics and robotics are not only available for technical university students, engineers at private companies or members in closed computer clubs. Instead, citizens with little prior experience can access, use and learn digital fabrication tools and eventually make 'almost anything' (Gershenfeld, 2012). While makerspaces have spread to libraries across the world (Born, Henkel, and Mainka 2018) to support learning (Li and Todd 2019; Halverson, Lakind, and Willett 2017; Bowler and Champagne 2016), attract and serve new groups of users and communities (Slatter and Howard 2013) and keep up with the pace of the times (Slatter and Howard 2013; Willett 2016; Born, Henkel, and Mainka 2018), the novelty is slowly fading. Consequently, makerspace activities do not only emerge. Over time makerspaces turn into routine-based practices and integrated library services that are expected to systematically deliver value to the library, its users and the surrounding community.

Whereas the benefits of library makerspaces are described in prior research, this study sets out to explore the ways library makerspaces sustain practices and benefits beyond implementation, activity design and spatial design. Based on interviews with practitioners in thirteen library makerspaces, this paper examines how participation, expertise and embeddedness in the library and the surrounding community are sustained in library makerspaces. In this study, makerspaces are considered as participatory initiatives (Iversen and Dindler 2014) that inform analysis of practices to maintain, scale, replicate and evolve library makerspaces. Participation, expertise and embeddedness is
discussed and distilled into three guiding principles for sustainable library makerspaces.

**Literature review**

**Makerspaces in Libraries**

Historically, libraries have evolved with the given information technologies of their times. Bennet (2009) demonstrates this development by studying library architecture. Originally libraries had modest collections of books while the design centered around reading rooms, offices and lecturing halls. The main principle for design was uniting readers and books. As book collections grew in the 1900s, books replaced the reading rooms, and libraries were increasingly designed as databases for efficient information storage. Currently, as books become digitized and information is superabundant, the library space is increasingly designated for computers, classrooms and cafés. Spaces for meeting, learning and constructing are placed in the heart of libraries to support interactions between diverse people in the community (Audunson 2005) and, ultimately, individual and collaborative learning experiences. The recent re-orientation has been described as a performative turn where users take an active role in contributing to library services through participatory initiatives such as co-creative and user-driven activities (Hvenegaard Rasmussen 2016; Jochumsen, Skot-Hansen, and Hvenegaard Rasmussen 2017).

Makerspaces are one approach to operationalize participatory initiatives in “[…] a center or workplace where like-minded people get together to make things” (Hatch 2014, 13). Makerspaces consist of combinations of tools and guidance for 3D-printing, laser cutting, electronics, woodworking and creative
materials that users can gather around, learn, share experiences and make novel products. Libraries are not the only public institution to implement makerspaces. Schools implement makerspaces to support constructivists and project-based learning (Blikstein 2013; Halverson and Sheridan 2014) and critical reflection on technology (Iversen, Smith, and Dindler 2018). Museums apply makerspaces to engage children and families in construction (Sheridan et al. 2014) and communal adult-oriented makerspaces facilitate a community of practice of experienced users (Sheridan et al. 2014; Dreessen and Schepers 2018; Taylor, Hurley, and Connolly 2016). While the size, shape and position of library makerspaces vary much (Caso and Kuijper 2019), library makerspaces have common objectives. They support the learning of their peers, attract new and diverse users to the library, support and build communities and responds to changing conditions in the library use (Slatter and Howard 2013; Willett 2016; Born, Henkel, and Mainka 2018). Compared to the other makerspaces, library makerspaces do not have a pre-defined target group, but rather serve to provide equitable access to tools and information for users at different ages, experience levels and conditions for participating. Studies of maker activities argue for several qualities. Li and Todd (2019) show that makerspaces can provide youngsters with opportunities for making, acquiring STEM knowledge, building friendships and pursuing their individual interests (Li and Todd 2019). Brady et al. (2014) also show that libraries can conduct accessible learning activities for users that otherwise are neglected in technology-construction. Einarsson and Hertzum (2019) argue that maker activities in libraries support formal educational, non-formal event-based activities and informal uses that have different conditions for learning. For example, formal educational trajectories and event-based activities
scaffold acquisition of technical competence, reflection on content or engagement in the activity. Informal activities, instead, scaffold project-specific and community-oriented objectives that require a great deal of self-directedness from their users.

