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Peer reviewed|Thesis/dissertation

UNIVERSITY OF CALIFORNIA,  
IRVINE

Designing Online Playful Activities for Distributed Teams

DISSERTATION

submitted in partial satisfaction of the requirements  
for the degree of

DOCTOR OF PHILOSOPHY

in Information and Computer Sciences

by

Mengyao Zhao

Dissertation Committee:  
Professor David Redmiles, Chair  
Assistant Professor Joshua Tanenbaum  
Assistant Professor Yi Wang

2018

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## **DEDICATION**

To

my son, Alan.

You have made me stronger and braver than I could have ever imagined.

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## ACKNOWLEDGMENTS

I am grateful for the people who supported me as I completed my dissertation.

My deepest appreciation goes to my advisor, Professor David Redmiles, who accepted me as his student and witnessed my growth for those years. Without his constant and dedicated support, it would not have been possible for me to complete this dissertation. He is one of the greatest mentors I have ever met, who has been providing wise advice on my Ph.D., career, and personal growth. He is also one of the best people I have ever known, who trusts me and respects my choices. He will be a role model for me as I am to be an equally kind-hearted, generous, and wise person.

I would like to thank my committee: Professor Josh Tanenbaum and Professor Yi Wang. Both have given me incredibly valuable guidance and encouragement. Josh is open-minded and sincere, and offered me great advice for developing my Ph.D. work. Yi encouraged me to explore my interests and helped open my eyes to more possibilities in research through his broad scope of knowledge.

I am grateful to faculty members Gloria Mark, Martha Feldman, André van der Hoek, Gillian Hayes, Marty Beach, Adriana Avina, Susan Barrows, and Debra Brodbeck. Professor Gloria Mark offered to be on the committee of my qualifying examination, guiding my work to develop it in terms of methodology and direction. Professor Martha Feldman offered to be on the committee of my qualifying examination and offered important critiques to revise my work. Professor André van der Hoek was the first faculty member I encountered during the first year of my Ph.D.; he gave valuable suggestions and critiques for me to be a professional researcher. Professor Gillian Hayes and Marty Beach helped me gain assignment as the teaching assistant for classes that well fit my remote schedule. Adriana Avina and Susan Barrows gave me helpful information when I needed their help during my studies. It was a great experience working with Debra Brodbeck on the ICGSE conference in 2016.

I would like to thank the Department of Informatics, which I can call “home” in Irvine. I have had such a warm and supportive experience for the past few years in the department, including financial and mental support. It has been a place I could turn to whenever I had challenges and needed help and support.

I am very thankful to my friends Xinning Gui, Yubo Kou, Yao Li, Yang Feng, Zhendong Wang, Tao Wang, Kate Ringland, Yu Chen, Jingwen Zhang, Qi Lou, among other kind and smart peers at ICS. You have been an important resource for inspirations and emotional support for me through those years. You have made the days at UCI special and unforgettable.

I thank all the participants in my studies. They fundamentally grounded this work.

I thank the people I met during my internships at Xerox, Google, and Uber. Working with professional groups helped me develop professionally into a design researcher.

I am grateful to my mom, Saihong Wang, who has always been there to support me, who has been giving me unconditional encourage and love. She has been a role model for me to be a strong and open-minded person.

I would like to thank my husband, Yuanzhe Dong. He has been a great partner to pair with for those years. We have gone through a challenging but exciting journey from China to USA. He supports me financially and mentally to accomplish my Ph.D. by working so hard for the family. His work on the development of DARTS was incredibly excellent and became the foundation of my final study.

Lastly, but most importantly, I thank my son Alan Dong. He has been the most inspiring addition to my life. He has made me look forward to a new day every day. He is one of the most valuable outcomes of this Ph.D. journey.

# CURRICULUM VITAE

## Mengyao Zhao

- 2011        B.A. in Digital Media Art, Beijing University of Posts and Telecommunications
- 2013        M.S. in Human-Computer Interaction Design, Indiana University,  
Bloomington
- 2018        Ph.D. in Information and Computer Sciences,  
University of California, Irvine

## FIELD OF STUDY

Computer-supported cooperative work (CSCW), Human-computer interaction (HCI)

## PUBLICATIONS

- Zhao, M.; Wang, Y.; Redmiles, D., "Using Collaborative Online Drawing to Build Up Distributed Teams," IEEE International Conference on Global Software Engineering, pp.61-65, 2017. doi: 10.1109/ICGSE.2017.3.
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# **ABSTRACT OF THE DISSERTATION**

Designing Online Playful Activities for Distributed Teams

By

Mengyao Zhao

Doctor of Philosophy in Information and Computer Sciences

University of California, Irvine, 2018

Professor David Redmiles, Chair

Distributed teams have become increasingly prevalent. However, distance brings challenges in practice, and chief among them is the development of trusting and cohesive relationships. By contrast, in co-located settings, informal social interactions beyond purely task-oriented communication support trust and cohesion building. This research fills the gap by exploring, in two related studies, how to use online playful activities to encourage informal social interactions at work and at a distance. The first study identifies the potential to use open-ended, freeform drawing to jumpstart trust, cohesion, and positive emotions in a distributed team setting. The results reveal that there are four core facets of the experience afforded by online playful activities: expressivity, reflection, interactivity, and playfulness. These results suggest that designing around the four facets could contribute to an engaging playful experience that would help teams build a common ground, support subjective affective expressions and experience, build up team knowledge in a relaxing social context, and promote positive emotional contagions. Thus, a prototype based on these findings was developed and tested in a short-term, in-situ study with five teams from industry contexts. The prototype supported asynchronous, anonymous,

collaborative online drawing. We found that participants obtained an increased engaging experience and perceived trust, cohesion, and transient positive emotions over five days. Findings also identified the relationship between the four facets; namely, how each was influenced by the others. Based on findings from the two studies, as well as insights from previous, related research, we developed a theoretical model to capture the characteristics of online playful activities for distributed teams. This model leads to a design framework with eight concrete design guidelines that form a basis for system design for online playful activities for distributed teams.



# Chapter I.

## Introduction

Distributed teams have become increasingly prevalent over the last decade (Olson and Olson 2000). Working in a team no longer means sharing the same physical workspace with other team members. Team members interact, communicate, cooperate, and work asynchronously from globally different locations. While information technologies have proven to successfully assist distributed teams to work at a distance, there are still challenges awaiting to be solved. For instance, barriers to building up effective teams at a distance (Oshri, Kotlarsky, and Willcocks 2008; Kotlarsky and Oshri 2005) include a lack of interpersonal interaction, common ground, and consequently, team cohesion.

Studies proposed solutions by building theories and software applications to tackle those challenges (Bradner, Kellogg, and Erickson 1998; Wang and Redmiles 2015; Zhao, Wang, and Redmiles 2015). As a result, task-oriented communication in distributed teams has greatly improved. However, beyond purely task-oriented communication, socio-emotional communication through informal social interactions is also critical to building a cohesive team, requiring explorations to understand the social dynamics in distributed teams and solutions to support socio-emotional communication at a distance.

