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Democratizing technology in a public library: A nexus analytical inquiry into a Hebocon maker activity

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A B S T R A C T

Despite a proliferation of digitally enhanced makerspaces in public libraries, there is an acute need for libraries to explore new strategies to broaden the engagement of diverse groups, especially those who do not see themselves as technology oriented. This qualitative nexus analytical inquiry analyses multimodal data from a Hebocon robot-making activity situated in a Finnish public library makerspace, targeting library and youth workers as participants. The findings illuminate how the Hebocon format helped to promote the democratization of technology and the inclusion of novices in robot-making activities, enhancing practice change by creating a safe space in which the participants felt confident about experimenting and being creative. This study contributes to research on maker practices and formats aligned with public libraries' mission particularly from the perspective of robot-making event organization, showcasing the value of the nexus analysis framework to guide research in this area.

1. Introduction

Along with technological developments, cultural institutions, such as museums, theaters, and public libraries, are undergoing a "performative turn" (Fischer-Lichte, 2008). This turn refers to cultural institutions' mission for the democratization of free access to information and knowledge, as well as the free use of digital production facilities and software in libraries. This approach positions publicly funded libraries as a cornerstone of strategies for the democratization of culture around technology (Penin et al., 2019; Sørensen, 2020).

In response to pressing transformational needs for service development, public libraries have utilized novel digital resources and made them available everyone by integrating makerspaces as part of their learning environments (e.g., Born et al., 2018; Bossart et al., 2020; Colegrove, 2017; Gahagan & Calvert, 2020; Kim et al., 2022). Library-based makerspaces aiming to promote social, human, and cultural capital (Barniskis, 2016) are gaining recognition and becoming one of the core "non-programmed" activities calling for collaboration and civic engagement (Halverson et al., 2017; Hapel, 2020). Makerspaces have created important opportunities for libraries to support technology democratization by becoming centers of technology, learning, and innovation (Einarsson & Hertzum, 2020).

This transformation can connect to a larger discussion on the democratization of technology, ranging from contributions focusing on democratizing innovation (Von Hippel, 2005) to those on democratizing invention (Blikstein, 2013), and technological practices (Tanenbaum et al., 2013). There has been an emphasis on encouraging and enabling citizens' meaningful use of digital technologies, their engagement, and leadership in the design and development of such technologies (e.g., Iivari et al., 2018; Iversen et al., 2017). This change has derived inspiration from the do-it-yourself (DIY), maker, and open-source movements, as well as from other creative, artistic, and critical engagements with technology. Altogether, makerspaces stand out among the avenues for such democratization, placing advanced digital means and tools into the hands of ordinary citizens for daily use (Braybrooke & Smith, 2020; Eaves & Harwood, 2018). Makerspaces located in public libraries, being open to all and with workshop devices free of charge, are particularly well-suited sites for such democratization of technology (Barniskis, 2016; Gahagan & Calvert, 2020; Slatter & Howard, 2013).

1.1. Problem statement

The introduction and sustained use of makerspaces in public libraries face many challenges, such as the high costs of digital equipment and the

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fact that not all consequences are known (Barniskis, 2016; Einarsson, 2021). Studies have reported that librarians do not have sufficient competence or confidence to facilitate activities and learning in makerspaces if making is digital or technological (Horton, 2019; Jochumsen et al., 2017). Current research predominantly focuses on the implementation of creative makerspaces and their services from the perspective of the citizens who use them. However, to meet development needs, further research attention needs to be paid to library workers' ability to support technology design and use in library-based makerspaces (Barniskis, 2016).

The motivation for this study stemmed from the fact that the role of library-based makerspaces in democratizing technology design and use for library and youth workers is still inadequately understood (Gahagan & Calvert, 2020; Kim et al., 2022). This empirical case study was undertaken in a Finnish public library, introducing a unique form of a maker activity named "The Hebocon" (consisting of a robot building workshop and a playful robot competition) to library workers and their collaborators. The Hebocon is a Japanese robot building competition format that encourages poor technical abilities with the motto "all failures are beautiful." Nexus analysis (Scollon & Scollon, 2004) was applied to explore library and youth workers' participation in a Hebocon maker activity and to understand the relevance of the Hebocon for supporting technology democratization in public libraries. To narrow the gap in the existing research, this study addressed the following research question: How can the Hebocon format support the democratization of technology design and use in libraries undergoing transformation needs? This study particularly focused on the perspective of library and youth workers tasked with organizing educational and recreational activities in libraries.