**Sustaining makerspaces**

While well-designed spaces and activities are important for makerspaces to deliver value, sustainability concerns making benefits and practices durable over time (Poderi and Dittrich 2018). Prior research in library makerspaces have discussed organizational aspects, such as staff competences, organizational embeddedness and community involvement. It is argued that facilitating, learning, adapting, collaborating, making allies, ensuring managerial back-up and re-using existing resources are central skills to be successful employees in a library makerspace (Slatter & Howard 2013; Koh & Abbas 2015). In addition, Oliver (2016) suggests that sustainability concerns strategies to “attract participants, community volunteers and expertise, and donations of supplies and cash” (Oliver 2016, 213). In other words, the prior research reflects that sustaining a makerspace includes a wide range of factors, such as managerial and financial support, staff expertise, user participation and integration in the library and surrounding community.

In participatory design, making benefits of participatory initiatives last has been a challenge since the first projects in the 1970s (Kensing and Greenbaum 2013). Similar to library makerspaces, participatory design is a field that aims to include users in technology design, support mutual learning between participants and empower users to affect technology design (Robertson and Simonsen 2012, 2). In this field, makerspaces are commonly viewed as infrastructures that sustain the participation of a community by situating the
activity of making (Dreessen and Schepers 2018; Seravalli 2012). That denotes a view on participatory processes beyond implementation projects towards the configurations, adaptations and appropriations that take place in practice (Björgvinsson, Ehn, and Hillgren 2012). Iversen and Dindler (2014) propose four ideal types to sustain the benefits and practices of participatory initiatives over time:

- Maintaining: The idea, technology or practice remains stable in the context.
- Scaling: The idea, technology or practice remains but is expanded to new groups or organizations.
- Replicating: The idea, technology or practice is the same but is reused in another setting.
- Evolving: The idea, technology or practice changes or acts as a catalyst for change elsewhere in the context.

Although library makerspaces in many cases are not initiated in a participatory design process, they share similar objectives and practices. For example, by making technology design more accessible, developing citizen capacity to reflect and act on contemporary technology and staging mutual learning processes between the library and its users. For this research, Iversen & Dindler’s (2014) framework is a helpful analytical tool to examine practices and initiatives to sustain participation, build expertise and integrate the makerspace in the library and the surrounding community that can strengthen practices and prolong the benefits in the long run. Practices for sustainability are especially interesting, as it directs focus away from the “disruptive” and “transformational” aspect of library makerspaces that is a tendency in the
common discourse (Willett 2016). Instead, it directs attention to ways that activities in makerspaces transform into everyday operations over time (Bertelsen and Bødker 2003) and integrate into the already existing cultural-historical system of activities (Kuutti 1996; Engström 1987).

**Methods**

This study examines practices for sustaining library makerspaces through the meta-theoretical framework of cultural-historical activity theory (Engström 1987), semi-structured interviews (Blandford 2013) and data analysis of activity systems and sustainable participatory initiatives (Dindler & Iversen 2014).

**Meta-theoretical framework - Cultural-historical activity theory**

Activity theory is a framework to analyze “[..] human practices as developmental processes, both individual and social levels interlinked at the same time” (Kuutti 1996). Activity theory addresses the dialogical process between the individual learning and development, on the one hand, and the social, cultural and historical environment on the other. Activities are object-oriented and tool-mediated actions that are performed in a cultural-historical system of rules, communities and division of labor (Engström 1987). When activities are performed over time, they become less reflective actions and eventually operations (Bertelsen and Bødker 2003; Leontyev 1977). However, as tensions arise, operations are reconsidered and the system of activities adapts (Engström 1987). For this research, cultural-historical activity theory is integrated in interview questions and data analysis that guides attention to two important interlinked aspects; 1) the practitioners work to sustain existing activity systems in their library makerspace, 2) practices and initiatives of integrating the makerspace in existing cultural-historical developed values,
resources and practices in libraries and 3) detect tensions and adaptation that can inform development towards more sustainable models of library makerspaces in the long run.