To support informal social interactions in teams, more recent research has begun to study informal interactions in a relaxing social context, for instance, with playful team building activities. Such informal, non-work-related interactions have proven effective in

promoting trust and collaboration (Cowan 2010). For instance, team members interact with each other outside work through creative practices such as drawing, crafting, dance, and music. Such playful experiences introduce teams to the ambiguity within them, which helps them explore the unknown aspects of their group (Gaver, Beaver, and Benford 2003). This could foster a higher team spirit and other positive affects (Karl and Peluchette 2006).

However, it is practically challenging for distributed team members to have informal interactions in a playful team building setting. Therefore, this work intends to fill this gap and contribute to the emerging research agenda by exploring how to support online playful activities via information technologies that encourage and facilitate informal interactions among distributed team members at a distance.

To support socio-emotional communication in teams, some studies specifically promote awareness of human emotions in the workplaces. Acute awareness of affect in teams could contribute to higher individual satisfaction and therefore a more effective team (Murgia et al. 2014; Guzman and Bruegge 2013; De Choudhury and Counts 2013; Guillory et al. 2011). To help transmit and communicate human emotions, research began to look to the arts and humanities, which have a broader range of studies around how to support affective communication through nonverbal conversations (Boehner et al. 2005; Leahu, Schwenk, and Sengers 2008). For instance, recent studies about promoting awareness of emotions in workplaces argued that we should support ambiguous, subjective, and user-selected parameters in affective systems. Fostering the subjective nature of affective experience can lead to better communication and experience of human emotions through technologies (Boehner et al. 2005; Leahu, Schwenk, and Sengers 2008).

However, for distributed teams, building awareness of affect seems a luxurious privilege when basic communication is lacking. Team members lack the motivation and interest to learn more about the people with whom they work at a daily basis, including their personalities, fun facts about them, or more broadly, affect. Therefore, this work also intends to explore how to use online playful activities to help distributed team members express and share personal affect to build up their teams.

## **1.1 Research Questions**

To summarize, we situate this dissertation work this work in the fields of computer-supported cooperative work, play at work, and human emotions in the workplace. We explore three research questions:

- How can we support socio-emotional communication through informal social interactions facilitated by online playful activities among distributed team members?
- What positive effects can a playful activity make to distributed teams?
- What positive experiences do team members perceive during a playful activity?

## **1.2 Research Approach**

In order to answer the research questions, this dissertation work began from insights from related literature that could inspire an effective solution. Grounded in these insights, to solve the research questions we decided to apply online playful activities as team building interventions via information technology.

To define “playful activities,” we refer to three intrinsic features of “play” (Gillin 1951; Caillois 1961). First, play is separable from everyday life, and playful activities are separable from everyday work. Fundamentally, the content of the activities should be non-work-

related. Second, it is safe, which means it is consequence-free. Playful activities should be non-competitive and freeform. Participants and anything they produce in the activities should not be judged as simply “good” or “bad.” 3) It is intrinsically pleasurable or fun.

In this dissertation work, we report on two studies around online playful drawing in distributed teams. The original research questions were refined in those two studies and we collected empirical evidences for rational answers to enlighten implications for a broader scale of online playful activities.

The first study fundamentally examined the effects an online drawing activity had on teams via a controlled lab experiment. The findings revealed that freeform online drawing in distributed teams rapidly and successfully helped build team cohesion and positive individual emotions during a short drawing session.

With evidences derived from findings of the first study, and insights from previous literature, we built a theoretical model to describe the four core facets of the positive, perceived experience afforded by online playful activities: expressivity, reflection, interactivity, and playfulness. We argue that positive, perceived experience in distributed teams contributes to positive effects on trust, cohesion, and emotions.

To further verify and evaluate the proposed approach, we built an application called DARTS. DARTS supports anonymous, asynchronous online drawing. It facilitates team members at different locations to collectively work on a shared team canvas and encourages team members to express themselves in an open-ended drawing setting. DARTS materializes the theoretical model we propose and showcases a concrete design solution that would help resolve the challenges in motivation we discussed.

The second study carefully examined DARTS with five industry teams. Findings from this five-day observational study proved that DARTS is a successful online anonymous, asynchronous drawing tool that helps distributed team members gain an engaging playful experience through expressivity, reflection, interactivity, and playfulness. Through the playful drawing activity, teams gained trust, cohesion, and positive emotions. Moreover, the trusting and cohesive feelings were said to last longer and extend into collaborative work relationships beyond the playful activity.

This work contributes to a larger research agenda:

**1) Implications to research:** this work provides knowledge to fill the gap about how to build up distributed teams by supporting informal social interactions through play at work. It is found that the casual, informal social interactions jumpstarted through the online playful activities could successfully help teams build a higher level of trust, cohesion, and transient positive emotions. The findings complement our understandings about how teams interact and proceed outside work in an online playful setting at a distance. This work proved to be a valid approach to solve the research questions and could further inspire more research inquiries and studies in this direction.

**2) Implications to design:** the theoretical model in this work provides a concrete framework for designing online playful activities for distributed teams. Findings demonstrated that expressivity, reflection, and interactivity can engender a great degree of playfulness. The four facets of the holistic experience influence each other and positively contribute to a higher degree of engaging experience in the activity. Therefore, this framework could guide mechanism/system design that intends to provide an engaging, playful experience.

## 1.3 Dissertation Outline

This work is divided into seven chapters. Chapter 2 synthesizes the literature that grounds this dissertation work. We summarize related work in three fields: typical computer-supported cooperative work (CSCW) about building teams at a distance; play at work; and human emotions in the workplaces. We describe the key findings from previous literature as fundamental insights of this work, which ultimately guided the building of the theoretical model described in Chapter 4.

Chapter 3 reports on study I. In this study, we performed a controlled experiment with co-located and distributed teams whose participants collaborated in an online drawing activity. Our goal was to evaluate how this intervention influences trust, team cohesion, and individual emotions. The findings showed that the intervention presented significant effects on increasing team cohesion and positive emotions. Effects on positive emotions were stronger in distributed teams. We also identified four core facets that comprised the positive, perceived experience participants received in the activity. Insights from this empirical study further guided the building of the theoretical model described in Chapter 4.

Based on the insights and evidences from the empirical study, in Chapter 4 we describe a theoretical model that illustrates the proposed solution to solve the research questions. The model is around how online playful activities can build up distributed teams. In the model, we define the four facets of experience an online playful activity should afford in order to effectively build up a team. Then we describe the potential effects online playful activities have on teams: trust, cohesion, and individual emotions. We also describe how the four facets of experience could theoretically influence the three team effects. We further

develop design guidelines based on the model. The design guidelines aim to guide a broader scale of mechanism/system design.

In Chapter 5, we describe the design process of the application DARTS. First, we describe the goals and use cases. Next, we describe a prototype that presents the information architecture, user interface, and interactions. We also report on an informal, small-scaled usability test focused on the application's flow. Finally, we present the final system demo as the ending point of an iterative design process.