2. Literature review

2.1. The potential of library-based makerspaces for democratizing technology

The contribution of public libraries to democracy has been built on the rhetoric of access (Lakind et al., 2019; Skøtt, 2021). Free and equal access to content has defined the institutions' key mission, which has materialized in public libraries' role in accumulating, preserving, and disseminating diverse media resources for enlightenment, education, enjoyment, and fun. The introduction of makerspaces in public libraries has aligned with the institutions' public service ethos, which is associated with open access, democracy, diversity, education, and lifelong learning (Lakind et al., 2019; Rogers, 2016; Serholt et al., 2018; Sørensen, 2020). Makerspaces in libraries are important for providing opportunities for empowering the public (Willett, 2016), for exerting the participants' sense of agency, and to pursue lines of action that go against dominant institutional frames (Skåland et al., 2020).

Makerspaces in public libraries have been introduced as spaces citizens can access a variety of materials and tools for crafting (e.g., sewing machines and tools for woodwork), digital fabrication, and electronics (e.g., 3D printers and laser cutters) (see e.g., Mehto et al., 2020; Riikonen et al., 2020). Similar to public libraries supporting knowledge democratization, library-based makerspaces can play an important role in the democratization of technology. Makerspaces are considered to create opportunities for developing technology literacy, and they contribute to closing the digital divide (Mann, 2018). These spaces apply constructivist and learner-centered pedagogies in which the "makers" can work on projects meaningful to them (Halverson & Sheridan, 2014; Kajamaa et al., 2019; Keune et al., 2019; Peppler & Bender, 2013). Studies report that the global "maker movement" (Dougherty, 2012; Sang & Simpson, 2019) has promoted participants' learning of science, technology, engineering, and mathematics, contributing to their technical competence and increasing skills such as communication, collaboration, and creative problem-solving (e.g., Egbert, 2016; Honey & Kanter, 2013; Kajamaa & Kumpulainen, 2020; Keune & Peppler, 2019; Peppler et al., 2016).

Although the potential benefits to participants in maker activities are substantial, makerspaces face some challenges in supporting inclusion and diversity in making. Among the most notorious criticisms is the narrow range of identities associated with the maker movement. In the movement's foundational story, makers were portrayed as American techy middle-class White males (Ames et al., 2014; Ames et al., 2018; Barton et al., 2017; Boeva & Troxler, 2021; Marshall & Rode, 2018; Vossoughi et al., 2016). Popular narratives have promoted uncritical views that move away from democratic understandings of technology in makerspaces (Nascimento, 2014).

In robot-building activities and robotic competitions, scholars have highlighted the lack of diversity in the participants attending these events (Melo & Rodney, 2023; Rusk et al., 2008; Sullivan & Bers, 2019). Maker activities have also been criticized for limiting technology design and use to robotics, electronics, and vehicles, and thus failing to engage groups who might not identify as "technology oriented" (Buechley & Hill, 2010; Dreessen et al., 2016; Lakind et al., 2019). Voices have called for developing strategies to broaden diversity in makerspaces (Brady et al., 2014; Capel et al., 2021; Holbert, 2016; Roque, 2016). Recently, the increasing adoption of maker activities in public libraries has ignited a discussion on the practices and approaches to making and learning that better resonate with their democratic mission (Einarsson & Hertzum, 2020; Willett, 2018). This study investigated a Hebocon maker activity in relation to technology democratization in a public library.

2.2. Nexus analysis as a theoretical lens

This study applied nexus analysis to investigate a type of robot-making activity, the Hebocon, involving library and youth workers in a public library makerspace. Nexus analysis is a multidisciplinary research framework linked with practice and activity theories, linguistic anthropology, and discourse analytic studies, taking a mediated discourse perspective on social action (Scollon & De Saint-Georges, 2013; Scollon & Scollon, 2004). Social action is perceived to be located at the intersection of trajectories from the past and the future (De Saint-Georges, 2005).

Nexus analytic inquiries approach the study of social action through examining three conceptual lenses: Interaction order, historical body, and discourses in place. The concept of interaction order stems from Goffman (1983) and refers to the networks of participants (both present and absent), and the in situ social interactions, which are shaped by power relations, as well as broader social conventions. The notion of historical body has its roots in Nishida (1958) and is closely connected to Bourdieu (1977) concept of habitus. According to Scollon and Scollon (2004), individuals' historical bodies encompass their experiences, histories, and beliefs, which are internalized as bodily memories. Scollon and Scollon (2004) acknowledged that the discourses in place shaping social action are real-time, situated and multimodal. These discourses are also manifested in physical spaces and materials used, affecting the participants and enabling certain interactions while hindering others.