Data collection

This study builds on data collected through semi-structured interviews (Blandford 2013) in thirteen Danish libraries. Library makerspace practitioners were recruited based on an initial mapping of all library makerspaces in Denmark. In total, twenty-three makerspaces with regular makerspaces were identified. From this list, fifteen makerspaces were invited for an interview. The libraries were purposefully selected (Blandford, Furniss, and Makri 2016) represent diversity in size of the space and geographic location in Denmark. In the invitation to the interview, it was stated that the interview both concerned practices for facilitating activities and organizing the space. Therefore, the interviewed practitioners were experienced in coordinating and facilitating in the makerspace. In addition, to narrow the scope on practices for sustaining library makerspaces, only makerspaces with regular activities and dedicated staff resources were included in the analysis. Two makerspaces were excluded from the analysis, because they did not meet the criteria of having regular activity. All regions in Denmark are represented and span urban, intermediate and rural municipalities.

The library makerspaces included are three small makerspaces, five medium-size spaces and five large-scale makerspaces. Small makerspaces have tools such as electronics stored in lockers, that can be brought out for specific activities. Medium size spaces have dedicated space and more advanced tools such as 3D-printers and a vinyl cutter. Medium-size spaces have a designated area that can be a separate room or an open space in the library. Large
makerspaces have multiple rooms and advanced tools such as laser cutters, CNC-mills and power tools.

The data was gathered through semi-structured interviews (Blandford 2013). Ten interviews were conducted face-to-face in the makerspace and three by phone. In each interview, practitioners were asked about the activity system (Engström 1987) in their makerspace. The interview guide covered background information on practitioners’ experience, development of the makerspace over time, objectives and reasons for the makerspace, division of labor in the space, attachment to local communities and library organization, spatial configurations and tools in the space, rules for accessing and using the tools, activities that take place in the makerspace and who uses it.

[Insert Table 1 here]

Data analysis

All interviews, except L13, were recorded and transcribed. The reason for the exception was a dysfunctional recorder. As compensation, the interview was transcribed during the interview, and the transcription was circulated to and accepted by the participants afterward. All interviews were coded and analyzed in two rounds in Nvivo 12.

In the first round, the data was coded for Engström’s (1987) elements in the activity system. The results mapped the existing activity system for each makerspace into an excel sheet that allowed overview and comparison of activities, objectives, users, rules, community, division of labor, history of development and tensions for each library makerspace. From the initial data analysis, it appeared that makerspaces on a regular basis adapt their practices to sustain or extend users’ participation, practitioners’ expertise and
embeddedness in the library or surrounding community. That insight informed the decision to examine the data material for practices to sustain library makerspaces. In the second round of analysis, the data was coded for the practitioners' efforts to maintain, scale, replicate and evolve (Iversen and Dindler 2014). As the sustainable initiatives are ideal categories, the codes were appropriated for the context of library makerspaces. The final coding guide is presented in Table 2.

[Insert Table 2 here]

**Findings**

In the following, findings from the data analysis is presented. It covers practices of maintaining, scaling, replicating and evolving library makerspaces and tensions regarding sustainability of benefits and practices.

**Maintain**

Maintenance of makerspace is a costly affair. Practitioners in eight of the thirteen makerspaces indicate that their management must not underestimate the costs associated with maintaining the space. One practitioner elaborates: “The machinery is not expensive when first established. The expensive part is the personnel” (Manager, L2). Maintenance practices are time-consuming and includes the day-to-day practical tasks of hosting the space in opening hours, serving coffee and snacks, cleaning the space, planning and facilitating activities, team meetings, servicing machinery and social tasks of welcoming new users and upholding rules in the makerspace.

While practices are similar, the interviewed practitioners approach staffing the makerspace differently, which affects the ownership of the space and integration of expertise in the library organization. Overall, three models for
staffing library makerspaces were discovered with each their strengths and weaknesses:

- Three libraries had hired individuals with prior experience.
- Three libraries operate their spaces with a combination of staff and volunteers.
- Seven libraries have developed competences from a team of staff that represent different sections in the library.