Chapter 6 reports on the final evaluative study based on DARTS. Study II was a five-day in-situ, observational, experience sampling study with five industry teams. Each team consisted of three members who were asked to participate in freeform, open-ended drawing for five days using DARTS. Experience sampling surveys were used to measure participants' experience of using the system, active session time, screenshots of drawings, and the three team effects. One-on-one interviews were conducted at the end of the study. Based on both of quantitative and qualitative analysis, findings revealed the positive results of DARTS on teams. The positive results demonstrate that online playful activities have a great potential to help distributed team members express affective information through drawing, have informal interactions through playful interactions, reflect on understandings about each other, and ultimately build up a trusting and cohesive relationship. In Chapter 6, we also compare the similar yet different behavioral patterns that emerged in teams in Study I and Study II. The comparison presented interesting findings around how teams proceeded and functioned in a short playful session versus in multiple sessions. Findings from Study II provide complementary details to complete the proposed theoretical model and provide solid evidence around the validity to use such an intervention to strengthen distributed

teams. The design implications further amend and complement the design guidelines in Chapter 4, and are valuable to form as a design framework to guide future online playful mechanism/system design and evaluation.

Chapter 7 summarizes this dissertation work. We discuss potentially implications and contributions of this work. We also describe two real-world concrete scenarios where this work can be applied. Finally, we discuss limitations and future work. Figure 1.1 presents the overall structure of this dissertation work.

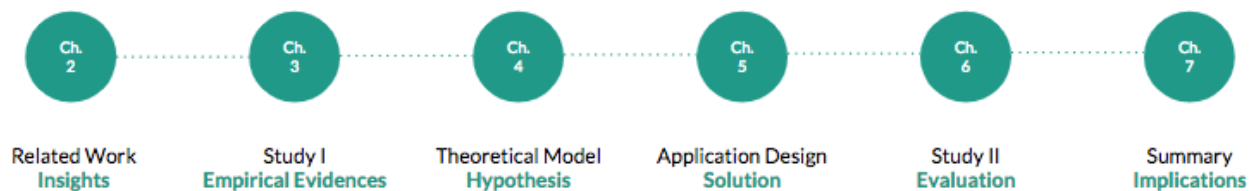


Figure 1.1 Overall structure of this dissertation work.



## **Chapter II.**

# **Related Work**

This work is grounded in literature in the fields of Computer-Supported Cooperated Work (CSCW), play at work, and human emotions in workplaces. The findings from previous related work supported our initial intuition to support online playful activities. In this chapter, we synthesize the research that grounded our understandings about the problem space, as well as inspirations to develop a research proposal from the three mentioned fields. We use insights to document the specific findings that are most related and meaningful to this work.

## **2.1 Building Teams at a Distance**

### **2.1.1 Distance matters in distributed teams**

As global collaboration has become more common, recent years have witnessed the reformation of teams in many industries. Teams become more distributed, with team members from different cultures and working in different locations. Innovations in Information and Communication Technologies (ICTs) make communication and cooperation at a distance easier and smoother. But as discussed in Olson's work (Olson and Olson 2000), the barriers distance introduces to distributed teams will not immediately disappear, despite rapid development of ICTs. Therefore, building a trusting and cohesive distributed team still requires continuous exploration.

Among the four key concepts Olson introduced that influence team effectiveness of common ground, coupling/dependencies of group work, collaboration readiness, and collaboration technology readiness, my work intends to innovate along the dimension of helping distributed teams build common ground. The lack of common ground is a huge barrier to build a trusting and cohesive virtual team at a distance. Olson defined common ground as the knowledge that team members have that they are aware of having in common. Common ground is not only about explicit knowledge obtained about an individual, but also about knowledge obtained from interacting with them, such as facial expressions during a conversation. We usually construct common ground from cues we observe while interacting with the individual, and the change of the established common ground helps us to adjust the way we interact with each other (Olson and Olson 2000; Bietz et al. 2012; Dabbish 2008). Interaction amongst team members who work asynchronously is improved by ICTs, yet effective interpersonal interactions remain a challenge. For example, it is more difficult in video conferencing to gain subtle information about each other through facial expressions, gestures, emotional status, and so on. Therefore, building common ground is more difficult for distributed teams.

Our first insight builds upon Olson's theoretical framework around why distance matters in distributed teams: **I1 - the lack of common ground is a huge barrier to building up a trusting and cohesive team at a distance.**

### **2.1.2 Team trust**

Trust plays an important role in teams. Greater trust amongst teams leads to more effective communication and cooperation, increased productivity, and more positive

individual team member feelings (Judith A. Holton 2001; Ilgen et al. 2005; Jarvenpaa, Shaw, and Staples 2004; Kotlarsky and Oshri 2005).

Defined by Mayer et al., trust is the “willingness to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party” (Mayer, Davis, and Schoorman 1995). Figure 2.1 shows the model of trust by Mayer and Schoorman. In this model, the outcomes of a trustor’s actions based on her/his trust with the trustee influences the perceived trustworthiness towards a trustee. Therefore, the ability, benevolence, and integrity of the trustee, as well as the interactive dynamics between the trustor and trustee are all important to developing a solid trusting relationship.

As discussed in the previous section, distance creates a barrier to effective interpersonal interactions amongst a distributed team. The lack of interactions leads to lack of awareness of each other’s ability, benevolence, integrity, and the interactive dynamics between team members.

In response to the above challenges, different approaches were investigated. For instance, researchers have argued that with tool support collaboration can be developed as a learned social practice along with trust building (Kotlarsky and Oshri 2005). The more ICTs support collaboration, the more opportunities team members could have to build up perceived trustworthiness of each other. ICTs were also shown to support teams to develop common ground by supporting the exchange of information. By facilitating interactions at a distance through applications such as video conferencing tools or instant messengers, technologies have to some extent helped resolve the conflicts caused by different cultures and time zones (Olson and Olson 2000; Kotlarsky and Oshri 2005). Having more common

ground in the team definitely helps with developing understanding amongst one another, which would ultimately help build perceived trustworthiness.

Besides the studies around ICTs, more recent studies also demonstrated how to build team trust through informal social interactions. Informal, non-work-related social interactions have been proven successful for building team trust. Zheng et al. observed that engaging in a text chat about non-work-related topics before work was nearly as good as meeting face-to-face in order to establish trust in a distributed team (Dabbish 2008). It has also shown that small talk and other types of informal conversations could effectively exchange personal information about collaborators (Herbsleb and Mockus 2003; Schumann et al. 2012; Wang and Redmiles 2015), and thus help distributed teams build trust. More flexible social mechanisms have proven effective as well. For example, Babble (Bradner, Kellogg, and Erickson 1998) is a successful example showing that informal, asynchronous, and conversational systems can complement the conventional communication approach people have in a work context. The type of information supported in such informal social contexts helps team members build more knowledge about the individuals, as well as their team.