Nexus analysis has gained interest among scholars who examine complex and changing phenomena where a variety of elements intersect (Kuure et al., 2018). In literacy research, nexus analysis has examined existing practices and changes in practices (see Hirvonen & Palmren-Neuvonen, 2019; Räisänen, 2015) and technology use (Wohlwend et al., 2018). In digital technology design and making context, nexus analysis has allowed examining exclusions (Iivari et al., 2018), participants' histories and interactions in design activities (Molin-Juustila et al., 2015), and discourses circulating 3D modeling and 3D printing practices (Norouzi et al., 2021).

3. Methodology

3.1. Research setting and participants

The research site was a Hebocon maker activity, organized in a Finnish public library, targeting library and youth workers. The event was organized as a collaborative partnership between researchers from a Finnish research university and a Japanese art and technology center, together with Finnish public libraries and a Finnish association promoting digital media and technology in youth work.

Hebocon is a robot-sumo competition proposed by Hebocon Master Daiju Ishikawa. The battles consist of two robots that fight by pushing each other out of the ring limits. The Hebocon term stems from the Japanese adjective "*heboi*," which refers to low-quality or technically poor things. According to Ishikawa, *heboi* robots are crappy, do not work as expected, and may break at any moment due to poor technical execution. While Hebocon is for everyone, the format especially welcomes those with poor technical abilities (Murer, 2018; Nijholt, 2018). In fact, the whole format is a celebration of a lack of technical competence and failure. The celebration of failure not only refers to malfunctioning robots, but it is reflected in the competition rules, which reward those who in other circumstances would be the losers. Therefore, the main purpose of the activity, from the design and building of the robots to the final competition, is more enjoyment and fun in a friendly social form than competing.

The Hebocon Finland competition consisted of two parts: A robot-building workshop and a robot competition. The robot-building workshop was a three-hour session in which the participants were introduced to the Hebocon competition rules and received some basic instructions on how to build their robots. Each participant was invited to build at least one robot using the available materials at the workshop. A total of 14 adults participated in the Hebocon maker activity. All of them worked in nonformal education contexts, such as in public libraries (n = 11) or learning and media education centers (n = 3). They were 18 years old to 54-year-old, and most were 25–34 (n = 6) and 35–44 (n = 5). Eight of them identified as women. In terms of education, the majority were highly educated (10 had university degrees, mostly in library and information studies). Participation in the event was voluntary. No previous skills in robot building or electronics were required. The participants' expectations included getting new ideas and methods for their own workshops and events, gaining skills, and becoming familiar with the Hebocon format, as well as discussing the possibilities of public libraries for supporting learning about science and technology.

The Hebocon maker activity was set in one of the library's rooms. A set of tables were arranged with materials and tools, such as screwdrivers, pliers, scissors, hot glue guns, paper, and recycled fabrics and toys, to build the robots (see Fig. 1 and appendix).

After the robot building workshop, 14 robots were ready to take part in the Hebocon Finland competition (see Fig. 2), which was organized as a public event in the library's open space (see Fig. 3). Before taking part in their first battle, each participant introduced their robot to the audience, who were library visitors, including a class of students from an elementary school.

3.2. Data collection

The research data was collected through questionnaires, a focus group discussion, follow-up interviews, and observations in which photographs and videos were taken from the robot building workshop and the robot competition (see Table 1). The multimodal data provided information about the participants' background and motivations, their interactions during the Hebocon maker activities, and the impact of the Hebocon event on the library and the youth workers' practices. Before data collection, participants were informed about the research and asked to sign an informed consent form.

3.3. Data analysis

In this study, the social action at focus was the Hebocon robot building workshop and the ensuing robot battle in which the library and the youth workers took part. To answer the study research question: How can the Hebocon format support the democratization of technology design and use in libraries undergoing transformation needs, the three intertwined concepts nexus analysis concepts were used as sensitizing devices, each offering a different analytical focus. In line with the nexus analysis field guide (Scollon & Scollon, 2004) and prior research (e.g., Norouzi et al., 2021; Wohlwend et al., 2018), attention was paid to those aspects that became the forefront in social action in situ. The aggregate of discourses circulating through the Hebocon Finland event were identified. The focus was on the social interactions or relationships between participants and for the historical body, the library and youth workers' trajectories (their background, expertise, and views toward technology and making) were examined before and after taking part in the event, as well as the impact that their participation in the Hebocon event had on their sense of agency.