By hiring a designer, engineer or an experienced maker, a library can quickly acquire relevant specialized expertise to manage the space and facilitate activities. On the other hand, the expertise is situated on individuals that are loosely affiliated to the library that can become a threat to maintaining the expertise in the library. One facilitator expressed this honestly: “I don’t work very well for long term operations. Eventually, I will lose interest and then some exciting ‘new shiny thing’ appears that I rather will do” (Facilitator, L12).

In the second model, existing staff from different sections in the library develops the competences to host the makerspace. The benefit is that the expertise is integrated in several sections in the library. The downside, however, is the time and effort it takes to develop expertise and to sustain it: ”If you don’t use it, you forget it. It’s like that with everything but especially with the techniques here” (L8, Coordinator). In addition, in a team, different members are responsible for specific activities or tools, which gives practitioners the opportunity to practice their skills regularly and develop specialized knowledge.
In the third model, engaged users are invited to take part in the day-to-day activities in the space. One makerspace outsourced the technical expertise to the users while the library focused their efforts on supporting the community: “We have spent little time and effort to becoming technically skilled. We facilitate the group, make coffee and serve cookies every time they meet. We call in meetings, buy materials and do everything we can to spoil them.” (L3, Coordinator). As the community holds the technical expertise, the library fills the role of caretaking for the community and does supportive tasks such as organizing meetings, communicate on Facebook and ensure a stock of materials. Inviting users to take part in maintenance work can help to sustain users’ interest and be cost-effective, but it also comes with three obstacles. First, it is a challenge to make users commit to tasks for a prolonged period: “It is about commitment and commitment to what you find interesting today [...] if something else captures their interest they are out. That’s also the case for our super users” (Coordinator, L9). Second, it is expressed in L3 and L5 that it is a fine balance between encouraging users to take part while not pressuring them. It is argued that too high expectations can be at the cost of at participation of the community. Third, expressed in L5 is that community ownership can be at the cost of inclusion of new users “[...] it is really nice that someone takes ownership but not that they feel they own the space [...] We manage and facilitate the space. We set the boundaries” (L5, Facilitator). In other words, the practitioner needs to set rules in the makerspace that reflect the values of openness and inclusion that is important for the library.

In sum, maintenance deals with a central tension to the sustainability. That is between the costs put into the space, the integration of
knowledge and expertise in the library organization and the integration to user communities by involving them in day-to-day activities.

Scale

Makerspaces have in common opening hours, staffing, rules, tools and activities are scaled and de-scaled regularly based on the practitioners’ experiences from conducting activities and interacting with users. The interviews reflect that there are two approaches to scaling the makerspace. The approaches are established in the implementation stages but affect the possibilities for the makerspaces to expand. A coordinator in a medium sized makerspace refers to the approaches as a chicken-egg problem: “This is an ongoing internal discussion we have. We talk a lot about the chicken or the egg. Should we start buying machinery that they [the users] want or should we reach them [the users] first and then acquire the equipment” (Coordinator, L6). In other words, libraries can take a tool-first approach by acquiring machinery and expect that user participation will follow, or an activity-first approach by conducting activities and acquiring machinery after participation is proven.

Five out of six large makerspaces and two of the seven medium or small-sized makerspaces scale tools first. That starts with the dedication of space and procurement of machinery where after practitioners learn to operate the tools, test activities and scaling participation in terms of the user base and establishment of a community. The advantage of scaling tools first is that the makerspaces can offer sufficient space and advanced tools to attract communities of users. The challenges are, first, that not all tools are put into use. For instance, the CNC-mill in three of five spaces that have one have never been used. Second, there is no guarantee that the makerspace will
succeed in developing sufficient participation in the community. That is reflected in the data when five of the makerspaces struggle to reach participation outside structured activities and to develop or attract communities. There are exceptions, such as in L2, that attracted users without much effort and adapted their services for more time for uninstructed use: “We never really understood why. Instead, more and more people began to attend the open makerspace. [...] So instead of ‘Go to tech’ and ‘Tech theme’ [...] We discarded this and had regular opening hours where people from the street could use the technologies with or without help” (Coordinator, L4). It remains, however, a threat to the sustainability if there is an imbalance between the scale of tools in the makerspace, on one hand, and the users’ interest in the tools and practitioners technical and facilitative expertise to instruct use of tools, on the other hand.

