Challenges and Opportunities in the Design of Digital Distributed Affinity Diagramming Tools

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ABSTRACT

Affinity diagramming is an oft-used sense-making technique in design research and practice to analyze qualitative data, utilizing a large number of sticky notes on walls. Over the past two decades, several digital tools have been tried and tested to augment or even replace the physical affinity diagramming process. Even so, the analog process usually prevails. We developed an online collaboration tool specifically tailored toward affinity diagramming to explore the challenges and opportunities of such a system in the particular case where the distributed teams do not have access to co-located settings. Here, we present a user experience study of five groups (dyads) of students based on a one-hour diagramming task under remote observation, followed by semi-structured interviews. Our study contributes three distinct insights to inform future work, namely that digital affinity diagrams 1) reduce the awareness of co-participants' actions, 2) provide fewer cues about ownership and use than physical diagrams, and 3) save time, improve manipulation, and overview. We end with a discussion of the challenges and opportunities for the design of digital tools for distributed teams involved in sense-making tasks.

CCS CONCEPTS

• **Human-centered computing** → Human computer interaction (HCI); HCI design and evaluation methods; User studies.

KEYWORDS

Affinity Diagramming, Qualitative Analysis, Global Virtual Teams, Sense-making

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1 INTRODUCTION

Among the different techniques for analyzing qualitative data in the field of Human-Computer Interaction (HCI), affinity diagramming is a well-established method that particularly stands out for its collaborative sense-making approach [1]. In this iterative process, qualitative data is split into small individual notes that are then clustered around insights and surprising findings identified in a subset of individual notes, i.e., clustering by affinity. Usually, this involves a team of several people working together, with physical sticky notes on a large wall [8].

Despite various efforts to digitize the affinity diagramming method, either by replacing it entirely with digital tools [3, 6, 13, 27] or augmenting the physical process [7, 16, 18], affinity diagramming remains a predominantly physical activity [7, 15]. One common aspect in those previous systems and their pertaining studies was their focus on co-located teams, i.e., comparing the physical and the digital experience side by side or at least presenting the traditional analog approach. Today, team members collaborating on a project may often be distributed and thus unable to conduct a co-located, collaborative affinity diagram. Instead, they might work without being co-located, which is similar to work exploring global virtual teams (GVTs) [4, 20].

Here, we explore some of the main challenges and opportunities for affinity diagramming specifically in such non-co-located settings. To this end, we developed a web-based affinity diagramming prototype that enables real-time, synchronous collaboration, to be used in conjunction with audio conferencing. The additional communication channel was chosen as a substitute for the lack of physical co-presence. For the evaluation we recruited ten participants (five dyads) to conduct an affinity diagramming session using our prototype for one hour while communicating with each other in an audio call, after which we interviewed them about their experience. The results were identified via an affinity analysis of the data collected, and highlight several interesting findings, such as a perceived increased effectiveness and performance of the affinity diagramming process, but also issues of each other's awareness and limitations of digital prototypes that warrant further investigation. We end with a discussion of key challenges and opportunities of

digital distributed affinity diagramming prototypes, and contribute to the community a set of recommendations for future research as well as the design of systems in this specific area.

2 RELATED WORK

As succinctly put by Beyer & Holtzblatt [1], the actions of an affinity diagramming process include that "The team, or a subset, sits down together and goes over the transcript or notes of each interview, writing facts about the user, interpretations, design ideas, and questions on Post-It notes. After the first round of interviewing is complete (usually 5 to 8 interviews or 400 to 600 notes), the team organizes the notes into clusters on a wall. These clusters are named and collected into higher-level groupings." Affinity diagramming, often considered synonymous with the 'KJ method,' is a well-established method for interpretive analysis of qualitative data. There are variations in the exact description of the method, but it is generally agreed that affinity diagramming is collaborative, interpretive, and aims at producing ideas and insights over objective answers [8].