The analysis followed a qualitative deductive-inductive approach

Fig. 1. The Hebocon makerspace.

Fig. 2. Robots built by the participants.

Fig. 3. Image of one of the Hebocon robot battles.

(Dey, 2003) in which observational, interview, and survey data from various sources were constantly triangulated, approaching the data first as a whole, and then focusing on selected events in greater depth. The verbatim transcripts of the focus group and interviews were coded with the NVivo data analysis program using the three nexus analytic concepts (i.e., interaction order, historical body, and discourses in place) as codes. Each of the codes were broken down into a set of sub-codes, which were identified from the data (see Table 2). Although the codes were strongly interrelated, each of the quotes was only assigned one code based on the category that was considered predominant. Specific attention was also paid to participants' comments indicating changes. The audiovisual data was used to identify instances showing particular forms of interaction among participants (e.g., how participants helped each other or created *heboi* robots). The data collected through questionnaires was used to assess the alignment between the participants' individual views and the overall group feedback.

The coding of the focus groups and interviews was conducted by one researcher, who first analyzed a small sample of the data, and after

Table 1
Research data collected in the study.

Research data	Description
Two questionnaires (before and after the Hebocon maker activity. All participants replied to both questionnaires ($n = 14$).	Questionnaires designed by the authors: The first questionnaire collected sociodemographic data; the second one feedback on the Hebocon experience and participants' intentions to adopt the format in their own work context.
Focus group discussion after the robot competition semi-finals (120 min, audio recorded and transcribed). This included all participants.	Participants shared their experiences and gave feedback about the potential of the Hebocon format for supporting inclusive participation in maker activities.
Verbatim transcriptions of the online follow-up interviews 22 months after the event (n = 5, duration 30–45 min, altogether 186 min of audio)	Some of the participants were interviewed to understand the Hebocon event's consequences on changing their everyday practice.
Researchers' notes, photographs ($n = 188$), and videos of the robot building workshop and the robot competition (38,21 min)	Observations on actions and relevant incidents happening during the robot building activities, the robot competition and in the interviews and in the focus group discussions.

Table 2
Examples of the subcodes and quotes identified in relation to the nexus analysis codes.

Code	Identified sub code (example)	Quote (example)
Interaction order	Effect of material arrangements	"There were plenty of tables that everyone could get around or, well everything wasn't on one table but they were a bit scattered around so, in a sense I guess it was easy enough to have these, private conversations as there were only two or three people around one table, at the same time."
Historical body	Attitude toward robotics	"It was really great to actually be able to, not only talk about it but actually participate. Because at first it was like, okay, I don't know anything about robotics or have a kind of like, present that to a group (because of) myself not being an expert. But then, from the get-go, it (isn't been like so) intimidating."
Discourses in place	Maker events as spaces to display mastery and expertise	"I think, in maker festivals you can go, like, Maker Faire (—-) other people who are, have had that hobby years and years and years and, the things they have in their tables to present to everyone there are so, wonderful and well-made and, there is no space for the crappy robots [laughs] like we did [laughs]."

discussing the codes and subcodes with three senior researchers, proceeded to analyze the remaining data. To ensure the reliability of the findings during the iterative analysis process, the authors arranged data analysis workshops where they collaboratively discussed the analysis to clarify what they could entail to reach an agreement on the findings.

4. Findings

4.1. Playful interactions through making robots

After introducing the Hebocon format and rules, the participants received basic instructions on how to connect batteries to hack toys. Despite minimal guidance, the participants took the initiative and started exploring the materials and trying out initial ideas to build their robots (see Fig. 4 and appendix). As one of the participants put it, "All the participants were really into building their own products and own robots or moving objects. (–) Enthusiasm was the keyword I think for that event" (Interviewee 4).