An activity-first approach mitigates this issue. Five of the seven small and medium-size makerspaces and one of the six large makerspaces practice an activity-first approach. That means low initial investments in tools. Instead, the space expands gradually by acquiring tools and occupy space in accordance to the needs that appear from activities or proposed by users. For instance, through a series of activities (e.g. lamp production workshop, repair cafés and a festival) for over a year, the coordinator in L7 has established a medium-sized makerspace. It is a value in the makerspace to make most of resource and use materials that are "available at hand" by reusing waste materials with tools such as soldering, sewing and glue. Scaling of tools is then initiated when it is meaningful for a specific activity. A laser cutter was, for example, bought for a collaborative project with the neighboring school: “[...] What makes sense to the students and how can we collaborate
where it makes sense to the teachers, so it doesn’t become laser cutter for the sake of the laser cutter”. (Coordinator, L7). The coordinator in L1, elaborates that the benefit of scaling gradually is that all tools are put into use and experience is built gradually: “In contrast to some other spaces, we have chosen to bring in technology one at a time. We then, master might be a strong word, but become familiar with it and conduct workshops in it before we continue to the next tool.” (Coordinator, L1). Put differently, in an activity-first approach to scaling, the practitioner learns by interacting with a community of users in activities and tools are acquired for specific reasons that allows expertise to be built gradually.

The practices for scaling reflect that participation and needs of the community are difficult to plan and predict. It becomes a concern for sustainability of the space if tools are not aligned with the needs of the community or practitioners’ expertise. While large makerspaces have sufficient space and tools to attract and develop user communities, smaller and more activity-oriented spaces have better conditions for scaling and de-scaling in accordance to the current wishes.

**Replicate**

Replication is important for sustainability in library makerspaces to make most of the experiences developed in the makerspace or by others. In the interviews, it is found that makerspace practitioners seek inspiration and information in online communities, professional networks of library practitioners and by documenting their practices for future use.

The interviewed practitioners mention following several communities on social media sites such as YouTube, Instagram, Facebook, Instructables and
Thingiverse. As one practitioner argues, these platforms are useful sources for inspiration and information on specific problem-solving: "YouTube is the best place for learning when it comes to this. I wouldn’t be able to work here if I was not able to sit down and watch a three-minute video on how to solve this specific problem." (Facilitator, L5). In addition to the vast amounts of information available online, practitioners also attend more focused private Facebook groups for library makerspace practitioners. In these groups, practitioners share knowledge and practices that are more embedded in the library context. To further support domain-specific knowledge sharing, one region hosts quarterly network-meetings for makerspace practitioners that three of the interviewed libraries regularly attended. This network supports the sharing of lessons learned, but as the makerspaces have many objectives in common, it also is a platform to coordinate practices and initiate collaborative projects.

One activity that is shared and reused in this network is the wind tunnel. The wind tunnel is a physical installation with a wind blower that blows air into a cylinder. It supports users learning about aerodynamics by letting users build objects, insert them into the wind tunnel and observe them float in the air or fall to the ground. The coordinator in L6 explains that the wind tunnel is designed to support disassembly and includes instructions for reassembly: “Our wind tunnel can also be separated as well as our car track. It’s easy and mobile. In that way, it can reach our branches” (Coordinator, L6). The wind tunnel is designed to fit into the carrier that transports books between libraries, and thereby the activity can be shared with other libraries. While there are Facebook groups and a website where library makerspaces
share practices, the wind tunnel illustrates an approach to sharing that is material and potentially more accessible for other practitioners.