Based on that, our second and third insights are:

**I2 - Trust depends on knowledge about an individual team member, as well as the experience of working on something together;**

**I3 - Informal social interactions can successfully help teams build trust.**

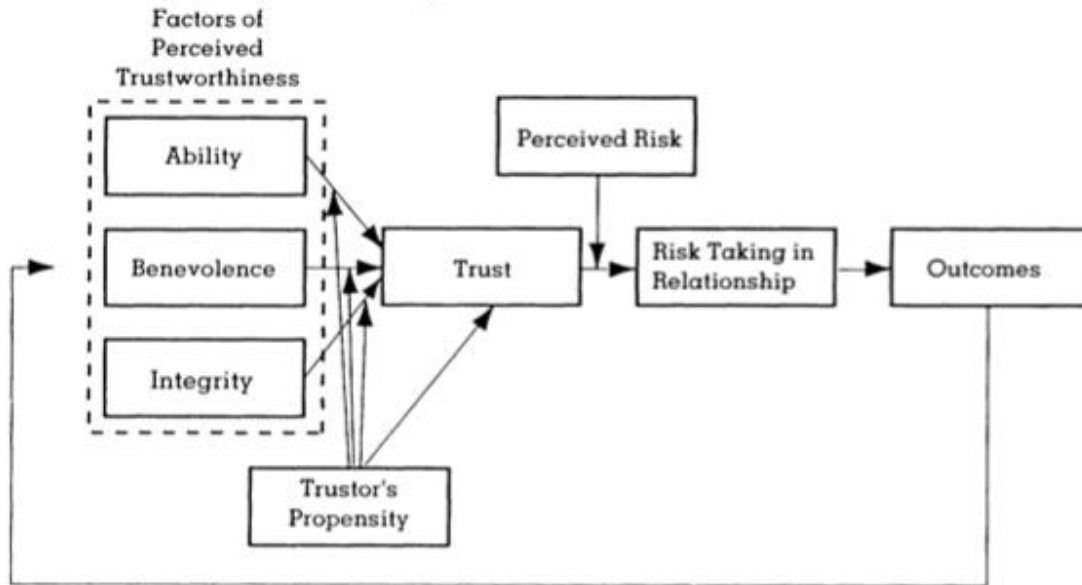


Figure 2.1 Model of trust (Mayer and Schoorman, 1997)

### 2.1.3 Team cohesion

Cartwright defined team cohesion as “the degree to which team members desire to remain in the team” (Cartwright 1968). In the model of teamwork quality (TWQ) built by Hoegl and Genuenden (Hoegl and Genuenden 2001), cohesion is one of six facets (Figure 2.2). Three forces of cohesion were distinguished by Mullen and Copper (Mullen and Copper 1994): team members’ interpersonal attraction, commitment to the team task, and group pride-team spirit. Team cohesion is critical because it influences several aspects, such as work quality, individual productivity, and team performance (Hoegl and Genuenden 2001). By definition, cohesion is essential for maintaining a team.

Studies show that team cohesion is less associated with surface-level diversities such as age, gender, and race, and more with deep-level diversities such as attitudes, beliefs, and values. Furthermore, it comprises the information exchanged among team members rather than the time they interact that determines their cohesiveness (Harrison, Price, and Bell 1998).

In a distributed team, information exchanged between team members is mostly focused on tasks and thus work-related. Knowledge about the remote team members is limited to knowing about their age, gender, and race. Since such surface-level information is insufficient for cohesion, distributed team members may work closely but feel far away from each other. The lack of interaction and information exchange makes the attachment to a team weaker. Meanwhile, it is more challenging for distributed teams to obtain or maintain any cohesiveness because distance makes the relationship more fragile (Kotlarsky and Oshri 2005).

Team building exercises have been proven to effectively build team cohesion. Team building is one of the most commonly applied interventions in organizations (Klein et al. 2009a; Salas et al. 1999). It is defined by Kelvin et al. as “a class of formal and informal team-level interventions that focus on improving social relations and clarifying roles, as well as solving task and interpersonal problems that affect team functioning” (Klein et al. 2009a). In the literature review developed by Klein et al., interpersonal relations are one of four components of team building and are effective for improving team cohesion as well as team trust. By improving the interpersonal relations and social interactions between individuals (Schein 1969), team building interventions help team members share feelings, improve communication, and develop mutual supportiveness, trust, and confidence in the team (Klein et al. 2009a). Moreover, research found that team building is highly effective for improving affective outcomes (Woodman and Sherwood 1980; Klein et al. 2009a). Team building could elicit positive affective reactions. The benefit of positive emotions in teams will be more discussed in section 2.3.

**Table 1 The Teamwork Quality Construct**

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• <i>Communication</i>
↳ Is there sufficiently frequent, informal, direct, and open communication?
• <i>Coordination</i>
↳ Are individual efforts well structured and synchronized within the team?
• <i>Balance of Member Contributions</i>
↳ Are all team members able to bring in their expertise to their full potential?
• <i>Mutual Support</i>
↳ Do team members help and support each other in carrying out their tasks?
• <i>Effort</i>
↳ Do team members exert all efforts to the team's tasks?
• <i>Cohesion</i>
↳ Are team members motivated to maintain the team? Is there team spirit?

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Figure 2.2 Model of teamwork quality (Mullen and Copper, 1994)

Recent studies found that team building can improve the quality of a virtual team (Kaiser, Tullar, and McKowen 2000); therefore, it is promising to use team building interventions in distributed teams. Some efforts have been made to bring such interventions from offline to online for distributed teams. For example, Ellis et al. (Ellis et al. 2008) designed a collection of games through Second Life and applied them to distributed teams. The games aimed at helping teams reflect on their work practice and develop stronger social ties. The results were positive and inspired other work on using online games to jumpstart relationships in organizations (von Ahn and Dabbish 2008).

Thus, our fourth and fifth insights are:

**I4 - Team cohesion is associated with deep-level diversities such as attitudes, beliefs, and values;**

**I5 - It is promising to use team building interventions from offline in online distributed teams to improve team cohesion.**

## 2.2 Play at Work

When talking about team building interventions, there is a related, but more fundamental concept that we cannot ignore—play. Play, first described as “a well-defined quality of action which is different from ‘ordinary’ life” by Huizing (Gillin 1951) presents everywhere. Previous research (Caillois 1961) defined six characteristics of play: 1) free, which means non-obligatory; 2) outside “ordinary” life; 3) uncertain results; 4) non-productive of goods or wealth; 5) governed by rules; and 6) make-believe, which means awareness of a second life that is against real life. Researchers (Gillin 1951; Caillois 1961; Salen and Zimmerman 2004) also defined three classifications of play: 1) game play, which is a more formal play with strict rules; 2) ludic activities, which means informal play activities, and 3) being playful, which describes the mental of being in a playful state.

All classifications of play have been explored in previous studies in terms of the benefits they can bring to teams. In the example I discussed in the previous section, studies used *Second Life* to design a collection of games for distributed teams to play, which improved team effectiveness (Ellis et al. 2008).

Other than game play, ludic activities and more generally encouraging employees to enter in a playful mental state are also beneficial for teams. Ludic activities are one of the most commonly applied team building activities for co-located teams (Depping et al. 2016; Kleinman, Carney, and Ma 2014; Malaby 2007). Team members interact with each other outside work through creative practices such as drawing, crafting, dance, and music, among others. Such ludic experience brings teams ambiguity through play, which helps them explore the unknown parts in their group (Gaver, Beaver, and Benford 2003). This can lead to higher team spirit and positive affects (Karl and Peluchette 2006).



Moreover, playfulness benefits teams in many other aspects (Ellis et al. 2008; Gallacher et al. 2015; Karl and Peluchette 2006). Playfulness in workplaces can generate more creativity, team cohesion, and positive emotions (Boehner et al. 2005; Salen and Zimmerman 2004).