Although the participants worked individually, the interaction order between them was collaborative and relaxed, and the group developed a sense of togetherness through casual interactions and small collaborative efforts when building their robots. As one of the participants put it, "People were really cooperating, sharing ideas and, if someone was searching for a specific kind of item someone else might look it up for them, or if they see it, then just give them a hint—hey, I found something that might interest you. And if someone (–) was in a tough spot, then they might get help from someone else, just to see what was wrong with it and how they could go on. The atmosphere was really friendly and warm" (Interviewee 1). It is worth noting that although not all participants knew each other, they all had similar backgrounds and interests, which might have positively contributed to the group dynamics.

In the feedback questionnaire, almost all participants reported feelings of being interested, excited, and inspired by the event. All participants described the event as fun and enjoyed the playfulness of the activities. The positive and playful interaction order was supported by spatial and material arrangements. Being in the same place and seeing what the others were doing inspired the participants, making it easy to socialize and share knowledge during the process: "It was the thing that we were at the same place, and we were all quite lost with what we were doing (–), I could spy what the other ones were doing. There was so much laughter and that kind of thing, so I think it was very important, part of the whole Hebocon event, that we were at the same place" (Interviewee 3). "There were plenty of tables that everyone could get around, or, well, everything wasn't on one table, but they were a bit scattered around, so, in a sense, I guess it was easy enough to have these, private conversations as there were only two or three people around one table at the same time" (Interviewee 1).

Regarding materials, the interviewees enjoyed the available supplies, such as old toys from the recycling center and everyday things and felt comfortable experimenting with them. This was reflected in the robots' appearance, characterized by a scrappy DIY look (see Fig. 4 and appendix). Making the robots and learning how things worked by disassembling and building from pieces was also appreciated by the participants: "I really enjoyed work with my hands and do things on my own" (Interviewee 3). "It was fun that in the training, we got to do that as a group and figure out how it works and break some toys and have fun with it" (Interviewee 5).

The participants were unsure whether their robots would perform as intended. However, rather than feeling stressed, they took it with humor. As one of the participants voiced, the Hebocon allowed them to "not take oneself too seriously." As pointed out by one of the interviewees, playfulness was possible due to the positive and playful interactions that created a safe environment: "I think the bottom line is that you need to feel safe and not be afraid of anything. It's also essential for creativity" (Interviewee 4).

4.2. Trajectories toward increased confidence

The participants' historical bodies can be characterized by being familiar with technology. Generally, they saw themselves as well versed, or at least able to learn about new tools and technologies. Interestingly, seeing oneself as technology literate did not prevent feeling intimidated when thinking about making a robot: "I would say that I'm not intimidated by technology but, for example, the idea of making some robotics with just wires and gluing them together and hoping it will work, that was a bit intimidating for me at first" (Interviewee 5). "My technology skills are, I'm good with computers, but when I have to make something like robots or something, then I have no idea what I'm doing" (Interviewee 3).

Most of the participants had some experience organizing maker

Fig. 4. Participants during the robot building workshop at the library.

activities in their work contexts (library or youth center, targeting children and youth), often connected to arts and crafts. Four participants did so frequently. By participating in the Hebocon event, they hoped to get new ideas for activities, skill development, and making contacts in their field that could potentially lead to future collaborations.

For most of the participants, the Hebocon event helped to increase their confidence in their robot-building abilities (10 out of 14 participants stated a significant increase). In the follow-up interviews, all five interviewees expressed that Hebocon helped them gain self-confidence. "I think it [the Hebocon] really gave something more as well, than the very successful event. I think all the participants agree that they were given confidence and a lot of joy" (Interviewee 4). Realizing they were able to build a robot was empowering, but even more empowering was the fact that they just needed the courage to try: "It kind of gave me confidence, (–) like, to try other things and feel more confident about organizing things that maybe I don't have so much experience with" (Interviewee 2). As some of the interviewees expressed, taking part in the Hebocon led them to reconsider some of their current practices and to find the courage to change (or at least revise) some of its aspects.

The increase in the participants' confidence seemed to be related to two aspects. First, their views on technology and robotics and what is required to engage in robot-making activities changed. After the Hebocon event, 12 reported changed views toward technology and robots (six described the changes as significant). In the feedback questionnaires, several participants highlighted how easy it was to build a robot, giving the impression that before taking part in the Hebocon, they regarded robot building as a complex task. As one of the interviewees expressed, "I think maybe before my idea of robotics was this very like engineer kind of coding" (Interviewee 2).