The interviews covered mostly the breadth of activities in each makerspace but also reflected that each makerspace tend to repeat and specialize in specific activities, be it facilitation of a community, school activities or workshops for families, children, or citizens. The coordinator in L12 explains that by repeating activities, the activity gradually turns into a more stable formats: “I also make these trajectories like a complete package with all the tools and power-point presentations. Then I test them, iterate, correct them, and then run them multiple times. I am running ‘Micro:Bit for adults’ for the fourth time, so it is becoming stable” (Coordinator, L12). His experience is that conducting activities for the first time comes with several challenges and unanswered questions. That can be who will attend, what is challenging for participants to learn and do, what questions will be asked and how long time each step takes. By iterating the material through activity, his PowerPoint presentation reflects his experiences and stores them in time. That contributes to making the activity reusable and shareable.

Replication is about documenting, iterating, and sharing practices that supports development of expertise and sharing of experiences. In relation to sustainability it both helps a space to specialize in certain activities and to make the most of the knowledge and resources available.

**Evolve**

Makerspaces are places that embody change. That is reflected in six of thirteen makerspaces included in this research that are directly linked to other transformations such as new municipal strategies or re-organization and
relocation of the library. In the remaining libraries, makerspaces still reflect a prioritization of space to new types of activities and services for their users, communities and neighboring institutions. One library manager claims that their library is in an ongoing development that “[...] replace books with people” (Library manager, L2). That implies more orientation towards spaces for activity rather than a collection of books.

Already in the sections on scale and replication, we see that practitioners tend to direct and re-direct their activities depending on what makes sense for their users and community at the moment. One practitioner even argues that responsiveness to change is a value in the makerspace: “I think one of my most important points is that the space is never complete. A space like this must always move in some direction. It is about the process. Or put in other words, new people will enter at some point and meet in new ways and have things that they find interesting” (Coordinator, L7). The practitioner argues that the makerspace must have some direction, but also is flexible enough to accustom to new users, their wishes and needs.

The flexibility in the makerspace is perceived by practitioners as an opportunity for the library to foster new collaborations with local partners that attracts new users to the library. That resonates when two makerspaces collaborate with local recycling stations and four mention partnerships with existing local maker communities such as hackerspaces, radio amateurs or train enthusiasts. Seven makerspaces also partner up with formal educational institutions such as schools, high schools or special schools. One practitioner explains that the makerspace has better conditions for partnerships: “It is easier to say ‘Hey we have started something new, maybe we could do something together’. It is easier when you have a blank slate than an almost
the makerspace offers a framework that is considered partially detached from traditional expectations for a library that can be appropriated for institutions or community groups for their specific interest.

However, it is also expressed that building on an existing institution comes with tensions: “The library as an institution is an old institution that needs to get used to that other than the traditional library activities can take place in the library” (Coordinator, L7). To elaborate, the practitioner subtly argues that the makerspace and the library evolve in different paces that causes tensions between established practices and new ones. The tensions are reflected when three practitioners mention challenges of sustaining managerial back-up, three mention resistance or lack of understanding from colleagues, and two argue that the makerspace activities are considered a lower priority than traditional library tasks: “I am still a librarian and I have my shifts. I have all other types of tasks that in fact need to be solved before I start repairing a 3D-printer.” (Facilitator, L11). In sum, tensions between traditional library services and the makerspace add to the concern that makerspaces become “add-ons” to the library instead of an offer that is integrated into existing values, practices and services. Few efforts to integrate traditional library services and makerspace activities were found:

- Using tools in the makerspace (e.g., folie cutter) to decorate the library space.
- Combining existing book-oriented activities with tools in the makerspace.
- Adding tools in the makerspace (e.g., micro:bit) as lending material.
• Mandatory makerspace activities for staff.

Overall, the results reflect that makerspaces are platforms for collaboration with actors in the local community that can sustain the relevance of the library. However, internally in the library organization, it is a risk for long-term sustainability that makerspaces struggle to become spaces that integrate into the existing values, resources and practices in the library.

**Discussion**

This research sets out to understand practices for sustaining library makerspaces beyond implementation by examining practices and initiatives of maintaining, scaling, replicating and evolving (Iversen and Dindler 2014). While Iversen & Dindler (2014) argue that the initiatives already take place in the implementation processes, this paper examines practitioners’ reflections on their everyday practices.