Several systems have been developed to provide a digital platform for conducting affinity diagramming; some of the most well-known research contributions being The Designers' Outpost [16], augmenting physical sticky notes on a large interactive whiteboard for adding digital links, among other features; AffinityTable [6], a system combining several interactive surfaces such as tabletops and wall displays, along with Anoto paper notes, to create a hybrid experience; and Affinity+ [3], a fully digital system utilizing a wide wall-sized touch screen. All those systems primarily sought to replace or augment the physical affinity diagramming experience, and like our approach focused on affinity diagramming specifically. However, the studies evaluating those and other similar systems [9, 14, 24] focus on co-located collaboration instead of a possible distributed approach, and others have added studies to strictly compare paper-based interaction with digital systems [11, 13, 23].

While our system supported the same overarching goal - replacing the paper-based process with a digital prototype - we are primarily interested in exploring the effects on the distributed aspect of the collaboration. Unsurprisingly, a plethora of research in CSCW has tackled those challenges. As early as the early 1990s, when technology was considerably more limited than today, researchers discussed the applicability of virtual spaces for collaborative sense-making meetings, among other use cases [2, 5] . One other aspect of research that tackles the intricacies of virtual meetings and difficulties of collaboration is research concerning global virtual teams. For example, Nguyen and Fussell [21] as well as He et al. [10] pointed out how different cultural backgrounds affect collaboration, and Pongolino et al. [22] identified the significance the choice of medium has on discussion in virtual meeting spaces. This reaffirmed our choice to explore one single system in a specific task setup with a homogenic set of participants, reducing the number of variables and and thus attaining a higher degree of ecological validity.

3 SYSTEM DESIGN

Our prototype was developed on the Webstrates platform [17]. Webstrates is a publicly available system that synchronizes websites between clients while making those changes persistent, allowing for a truly synchronous and collaborative experience, similar to Google Docs. Other existing systems offer features that enable an online affinity diagramming experience, such as Miro[1] or Mural[2]. We chose to create our own implementation using Webstrates, as it enabled us to focus on the core affinity diagramming principles and tailor the system toward the user experience study. For this reason, we also opted for a minimal feature set that was developed iteratively based on feedback from pilot studies and affinity diagramming experts. We describe the main features below. Figure 1 shows a screenshot of the prototype.

The main activity during affinity diagramming is to drag around notes. To emulate the 'stickiness' of analog sticky notes, we made the entire surface of any note sticky. If a note is moved, anything that is *on top of that sticky note* is moved along with it. New notes are created by right-clicking anywhere on the canvas. Following the description of Holtzblatt et al. [29], one can create new affinity text notes (white background), three different category notes (blue, pink, green), and idea notes (yellow). We also added a 'comment note' feature (transparent background) to let users add text anywhere, similarly to the affordance of annotating any note with a pen in physical affinity diagramming. Right-clicking on a note enables cutting, copying, or duplicating any note. To visualize the temporary workspace, we added a clipboard to the top left side of the screen, which expands when hovered over (it can be pinned to remain open, see Figure 1). Due to technical limitations, the clipboard only displays the last item added to it, effectively working as a 'first in, last out' stack. Below the user's clipboard, a view-only clipboard of other users actively working in the prototype can be selected. For navigating the diagram, a simple left-click and drag anywhere on the canvas moves the diagram. Mouse-wheel scrolling and a two-finger touchpad gesture allow for zooming in and out. At the right side, there is a zoom level slider, while a window at the top right shows a transparent overview of the entire diagram for navigation.

The first of the three buttons (magnifier) at the top opens a search window for a quick keyword search, highlighting all notes with the search phrase and making all other notes transparent. The second button (nodes) allows for drawing connections between notes, mimicking the physical process of drawing lines between notes on the wall. The last button (lines) opens a context menu not included in the user study. It implements simple versioning (tagging a board at the end of a session, restoring a previous board's version) and an 'import note' feature. Importing the notes was done by the authors at the beginning of the user study. It was as simple as pasting all notes into an input window, whereby each new line of text creates a new note, and all notes are added to the center of the canvas with a slight offset, resulting in one large stack of notes.