Distance brings challenges for distributed teams wishing to have more structured game play activities. Even though team members can play games online, it is still an open question of how to motivate teams to engage. Distance also sets up a barrier for teams to conduct other effective interventions through a more generally playful experience. Some studies explored this challenge. For instance, by allowing lab mates to post informal, playful, personal notes to an interactive display in the workplace, Netboards demonstrated that it successfully maintained group awareness, promoted trust, and built a sense of community in the workplace (Wood and Robinson 2014).

Therefore, our sixth insight is: **I6 - Supporting distributed teams to have playful experiences benefits teams, but requires more exploration.**

## **2.3 Human Emotions in the Workplaces**

### **2.3.1 Socio-emotional communication and experience**

Socio-emotional communication plays an important role in informal social interactions (Scholl 2013). People share feelings through both verbal and nonverbal communication, exchange information about each other's personalities and affective information, which ultimately influences their interpersonal behaviors (Scholl 2013).

Emotions play an important role in teamwork. Fundamental research about human emotions in the workplace has contributed to our understanding of the behaviors in

organizations (Bono and Ilies 2006; Judith A. Holton 2001). Studies show that emotions are linked to motivation (Erez and Isen 2002), creativity (George 1991), work performance (Mark et al. 2016), and individual employees' well-being (Diener, Oishi, and Lucas 2003). More specifically, positive emotions, as defined by Fredrickson (Fredrickson 2013) as "individuals' transient inner states of joy, interest, pride, contentment, and the like," have positive influences for organizational behaviors (Seligman, Martin E P et al. 2005). Recent studies also demonstrated emotion contagion as "a process by which group members influence the emotions or behavior of other members via conscious or unconscious transfer of emotions, behaviors and attitudes" (Guillory et al. 2011), which influences levels of cooperation and performance and lowers levels of conflicts in teams.

There has been a growing interest in using digital devices to detect and improve mood. Studies have used sensors and image recognitions to detect and measure human emotions in the workplace (Matic et al. 2011; Tsujita and Rekimoto 2011). One issue associated with detecting and measuring human emotions relates objective measures with subjective human experience. It is still an open challenge to link the objective signals captured by digital devices to meaningful human emotions (Leahu, Schwenk, and Sengers 2008). To help transmit and communicate subjective human emotions, in more recent studies researchers have begun to look to arts and humanities (Höök, Sengers, and Andersson 2003), which deal more with the subjective nature of affective experience. Instead of modeling human emotions, affective systems should communicate emotions through an ambiguous and evocative aesthetics derived from user-selected parameters (Boehner et al. 2005; Leahu, Schwenk, and Sengers 2008).

For instance, “Office Plant #1” (Figure 2.3) is a robotic sculpture that can respond to the emotional and social tenor of users’ email streams. By filtering users’ emails into categories, the plant shape changes, responding to different emotional and social categories. No explicit meaning is associated to the change of shape, but it clearly requires subtle interpretations of the plant by users to perceive what is going on and to have an affective experience (Böhlen and Mateas 1998).



Figure 2.3 Office plant #1 (Böhlen and Mateas, 1998)

Our seventh insight builds on top of the recent trend in communicating and experiencing human emotions in the workplaces: **I7 - It is beneficial for distributed teams to support socio-emotional communication via subjective affective experiences.**

### **2.3.2 Positive emotions in the workplaces**

Positive emotions contribute to emotional well-being, which is an essential part of mental health (Chen, Mark, and Ali 2016; Ryff and Keyes 1995). Moreover, positive emotions have been proven to benefit teams with frequent, hard-to-solve conflicts (Hinds and Bailey

2003). When people feel good, they are more creative and open-minded. Such positive emotions ultimately contribute to a reduction of conflicts caused by a lack of understanding and compassion among team members.

Self-expression has been shown to promote positive emotions (Cowan 2010; Wood and Robinson 2014). Through disclosing and sharing feelings, thoughts, and values, people make themselves more recognizable and understandable (H. S. Kim and Sherman 2007). For example, one study demonstrated that taking selfies of smiling faces can bring positive emotions (Chen, Mark, and Ali 2016). Expressive acts create opportunities for further communication between individuals and thus increases the opportunities to resolve potential conflicts. They also prompt emotional contagion, because when people express themselves their emotions and preferences become more concrete and observable (H. S. Kim and Sherman 2007), which promotes further positive emotions.

In order to support self-expression, different approaches have been demonstrated to be effective (Bargh John A., McKenna Katelyn Y. A., and Fitzsimons Grainne M. 2002; Church, Hoggan, and Oliver 2010; D. Kim and Lim 2012; Kleinman, Carney, and Ma 2014). Cowan argued that instead of the typical communication mechanisms available on mobile devices, we should design mechanisms that support self-expression through implicit interactions for informal visual communication (Cowan 2010). iSpace (D. Kim and Lim 2012) is an example that uses the concept of interactivity as a new medium for self-expression in online communication. MobiMood (Church, Hoggan, and Oliver 2010) is another example that enables groups of people to express their current moods to increase mood awareness and communication among group members. Those social applications enable users to express

the “self” in different ways while creating a good opportunity for users to interpret each other’s expressions, emotions, and thoughts.

Therefore, our eighth insight is: **I8 - Encouraging self-expressions helps build positive emotional contagions in the workplace.**

## **2.4 Summary**

In the first three sections in this chapter, we synthesize insights from previous research in three fields: 1) studies about distributed teams and team building in CSCW; 2) play at work; and 3) human emotions in the workplace. Reviewing literature in those three fields illuminated the challenges distributed teams are facing, approaches studies have taken to tackle the challenges, potential benefits, and open questions that still require further investigation and exploration. Table 2.1 summarizes the eight insights, which forms an overview of the theoretical foundations of this work. Those eight insights comprise the critical sources of intuition for our proposed solutions. Together with empirical evidences obtained from Study I, we propose a theoretical model as the essence of the proposed solution, described in Chapter 4.

Table 2.1 Summary of insights from related work.

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<b>Insights</b>
I1 - The lack of <b>common ground</b> is a huge barrier to building up a trusting and cohesive team at a distance.
I2 - Trust depends on <b>knowledge</b> about the individual team member, as well as the <b>experience</b> of working on something together.
I3 - <b>Informal social interactions</b> can successfully help teams build trust.
I4 - Team cohesion is associated with <b>deep-level diversities</b> such as attitudes, beliefs, and values.
I5 - It is promising to use <b>team building interventions</b> from offline contexts to online contexts in distributed teams to improve team cohesion.
I6 - Supporting distributed teams to have <b>playful experiences</b> benefits teams but requires more exploration.
I7 - It is beneficial for distributed teams to support socio-emotional communication via <b>subjective experiences of affect</b> .
I8 - Encouraging <b>self-expression</b> helps build positive emotional contagion in the workplace.

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## **Chapter III.**

# **Study I: Exploring Online Playful Drawing in Teams**

## **3.1 Motivation**

In Chapter 2, we conceptually established the insights around the challenges and potential solutions. The insights shed light on an approach of using online playful activities as team building interventions in distributed teams to build up a trusting and cohesive team. One assumption is: through appropriately designed online playful activities, distributed teams can build common ground, have informal social interactions, gain deep-level knowledge about their team members such as values, personalities, and attitudes, and therefore could achieve trust and cohesion. Moreover, team members could be expressive through the playful experience and experience subjective human emotions, and therefore obtain effective socio-emotional communication with each other. In this chapter, we describe a lab-controlled study that we conducted in order to investigate the initial assumptions.