As makerspaces are born into existing cultural-historical systems of activities (Engström 1987) that take place in libraries, developing durable makerspaces do not happen overnight. Instead, this research sheds light on the complex acts of balancing division of work, sharing of ownership, repetition and re-use of practices and integrating the space into the library organization and the surrounding community. There is no one-size-fits-all model to ensure the sustainability of a library makerspace because makerspaces vary in size, shapes, placement, access to resources and objectives. Nonetheless, the following section will discuss practices for sustaining participation, expertise and embeddedness and propose three guidelines that practitioners should consider when addressing the long-term benefits of a library makerspace.
Sustainable participation

Participation is a focal concern for practitioners in library makerspaces (Moorefield-Lang 2018), which implies both recruitment of users and sustaining their attendance over time (Dreessen and Schepers 2018). The results of this paper reflect that participation is not a fixed and predictable variable. Instead, library makerspaces tend to continuously direct and re-direct their activities to what attracts users – be it community-evenings for experienced makers, collaborative trajectories with schools or weekend activities for families. In this dynamic approach, there are two points practitioners need to consider. First prior research has established that different types of activities provide different conditions for togetherness, collaboration and learning (Khanapour et al. 2017, Einarsson & Hertzum 2019). For instance, short-term workshops aim for fun and social experiences that might recruit users, while community-driven activities can support sustaining user interests and learning processes over a longer period of time. Second, specializing in one type of activity that is useful for a specific group will neglect others. In particular, children, families and groups with specific technical interest are involved in the makerspace activities (Li and Todd 2019; Bowler and Champagne 2016; Sheridan et al. 2014). Despite that Brady and his colleagues present an exception (Brady et al. 2014), elders, immigrants or disabled users rarely addressed. In particular, if libraries intend to be inclusive, represent the diversity of their community and support meetings between different groups (Audunson 2005), makerspaces can be productive venues to do so (Halverson, Lakind, and Willett 2017; Brady et al. 2014). However, practitioners must dedicate efforts to also include groups that are less likely to
be involved technology construction despite that it will require more work to attract the users and facilitate the activity.

**Sustainable expertise**

Previous research has stated that makerspace practitioners require skills of learning, adaptation, collaboration, facilitation and advocacy to facilitate activities in the makerspace (Koh and Abbas 2015; Moorefield-Lang 2015; Slatter and Howard 2013). For many library professionals, these diverse skills are new and expertise, therefore, needs to be developed. The findings show different approaches for makerspaces to develop and maintain the expertise. It is pointed out that expertise is embedded in different ways in teams of library staff, in the community of users or in newly hired professionals with experience in organizing makerspaces and facilitating activities. Models of staffing is a concern because it can affect the involvement of a user community (Seravalli 2012) but it also concerns how knowledge is embedded in the library organization.

Important for the durability of makerspaces is that there is a coherence between the work put into the makerspace, the scale of the tools and space and the value the makerspace produces for its community. Practitioners argue for the challenge that the skill in the makerspace is in a tangible, hands-on manner that is forgotten if not practiced regularly. Therefore, the repetition of activities, documentation, division of work, specialization and gradual scaling is important for turning new activities into operations (Bertelsen and Bødker 2003) that drive value cost-effectively.
Sustainable embeddedness to library and community

Library makerspaces are implemented for modernizing libraries by adding new services that potentially can attract new users and involve them in untraditional ways (Slatter and Howard 2013; Willett 2016). The findings from this study suggest that library makerspaces are perceived as a flexible platform to form collaborations with municipal actors, schools or groups in the community. That contributes to establishing the relevance of the library but is also found that makerspaces are in risk of becoming add-on services that are considered inferior to more traditional tasks of caretaking for the collection and helping users searching and finding materials. In prior research, it has been argued that libraries and makerspaces share values of providing access to tools and information, support informal learning, contribute to the development of future literacies and support the interest of the community (Willett 2016; Slatter and Howard 2013) but at the level of practice, skills and activities in the makerspaces are new for many libraries (Willett 2016; Koh and Abbas 2015). This study identifies a range of practices for integrating the makerspace into existing activities, but for long-term sustainability the existing activities and resources should be utilized and integrated further.