Second, Hebocon motivated some participants to change the "historical" ways they carried out library services. After the event, they realized they could release their own "expert position" and let the youth and children actively engage in joint exploration: "I think the biggest thing that I gained from the event and taking part in it is to have the courage to start to do something like this; I mean, the idea that you don't have to know exactly what you're doing and just go for it" (Interviewee 5).

In the feedback questionnaires, all participants reported intentions to organize a Hebocon event in their own work context in the short term (eight of them indicated strong intentions). Despite the impact of the COVID-19 pandemic on public libraries, the follow-up interviews revealed that two participants had organized a Hebocon event in a public library, and other two participants had actively shared the format with their colleagues, aiming to organize a similar event in the short-term.

4.3. Challenging the dominant discourses on maker activities and robot competitions

The participants regarded the Hebocon event as part of the maker culture, which was also perceived as a growing trend in their professional contexts. According to the interviewees, Hebocon shared a hands-on approach to technologically enhanced project-based activities in which participants spontaneously shared knowledge and collaborated. Despite these similarities, the Hebocon participants noticed some particularities that differentiate the format from other maker events: "I think in maker festivals you can go, like Maker Faire (–), other people who have that hobby years and years and years, and the things they have in their tables to present to everyone there are so wonderful and well-made, and there is no space for the crappy robots like we did. And that is (–) important that you can have a safe place to have this experience to try something that you probably would never try anywhere else" (Interviewee 3). The discourses in place at the Hebocon contributed to creating a space in which people without technical expertise felt comfortable participating.

When building the robots, the participants started to embrace failure with a playful attitude, lowering their expectations and seemingly enjoying the process: "You are building something that's going to fail at some point" (Interviewee 2). During battles, the participants also struggled to make their robots move in a particular direction, or even make them move at all.

Referee 1: OK, it's likely to be a crappy battle. Ready to…

Referee 2: Fight?

Participant 1: Just a second [the participant needs to manually connect the cables to switch on the robot]. I have some manual…

Referee 2: Oh no! [laughs, also from the public].

Participant 1: This is really crappy.

Referee 2: OK, ready to fight?

Participant 1: Yeah.

Referee 2: OK.

Participant 1: Eh, just a second [the participant needs to attach the cables again. The public laughs].

This discourse around failure made the participants comfortable experimenting with digital tools and hands-on materials. Given that there was no right or wrong way of making a robot, the participants felt encouraged to be creative, as, no matter how crappy their robots were, they would still be appreciated in the competition: "The highlight was that I enjoyed very much that you can make whatever you want, and there is no right or wrong, and you cannot make good or bad robots" (Interviewee 3).

With its celebration of poor technical skills, low-tech, and scrappy aesthetics, Hebocon challenged discourses regarding what counts as a robot. This was positively valued by the participants, seeing this as an opportunity to change mainstream perceptions of robotics: "I want to bring it [the Hebocon] because (–) when people think about robotics, like okay, we're going to organize some kind of robotics (–) with teenagers, they may have an idea what it's going to look like, and I think Hebocon kind of breaks out of that mold" (Interviewee 2).

Considering that traditionally technical expertise is celebrated and exhibited in the maker culture, the Hebocon format changes the discourses associated with making, easing newcomers' engagement by making them feel that their contribution is appreciated. It also turns upside down the values of traditional robot competitions, moving away from the winning-losing logic. This was welcomed by the participants who were usually critical about using competitions to attract children and youth to maker activities: "I just think there are a lot of competitions in the field now (–), and not everyone likes to compete all the time" (Interviewee 4). Hebocon's logic, described by one of the participants as "a kind of Monty Python competition," modified the competitive behaviors traditionally associated with robot tournaments, escaping from societal pressure to compete all the time. Similarly, there is a hint of irony in the activity, making fun of technological fetishism and technology-driven society in a "carnival sense of the world" (Bakhtin, 2013, p.107). The Hebocon format offered the participants the possibility of being creative without feeling judged in a relaxed and playful environment in which people could enjoy themselves equally, irrespective of their technical expertise.

5. Discussion

When implemented in a library, the Hebocon works as a nonformal learning activity that is scaffolded in an object-driven way, meaning that the emphasis is on the production of a specific object (e.g., a robot). This study illustrates how the Hebocon format can support the democratization of technology design and use in libraries that are undergoing transformation needs: Hebocon is an example of a robot building maker activity in which participation is accessible for library and youth workers with varying, or even nonexistent, technical skills; it also allows experts' participation while providing tools to challenge the dominant discourses on making and robots.