4 USER STUDY

For the user experience study, we recruited ten participants (three self-identified as female, seven as male), who conducted an affinity analysis in groups of two (dyads). All participants were Master's students, who had attended an HCI design course featuring affinity diagramming as a data analysis method. This allowed us to have a

[1] http://www.miro.com
[2] http://www.mural.co

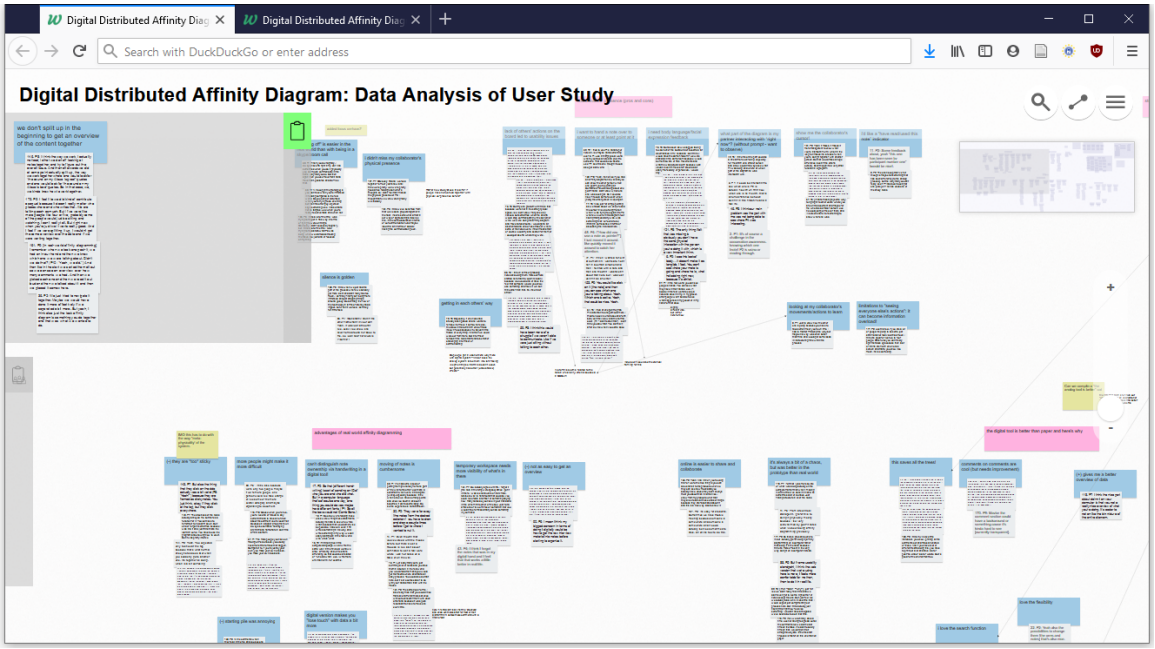

Figure 1: A segment of the prototype and a diagram with several categories. At the left the (pinned) temporary workspace, currently containing a category with three notes.

more uniform background of participants and to ensure that the prototype met the participants' needs, as affinity diagramming in practice might vary widely [8]. All participants had used affinity diagramming at least once, and many of them several times outside the course, and each knew their partner well. For the affinity diagramming task, we chose a sample data set comprising quotes from elaborate Amazon reviews[3] of the *Echo Dot* device, similar to the data set of *NEST* thermostat reviews that had been used in the affinity diagramming session in the course. All participants were therefore familiar with the procedure, the format of the notes, the task, and their collaborators. The only variation from their usual process was, besides the new data set, that the activity was now conducted online using a web-based prototype while being in a Skype (two groups) or Zoom (three groups) call, based on their preference. While the study was designed in the fall of 2019, the user study itself was carried out approximately one month into the COVID-19 lockdown, so all participants were accustomed to online meetings.