When making the initial design decision to embed a specific playful activity in the mechanism design, we looked to the arts, which was also discussed in Senger's work (Boehner et al. 2005; Leahu, Schwenk, and Sengers 2008), as well as a broad spectrum of team building literature (Adler 2015; Antal 2009, 2013; Austin, Devin, and Sullivan 2011; Schiuma 2011). Art-based research for engaging the unknown through artistic interventions

in organizations has demonstrated its capacity to turn ambiguity into inspiring resources for businesses (Antal 2009). Besides boosting new perspectives and creativities, art is also broadly applied in organizations to build up teams. Researchers in positive psychology have a long history of using art therapy to promote positive emotions, create a favorable social environment, and reduce interpersonal conflicts (Oshri, Kotlarsky, and Willcocks 2008). Art contributes to these aspects through expressive activities, such as dancing and drawing (Malchiodi 2013). People see and sense the world and the “self” through the tangible, sensual form that art brings. Art materials help people explore thoughts and feelings and create meanings. The art activities help employees learn about themselves and their colleagues and feel more passionate about their jobs, their companies, and even their lives in general (Antal 2009). Among a varied type of artistic interventions, we chose to embed drawing in the online playful activity for further investigation.

Drawing, as an artistic activity, inherits the notion of “expression of affect” as a central role (Goodman 1968). The rich expressivity afforded by drawing can promote distributed collaborators’ non-verbal communications. Interacting via collaborative drawing can disclose personal affective information about the participants such as thoughts, preferences, personalities, and even values. The experience of collaborative drawing can help create echoes in the team and build up the team spirit. The online space for collaborative drawing can facilitate informal social interactions and socio-emotional communication. Moreover, drawing is a familiar creative practice with a small learning curve. It is also easy to visualize the information gathered from distributed team members, since drawing heavily depends on visual representation. Practically, it is an ideal practice as a concrete example of playful activities to investigate in our study.



Therefore, the motivation of this study was to empirically examine the effects online playful drawing has on distributed teams. The results would verify our initial assumptions based on the insights from related literature.

## 3.2 Research Questions

In general, since co-location is the best setting for collaboration (Olson and Olson 2000), it is often a baseline in experiments of this nature. Therefore, we intended to evaluate the effects of playful drawing in a distributed setting as compared to a co-located setting, and sought to answer our first research question:

**RQ1:** Compared to a co-located setting, how effective is playful drawing in improving team trust, enhancing team cohesion, and promoting individual positive emotions in distributed teams? Given that ambiguity in drawing could support the freedom of an individual's self-expression, we wanted to empirically investigate:

**RQ2:** Do the effects differ between different modes of drawing?

Developing theoretical knowledge and deriving practical design implications requires deep understandings of how playful drawing reaches (if it does) its potential in building up distributed teams. Therefore, we sought to answer:

**RQ3:** How does playful drawing influence trust, cohesion and emotions?

Finally, the definition of an online playful activity was derived from classic literature that defined "play." However, we were also interested in understanding the playful experience from findings grounded in an empirical study with existing, professional teams. Therefore, we wanted to empirically explore:

**RQ4:** What is the positive, perceived experience in a playful drawing activity?

## 3.3 Study Design

### 3.3.1 Approach

We designed a 2×2 factorial controlled lab experiment. The choice of a factorial study allowed us to control the mode of drawing and the type of team configuration.

In this study, we used the website Groupboard,<sup>1</sup> a free online whiteboard with chat service that works on web browsers (Figure 3.1). This service does not require account information; users only need pseudonyms to collaborate and chat. One sketch room can support more than three users for real-time collaborative drawing. The functionalities are basic, but enough for simple drawing, including: line, shape, color fill, text, and eraser.

We explored two modes of drawing: 1) freeform drawing, in which we allowed participants to draw anything that they would like to express and share on the shared canvas. 2) directed drawing, in which we asked participants to “draw a building at participants’ university,” providing an image of the building outline for reference. We compared co-located drawing to distributed drawing in both modes. Table 3.1 shows a summary of the four conditions.

In the co-located conditions (C1, C2), participants drew in the same study room. They were allowed to talk while using the drawing tool. In the distributed conditions (C3, C4), participants drew in separate study rooms. They could chat on the website using the chat box.

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<sup>1</sup> <https://www.groupboard.com>

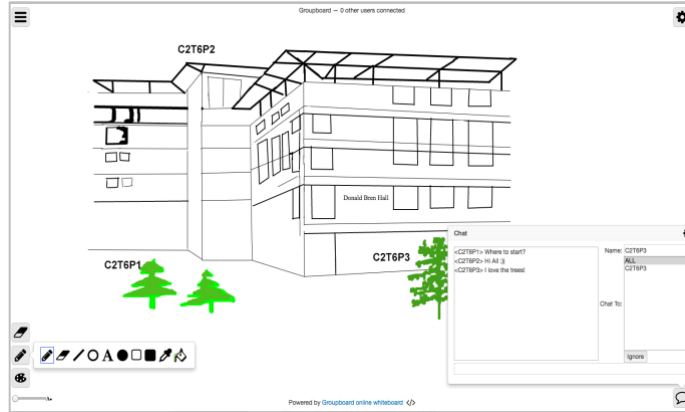


Figure 3.1 Users can draw and chat in a sketch room. This is the final drawing from one distributed team in study.

Table 3.1 Four conditions in the 2 × 2 factorial study.

	<b>Co-located</b>	<b>Distributed</b>
<b>Undirected</b>	C1	C3
<b>Directed</b>	C2	C4

### 3.3.2 Subjects

We recruited six teams under each condition, with three participants per team. We recruited participants through an official school mailing list to access all registered students in the School of Information and Computer Sciences from a North American research university. It was a requirement that eligible participants did not have any formal training in art before the experiment.

A total of 72 students participated. Among those participants, 34 were female and 38 were male; 8 were between 18 and 20 years old; 12 were between 21 and 23 years old; 18 were between 24 and 26 years old; and 34 were over 26 years old.

### **3.3.3 Study Process**

We randomly assigned 72 participants into four conditions. In each condition, we randomly assigned 18 participants into six teams. In order to avoid bias, we did not disclose the underlying inquiry of this study during the recruitment process. In all conditions, while introducing the study procedure, we told the team that they would collaborate on a software development project in a follow-up session. This helped the participants to expect a longer, more serious collaborative relationship with each other. We provided a dehoaxing at the end of each session, informing participants that there would be no follow-up session. We also required participants to keep the study content confidential in order to keep the deception effective for other participants.

In all conditions, teams participated in a 20-minute drawing session. Procedures in all conditions were identical, except that in undirected drawing conditions (C1, C3) during the introduction phase participants were told to “draw whatever you want to express;” and in directed drawing conditions (C2, C4) participants were told to “draw the building of School of Information and Computer Sciences.”

### **3.3.4 Data Collection and Measurements**

To examine the effects of each of the different conditions, we assessed three dependent variables: team member’s trust, perceived cohesiveness, and emotions. We used three standardized tests for each effect. All measures were specified on the individual level.