5.1. Increased confidence by lowering the threshold for novices

Rather than receiving instruction for learning new skills, such as soldering or 3D printing, as happens in traditional maker education activities, library, and youth workers were encouraged to build scrappy robots that barely move. By rewarding poorly executed robots and even penalizing high-technology solutions, such as using sensors or programming, the Hebocon lowered the threshold for engagement, creating a particular interaction order in which "newbies" in robot making could feel safe to experiment through hands-on making. The interaction order afforded the students to develop their sense of agency, as competent and skillful learners and doers, able to act and invent, despite the constraints and obstacles that they faced (see also Skåland et al., 2020). This approach supported social interactions and peer support, but it also challenged deficit narratives by encouraging participants to try to figure out things on their own.

Deficit perspectives hold the assumption that "individuals from some cultural groups lack the ability to achieve just because of their cultural background" (Silverman, 2011, p.446). The notion that deficit perspectives are counterproductive for engaging underrepresented groups in science, technology, engineering, and mathematics learning (Mejia et al., 2018) is not easily dismantled, as it might also be embedded in participants' self-perceptions and assumptions. As the analysis of Hebocon participants' historical bodies shows, even technology-savvy persons may feel insecure about their robot-making abilities. Similar to Reich-Stiebert et al. (2019) report, the findings of this study show that the opportunity to playfully experiment with designing a robot changed the participants' attitudes toward facilitating activities focused on robot design and use in the library. Hebocon challenged historical narratives about who could build a robot and what skills were required. This enhanced the democratization of technology design and use in the studied library. This aligns with scholars' calls for building new cultures around technology to foster democratization of technology design and use (Buechley & Hill, 2010).

In Hebocon events, participants are invited to create their robots using easily available materials and recycled objects, such as old toys, which are disassembled and repurposed. These ways of doing resonate with DIY and hacking practices (Meissner et al., 2019; Richterich & Wenz, 2017), which have been applied in makerspaces (Diaz et al., 2021; Hurst & Tobias, 2011; Meissner et al., 2017). DIY and hacking connect with approaches that link making with supporting makers' agency and empowerment (Diaz et al., 2021; Einarsson & Hertzum, 2020; Hira & Hynes, 2018), and the democratization of technological practices (Davies, 2018; Nascimento, 2014; Tanenbaum et al., 2013). This study illuminates how the Hebocon experience transformed many of the participants' self-perceptions about technology design and use, empowering them to move out of their comfort zones. This is evident in their becoming sufficiently confident to change some of their professional practices, to explain the format to their colleagues, and to run a Hebocon in their work context.

5.2. A low floor and a high ceiling

Hebocon is successful in offering an engaging first experience to participants who are unfamiliar with makerspaces and robot-making, with a format that is also attractive for those who have technological expertise. In this regard, similar to educational programming languages such as LOGO and Scratch, the Hebocon format has "a low floor and high ceiling," meaning that "it is easy for novices to get started (low floor) and possible for experts to work on increasingly sophisticated projects (high ceiling)" (Resnick & Silverman, 2005, p.118). Fun activities that do not require advanced skills, such as Hebocon, meet the "low floor" requirement, whereas ambiguous objectives such as *heboi* meet the "wide walls" requirement, allowing for diverse approaches to participation. Considering that library makerspaces are in acute need of new formats and strategies that help broaden the engagement of all citizens, while addressing the needs of serious and casual users (see Barniskis, 2023), the adoption of the constructionist principle of "low floor and high ceiling" when designing maker activities in these environments is advocated.

Although the Hebocon might help broaden participation in making by engaging people without technical skills, the Hebocon alone may not be enough for participants to achieve further growth in maker activities. It's crucial to design a curriculum that allows for the acquisition of progressively advanced skills based on the participants' technical levels and interests. Drawing on Arnstein (1969) "ladder of participation," it becomes necessary to develop opportunities for growth for various types of users. For instance, offering advanced workshops like 3D printing and programming to the community that participated in Hebocon could create an inclusive maker space that accommodates everyone from beginners to experts. To achieve this, further ideas for workshops and events that match each stage are needed.