One researcher briefly introduced the study procedure, the prototype, and its basic functionality via screen sharing. Once the diagram was set up and the stack of 104 notes (3,584 words) was imported, the URL was shared with the participants, who were given roughly one hour for the affinity diagram process. Within this time frame, they went through between roughly half to two thirds of the notes, creating between 11 and 26 categories (average 16). During the affinity diagramming process, the researcher remained silent except for an update on time after 45 minutes to give participants space to discuss and collaborate. Following the participants' affinity analysis activity and a short break, a semi-structured group interview of approximately 30 minutes was conducted, focusing on the collaborative aspects and reflections on positive and negative user experiences, including their flow and how they felt this setup deviated from their usual affinity diagramming experience. The interviews were fully transcribed, split into affinity notes, and analyzed iteratively by all authors, mostly asynchronously. Inspired by Engelbart's notion of bootstrapping [28], this affinity analysis was done using the prototype itself. Figure 1 shows a part of the diagram of this analysis.

4.1 Themes

We analyzed 177 notes and arrived at 43 categories or smaller insights. We clustered these into three major themes pertaining to the participants' awareness of each other, their perception of the diagram, and perceived consequences of the digital distributed affinity diagramming experience. Participant IDs below are sequential, so that P1 and P2 belong to the first group, P3 and P4 to the second, and so on.

4.1.1 Digital Diagrams Reduce Awareness of Co-participants' Actions. Working digitally and distributed entails shortcomings due to the lack of physical co-presence, such as seeing others' positioning in front of the affinity board to know their focus and whereabouts, but also being able to interpret body language to determine if they are engaged in reading. This is exemplified in a quote by P5, which many other participants echoed: *"The thing I was kind of missing is the presence of the other participant [...] I could not really see what*

[3]The reviews were chosen from the most extensive, elaborate, and "story-rich" reviews on Amazon.com. Ten reviews with a total of approx. 10,000 words were split into 103 notes. The reviews span the entire spectrum from one to five stars and were written between October 2018 and January 2020.

they were doing. Which I guess is kind of a needed point in collaborative working that I can actually easily see and decode what my other participant is doing. And sometimes I had struggles with that." The lack of this physical presence made participants worry they might interrupt each other's thinking process, or move notes that the other participant was reading at that precise moment. One particular issue that all groups brought up was the need for a pointer. As P10 stated: *"Sometimes [P9] was talking about one Post-it and I didn't know which one she was looking at. So, it would be nice if it could be clearer which [note] the other person is looking at."* Participants' workaround was to *"quickly move [the note] around to catch her attention"* (P4); a gesture observed in all but one affinity diagramming session. Interestingly, a few participants (P6, P7) said they did not miss the collaborator's presence, though both attributed this to a long-standing collaboration experience. This knowledge of each other's established analysis strategy in combination with being on an audio call helped mitigate the lack of physical presence, although being in a permanent audio call can be overwhelming, as P4 jokingly said: *"you know, she never turns her back to me, so I can hear her always."*

4.1.2 Digital Diagrams Provide Fewer Cues About Ownership and Use. Another major theme we found was the perceived differences in how the digital diagram lacked some of the physical features, e.g., the fact that digital tools afford no handwriting, which leads to a lack of immediate ownership of parts of the diagram: "*In the physical world we draw differently and write letters differently, so that could be a relation of 'who did what'*" (P2). The sheer size of the virtually unlimited board also caused issues, as the overview of the physical wall was not there on a comparatively small computer screen. As P5 explained: *"Sometimes when [P6] and I would stop communicating with each other while we were doing the affinity diagram and move notes around, I would get a bit disoriented and kind of lose track of where some of the notes were."* While our system technically allows for versioning through displaying a history of the diagram's development, this was not part of the user study, but might prove useful in long-term studies. Just as being able to observe the history of the entire diagram, participants suggested retracing, or at least indicating, the history of a given note, e.g., by attributing to it an increasingly worn or crumpled look if it had been moved several times, similar to book pages: *"When you use a sticky note it gets used, like when you have a book you can see the pages have been turned several times"* (P2).