Building on the existing cultural-historical activity systems in libraries, makerspaces could develop activities to live up stories and information stored in collections, teach critical literacies for construction (e.g. such as information seeking and project planning), develop activities that support engagement and meeting between diverse actors in the local community and actively seek to involve marginalized users that are underserved in other types of makerspaces.
Guiding principles for sustainable library makerspaces

Makerspaces have spread to libraries around the world and are becoming an increasingly common service (Born, Henkel, and Mainka 2018). As individual makerspaces age, their newly formed activity systems over time will evolve, become integrated into existing resources, practices and values (Engeström 2001; Kuutti 1996) and are expected to contribute values to libraries and their surrounding communities. Long-term sustainability, according to Dindler and Iversen (2014), is not an end in itself, and makerspaces that do not deliver and articulate value will expectedly cease to exist. The main arguments from this research can be distilled into three guiding principles for sustainable library makerspaces that can help practitioner to sustain participation, expertise and embeddedness:

• A sustainable makerspace balances the participation from diverse groups by prolonging use by existing users by caretaking and giving them opportunities to take ownership, offering activities for less experienced users and actively dedicating efforts to include underserved users in their communities.

• A sustainable makerspace has the technical, facilitative, collaborative and organizational capabilities to deliver value cost-effectively. The makerspace learns by re-using and appropriating others' experiences and develops expertise by repeating, documenting and sharing their own practices. Practices can also be shared with a community of users. Yet, it is important for durability that the expertise also is integrated into the library organization.

• A sustainable makerspace is a flexible structure that can evolve and adapt to accommodate diverse interests, needs and wishes from user
communities and local partners. Though the makerspace changes fast, it must continuously evolve to adopt library values, practices and resources to become an integrated service in the long run.

The principles should be conceived as a complete list of rules or a checklist. Instead, they point to central tensions in relation to participation, expertise and embeddedness that makerspaces practitioners must reflect upon and address to ensure the long-term sustainability of library makerspaces. In practice, the principles for sustainability should already be addressed in the implementation stages, but the principles are also relevant for makerspaces to adjust practices towards sustaining makerspaces in the long run.

**Limitations**

This study has three limitations worth mentioning. First, the data material is based on the practitioners’ perspective. Therefore, users, management and other relevant stakeholders in sustaining a makerspace are excluded. Li and Todd (2019) argue that the practitioners’ perspective has been overemphasized compared to the users’ perspective at this point. For the subject of sustaining the makerspace, practitioners are valuable sources of information. They face users, local community actors, library management and co-workers in library and makerspace, and ultimately, they are responsible to make the space work in the short-run and the long one. However, including users in future studies would advance the understanding of integration of the makerspace into library services, for example, by exploring users’ affiliation to the library, the makerspace and local community. Second, the study builds on interviews from diverse makerspace that provide a broad picture of practices and tensions in enduring benefits of library makerspaces. Case studies of practices and user activities could compliment this research by providing rich descriptions and
examples of activities and practices for productively integrating makerspaces into existing library resources, practices and values. Finally, this study aims to inform sustainable makerspaces beyond the limits of Denmark. Internationally there is much variation in libraries in terms of physical location, funding, size, attachments to the local community and objectives. To compensate, this study sampled libraries makerspaces with variation in size and regional spread in Denmark. Hopefully, this study could inspire comparisons of sustainability in makerspaces beyond Scandinavia and even beyond the library.

**Conclusion**

This study sets out to examine practices to sustain library makerspaces. It is important to address the durability, as the novelty of makerspaces is fading. This paper analyzes data gathered through interviews in thirteen library makerspaces through the lenses of cultural-historical activity theory (Engström 1987) and sustainable participatory initiatives (Iversen and Dindler 2014). The findings disclose practices and tensions regarding the division of work, sharing of ownership, scaling of tools and activities, documentation, sharing and repetition of practice and the integration in the library and surrounding community. The findings inform three principles for sustainable library makerspaces that can guide libraries to balance the participation in makerspaces to represent diversity in the community, develop efficient practices that integrate into the library and progress towards deeper embeddedness in the local community and library organization.
References


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