5.3. Failure and critical arts-based approaches as tools to challenge dominant discourses

The concept of failure has a central place in the Hebocon format, as participants are explicitly encouraged to fail when building their robots. This approach aligns with existing research on science, technology, engineering, mathematics, and maker activities, emphasizing the importance of multiple trials and errors and failure as inherent elements of the making processes (Hilppö & Stevens, 2020; Morales-Navarro et al., 2021; Plemmons, 2014). According to previous studies, makerspaces leverage the role of mistakes and failure as a strategy to improve and learn, whereas in Hebocon, failure works as a tool to rearticulate dominant discourses and historical traditions about making and robot competitions. The celebration and promotion of mistakes and failures in the making of *heboi* robots works at the level of the discourses in place, defying engineering principles based on technically sound designs and connecting with critical approaches that frame technology as experience (Song & Paulos, 2021). With its celebration of poorly executed designs producing scrappy robots, Hebocon challenges one of the hallmarks of dominant maker culture and robot competitions' narratives, which is the appreciation of craftiness and technical skills (Boeva & Troxler, 2021; Miller et al., 2018). Importantly, Hebocon's approach to failure links with the discussion on democratizing technological practices (Tanenbaum et al., 2013), which entails critical engagement with technology that includes "a sense of play around technological norms" (p. 2606). The emphasis is on pleasure and expressiveness rather than on the utility of end products. This connects with recent research highlighting makerspaces' social impacts on various types of users, which include aspects such as joy and social interactions (Barniskis, 2023; Einarsson & Krogh, 2022).

By questioning discourses traditionally framing making and technology from a productive perspective, Hebocon aligns with approaches such as critical making and critical design (Dunne & Raby, 2001; Hertz, 2012; Malpass, 2016; Ratto, 2011; Stoyanova, 2017). These approaches build on arts and philosophical traditions to propose alternative uses, drawing from playfulness and criticality to create a social experience of technology. Similar to glitch art, *heboi* robots encourage critical reflection on what error and failure mean. Broadening participants' imaginaries about what counts as a robot enabled the Hebocon participants to see their work as a "success" without feeling judged. The findings of this study show how critical arts-based approaches to making, such as Hebocon, align with the vision of public libraries as places for enhancing a culture that endorses democratic values (Sørensen, 2020). In this regard, formats like Hebocon might contribute to the democratization of technology design and use by shifting the discourses traditionally associated with making and thus opening spaces for the participation of all citizens.

5.4. Implications

First, the discourses underlying maker activities need to be carefully examined. As this study shows, the Hebocon format is a good example of the how-to upside-down traditional discourses associated with making and robot competitions for broadening participation and including audiences who might not otherwise feel part of the community. Second, there is a need to go beyond approaches that frame democratization as access. It is important to support library workers' technical confidence when adopting maker pedagogies and practices, helping them to move away from deficit models. Third, public libraries' makerspaces offer great opportunities to foster critical and democratic understandings of technology through approaches that link making and technology with the critical arts tradition. Considering public libraries' mission, critical arts-based approaches to technology have great potential for broadening participation and supporting inclusion.

5.5. Limitations

Due to the limited number of participants and the particularities of the Finnish library system, caution is advised when interpreting these findings. It needs to be noted that the study involved a distinct group of professionals used to run participatory events, and as such, the findings of this study are especially pertinent to those organizing maker events for broad audiences. Given the participants' particular background, they might have been more open to new experiences, tolerant of failure, and critical toward technology than the general public. Although the findings show the Hebocon format's potential for opening spaces for novice makers and supporting change in power structures in robot-making, further research is needed to better understand how the format works among various types of library makerspaces' users, as well as how the material arrangements might impact social interaction among diverse participants.

6. Conclusion

In this study, nexus analysis was drawn on as a theoretical lens to investigate the Hebocon format as social action in relation to the discourses activated by the library and youth workers who participated in the event. The findings of this empirical study indicate that the Hebocon contributes to the democratization of technology design and use by dismantling discourses around technology based on technological expertise and competition. The careful examination of the three intertwined concepts guiding the analysis (*interaction order*, *historical body* and *discourses in place*) sheds light on how the Hebocon supported practice change among library workers. These findings are valuable for innovation and practice change in public libraries aligned with their core mission, as well as for inspiring further research in library and information science analyzing the nexus of practices happening in library makerspaces.

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CRediT authorship contribution statement

Eva Durall Gazulla: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Anu Kajamaa:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Marianne Kinnula:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Netta Iivari:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Teemu Leinonen:** Writing – review & editing, Investigation. **Kiyoshi Suganuma:** Writing – review & editing, Investigation.

Declaration of competing interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.lisr.2024.101303.

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