To measure trust, we measured team member’s “initial trustworthiness” before the study and “early trust” afterwards. According to Jarvenpaa’s model of trust in global virtual teams (Jarvenpaa, Shaw, and Staples 2004), initial trustworthiness is “a member’s trusting belief of the work team before it has started to interact,” and is measured using six items.

Early trust is “trust generated through early team interactions” and is measured using four items. The tests used five-point scale from 1=strongly disagree to 5=strongly agree.

To measure team cohesion, defined as “the degree to which team members desire to remain in the team” (Mullen and Copper 1994), we used the 10-item test for cohesion from Hoegl and Genuenden’s model of teamwork quality (Hoegl and Genuenden 2001). Participants were asked to take the test twice, before and after the study. The tests use a five-point scale from 1=strongly disagree to 5=strongly agree.

To measure individual emotions, defined as “individuals’ transient inner states” by Fredrickson (Fredrickson 2013), we used the 20-item test of Geneva Emotion Wheel (Bänziger, Tran, and Scherer 2005). This test includes self-assessment of ten positive emotions and ten negative emotions. The tests used a six-point scale for intensity from 0=not at all to 5=extremely strong. Total scores were calculated for two dimensions of emotions: positive and negative. Scores for these two dimensions range from 0-50 respectively.

We recorded participants’ activities in study rooms and also took screenshot recordings of activities in the online sketching rooms. At the end of each study session, we conducted semi-structured interviews with the participants separately. Each of three researchers interviewed one of the team members. All researchers followed the same interview script to maintain consistency across the elicitation questions. Interviews were 10-40 minutes and were audio recorded. Some example interview questions were: how did your team approach the final drawing? What did you want to express during the activity? How did the other peoples’ drawings change your behaviors? Do you think this activity helped you build trust/cohesion and how? How do you feel?

### 3.3.5 Data Analysis

To answer our research questions, we conducted a Linear Mixed-Effect Model (LME4) in SPSS to compare the main effects of setting and mode on trust, cohesion, and emotions (positive and negative) respectively. We used the before and after test results as within-subject variables, and setting (co-located vs. distributed) and mode (undirected vs. directed) as between-subject variables. We also used 24 groups as the random effect.

To answer our research question 3 and 4, we conducted an iterative, qualitative data analysis of 72 interviews (Hoffart 2000). The process consists of conversations with the study participants. We associated related insights with the quantitative results to discover potential explanations. Table 3.2 summarizes the analysis methods.

Table 3.2 Summary of data analysis methods.

<b>RQ1: Compared with a co-located setting, how effective it is to use collaborative online drawing to improve team trust, enhance team cohesion, and promote individual positive emotions in distributed setting?</b>	
<b>RQ2: Do the effects differ between undirected, freeform drawing and directed drawing?</b>	
<b>Data</b>	72*2 questionnaires
<b>Method</b>	LME4
<b>Within-subject Variables</b>	Trust: initial trustworthiness and early trust Cohesion: before and after values Emotions: before and after values
<b>Between-subjects Variables</b>	Setting (Co-located vs. Distributed) Mode (Undirected vs. Directed)
<b>RQ3: How does the DARTS intervention influence trust, team cohesion and individuals' emotions?</b>	
<b>RQ4: What is the positive, perceived experience in a playful drawing activity?</b>	
<b>Data</b>	72 interviews
<b>Method</b>	Qualitative data analysis

## **3.4 Findings**

### **3.4.1 Changes of People's Trust, Cohesion and Emotions**

Table 3.3 presents the changes in participants' trust, cohesion, positive emotions, and negative emotions. All effects were statistically significant at the 0.05 significance level except for the effect on trust ( $p=0.22$ ). Specifically, team cohesion and positive emotions increased ( $p=0.002$ ;  $p<0.001$ ), and negative emotions decreased ( $p=0.037$ ).

### **3.4.2 RQ1 & 2: Effects of team setting and drawing mode**

The statistical results show that the random effect does not account for a meaningful amount of variance (Table 3.4). Therefore, we only report the fixed effects. Table 3.3 presents the results of the analysis, showing the fixed effects of two independent variables: setting (co-located vs. distributed) and mode (undirected vs. directed) on trust, team cohesion, and emotions.

#### ***Trust***

The results show that the effects of setting or mode were not significant on trust. In sum, participants' early trust was not significantly different than their initial trustworthiness no matter where they drew or what they were asked to draw.

#### ***Cohesion***

The results show that the effects on cohesion were not significant for different types of setting and drawing modes. In sum, participants' perceived team cohesiveness significantly increased; but the intervention in distributed teams was as effective as in co-located teams and there was no significant difference in undirected and directed drawing.

Table 3.3 Fixed effects of setting and mode on trust, cohesion and emotions. \*\*\* = p<0.001, \*\* = p<0.01, \* = p<0.05.

Data Type	Factor	Initial Trustworthiness	Early Trust	% Inc.	df	F	p-value
<b>Trust</b>	Trust	3.7	3.6	- 2.7	1	1.543	0.22
	Trust*Setting				1	0.119	0.732
	Trust*Mode				1	0.119	0.732
	Trust*Setting*Mode				1	0.495	0.484
Data Type	Factor	Before Mean	After Mean	% Inc.	df	F	p-value
<b>Cohesion</b>	Cohesion	3.01	3.2	<b>6.3</b>	1	12.918	<b>0.002*</b>
	Cohesion*Setting				1	0.332	0.571
	Cohesion* Mode				1	1.795	0.195
	Cohesion*Setting*Mode				1	1.332	0.262
<b>Positive Emotions</b>	Positive Emotion	20.32	25.99	<b>27.9</b>	1	24.788	<b>0.000**</b>
	PEmotion*Setting				1	7.339	<b>0.014*</b>
	PEmotion* Mode				1	7.339	<b>0.014*</b>
	PEmotion*Setting*Mode				1	0.01	0.923
<b>Negative Emotions</b>	Negative Emotion	4.78	3.31	<b>- 30.8</b>	1	4.998	<b>0.037*</b>
	NEmotion*Setting				1	3.29	<b>0.045*</b>
	NEmotion*Mode				1	2.18	0.155
	NEmotion*Setting*Mode				1	0.514	0.482

Table 3.4 Random effects of group variance.

Data Type	Estimates of Covariance Parameters	
	Residual	Group Variance
<b>Trust</b>	0.43	0.001
<b>Cohesion</b>	0.16	0.079
<b>Positive Emotions</b>	56.35	12.31
<b>Negative Emotions</b>	19.14	4.03



Table 3.5 Descriptive statistics of emotions' changes in four conditions.