4.1.3 Digital Diagrams Save Time, Improve Manipulation and Overview. While physical affinity diagramming has several advantages over its digital counterparts, in particular with regard to the (tactile) feel of paper, participants mentioned several benefits of the prototype. As a case in point, the participants did not miss the tedious preparation process of physical notes. As P9 explained: *"It will save time instead of printing all the comments out [...] it's good for the environment too."* Unlike physical sticky notes, digital notes always behave the same: *"they don't get crumpled more and you don't lose one and they don't stop being sticky"* (P2). Several participants also stated how moving sticky notes was easier, especially large clusters, as the stickiness was reliable and invariable. In the real world moving multiple notes at once is often challenging, as it *"would take more than one person to move the physical notes, and here you can just drag all of them at once, which saved a lot of time"* (P3). Digital sticky notes also do not come loose and fall off. The diagram remains the same, so there is a sense of imperishability that physical diagrams cannot afford.

Another benefit mentioned by several participants was the notion of unlimited supplies, such as an *"infinite amount of pencils"* (P1), *"infinite space"* (P5), and an infinite number of sticky notes of any desired color, as *"you can't really run out of a certain type of note"* (P3). While the unlimited amount of space might be overwhelming, as stated earlier by P5 and echoed by P9, we attribute this to them only having a small display (13" laptop). Other participants working on a larger external monitor (24") disagreed, e.g., P7: *"It's easier [on a computer] to get the big picture of the entire diagram,"* and six participants explicitly mentioned they preferred the digital prototype overall. Supporting previous work investigating digital affinity diagramming [15, 16], participants saw significant value in being able to undo, easily edit text, share the diagram in its entirety, and especially the search function, which was explicitly lauded by multiple participants.

5 DISCUSSION AND CONCLUSION

The findings from this user experience study offer insights to inform the design of future digital systems for supporting synchronous, distributed collaboration beyond affinity diagramming. While there are limits to generalizability, as we only tested one system in one particular setup (a two-person audio conference call), we believe the insights gained from our user study highlight avenues for future research that can inform the design of future systems. As highlighted in the first theme, the awareness of one another (or the lack thereof), particularly the inability to recognize co-participants' body language, was striking, albeit not surprising, as it is a well-reported finding in three decades of CSCW history [2, 5, 19, 25]. Even so, our findings permit us to derive concrete suggestions for designing better support for the specific task of affinity diagramming, such as implementing a *feature to direct attention (e.g., point) to a specific note*, and adding an *indicator to any note that has been read, touched, moved, or edited* by a participant. Our participants also suggested assigning a *virtual cursor to each collaborator in the diagram*, or in some other form display where the collaborator's locus of attention is at any time. One way of achieving this is via eye-tracking, which has become a widespread feature in commodity devices [26]. This could be used to add *a 'read' checkmark* to any note the eye has rested on for a certain amount of time, and *to indicate one's focus to collaborators* in lieu of physical presence, addressing well-known, unsolved CSCW issues highlighted almost thirty years ago [12].

Generally, the digital distributed affinity diagramming prototype was well-received by all participants. Despite said issues of digital systems, the participants asked for a public release of the system, so they could use it for their own studies. One contextual factor we cannot neglect is the current situation, since, at the time of the actual user study, all participants were quarantined due to the COVID-19 lockdown. We speculate that this extraordinary situation might cause the general acceptance of digital systems to be slightly higher than usual, and thus our system's study became more relevant and timelier than initially foreseen. We believe that our key insights –

namely that digital affinity diagrams *1) reduce the awareness of co-participants' actions, 2) provide fewer cues about ownership and use than physical diagrams*, and *3) save time, improve manipulation, and overview* – contribute to the design of future systems in this specific domain, and the lessons learned potentially even inform research in other groupware systems for similar sense-making tasks. Given recent developments and the increased demand for distributed and remote work, there is a growing need for more studies of digital systems to improve the user experience, and we seek to contribute to this research area with the lessons learned from our study.

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