Data Type	Setting	Mode	Before Mean	After Mean	% Inc.	N
Positive Emotions	Co-located	Undirected	18.22	23.78		18
	Co-located	Directed	21.72	21.33		18
	Distributed	Undirected	19.83	31.78		18
	Distributed	Directed	21.5	27.06		18
Total	<b>Co-located</b>		19.97	22.56	12.97	36
	<b>Distributed</b>		20.67	29.42	<b>42.33</b>	36
	<b>Undirected</b>		19.03	27.78	<b>45.98</b>	36
	<b>Directed</b>		21.61	24.19	11.94	36
Negative Emotions	Co-located	Undirected	6.56	2.44		18
	Co-located	Directed	3	1.78		18
	Distributed	Undirected	5.17	4.39		18
	Distributed	Directed	4.39	4.61		18
Total	<b>Co-located</b>		4.78	2.11	<b>- 55.86</b>	36
	<b>Distributed</b>		4.78	4.5	- 5.86	36
	<b>Undirected</b>		5.86	3.42	- 41.64	36
	<b>Directed</b>		3.69	3.19	- 13.55	36

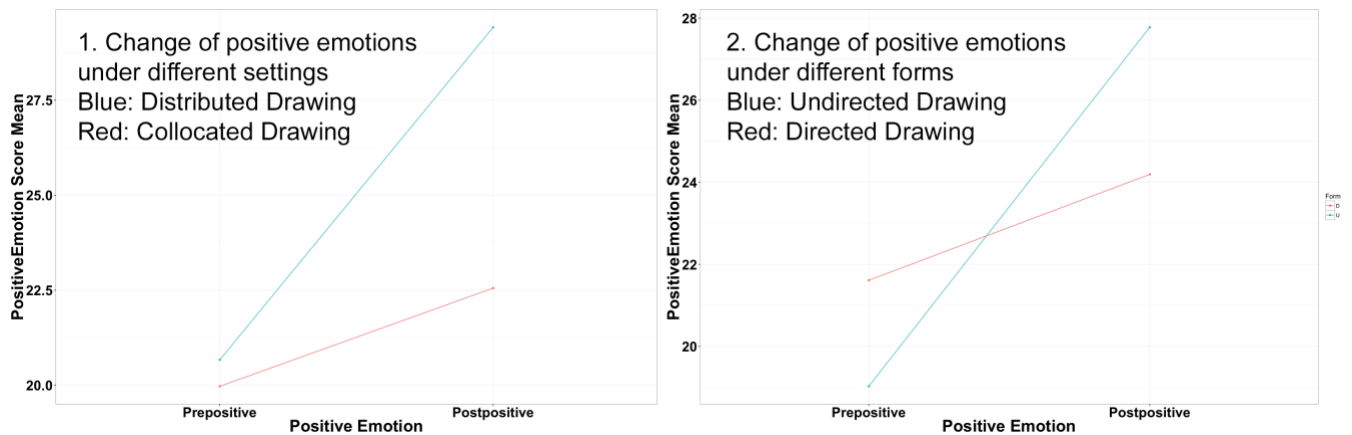


Figure 3.2 Changes of positive emotions. Line starting points: mean of before values, line ending points: mean of after values.

## ***Emotions***

The results showed that the effect of setting was significant. The main effect for setting on positive emotions yielded an F ratio of  $F(1, 68)=7.339$ ,  $p=0.014$ ; on negative emotions, F ratio was  $F(1, 68)=3.29$ ,  $p=0.045$ . The effect of mode was significant on positive emotions with an F ratio  $F(1, 68)= 7.339$ ,  $p=0.014$ , but it was not significant on negative emotions. Table 3.5 presents a detailed statistical description of changes in emotions in all conditions. In sum, distributed drawing was more effective in increasing participants' positive emotions (%Inc.=42.33), but co-located drawing was more effective in decreasing people's negative emotions (%Inc.= -55.86). Undirected drawing was more effective in increasing people's positive emotions (%Inc.=45.98), and there was no significant difference between undirected drawing and directed drawing in terms of decreasing people's negative emotions. Specifically, Figure 3.2 shows the changes in positive emotions under different settings and modes respectively.

### **3.4.3 RQ3: How does playful drawing influence trust, cohesion, and emotions?**

The results showed that during the activity participants could express themselves about “the thoughts and feelings on top of head” at the moment, how they usually “approach things,” the “new aspects of self,” etc. The insights below are syntheses of how the intervention worked from the interviews with the participants.

#### ***Trust***

The results did not reveal significant increases in the participants' trust for all conditions. However, we still discovered some potential explanations. This contributes to future tool design that could successfully help people build trust.

### *1. Participants became more reasoned for serious collaborations*

Our results showed that the initial trustworthiness in each condition was high, with the lowest as 3.44 out of 5 (C4), and the highest as 3.95 out of 5 (C2). From the interviews, participants commented that the drawing activity was a “low-risk project” in which they experienced more “playing with each other.” So, participants were already less tense and more trusting at the beginning of the study. They also mentioned that as time passed the trust and confidence of collaborations increased. However, at the end of the activity, when participants needed to think about serious collaborations, they had a more reasoned attitude towards the strangers they had interacted with for just awhile. Participants provided more concrete concerns about collaborations and the potential collaborators, as presented in the next point.

### *2. Participants wanted to know the professional side of the teammates*

Table 3.6 shows a synthesis of what participants actually got to know about each other from the activity, and what they still needed to know in order to work with the other two teammates. There was no difference in participants’ feedback across all conditions. In summary, participants got a chance to know about the personal and “soft” side of their teammates by interacting with each other during the drawing activity. For example, one participant said she sensed one of the other teammates “is someone who has leadership, because he or she proposed to make a plan of what to draw and how to draw first.” Most of the participants said they felt the other two teammates were “being friendly, and helpful.”

However, the knowledge from a short, single, 20-minute drawing session did not provide any knowledge about the others’ professional skills. Although some of the participants mentioned that this activity helped them to build “initial confidence” to work

with the potential teammates, the lack of knowing about the “hard” or professional side of their teammates makes them still not confident enough to trust each other in serious collaborations.

Table 3.6 Information participants gained and still required for future collaborations.

<b>Knowledge they got about their teammates</b>	<b>Things they still needed to know for serious collaborations</b>
<ul style="list-style-type: none"> <li>- Hint of personalities</li> <li>- Hint of emotions in the moment</li> <li>- How people approach and handle things</li> <li>- People’s inner thoughts</li> <li>- People’s behaviors</li> </ul>	<ul style="list-style-type: none"> <li>- Names</li> <li>- Profiles</li> <li>- Technical skills</li> <li>- Professional background</li> <li>- How they handle difficulties</li> </ul>

***Cohesion***

The results showed that participants’ cohesiveness in all conditions increased. Our interviews reflect how the intervention made participants feel more cohesive with each other.

*1. Drawing created a common ground to start and continue conversations*

Participants told us that the activity and the drawing gave them “something in common” to talk about. Considering the activity only lasted for 20 minutes without a facilitator, working towards a common goal made it easier for participants to start and continue conversations. It was the conversations that made participants more comfortable with each other, and provided a higher degree in perceived cohesiveness.

*2. Mutual feeling made participants feel like a team*

Participants mentioned that when they accidentally worked on the same part of the drawing the mutual feeling made them feel more like a team. From our interviews, most participants were satisfied with the drawing results, and thought they together “did a good

job” that was “better than what I would have done alone.” The satisfaction about the final drawing strengthened the mutual experience participants had together, which made the team closer than they were at the beginning.

### *3. Curiosity about each other bonded the team together*

Defined by Hoegl and Genuenden’s model of teamwork quality, one important factor in team cohesion is the attractiveness of the teammates (Hoegl and Genuenden 2001). In our study, participants got a chance to learn something about the people they interacted with from their natural behaviors under the relaxing context of drawing. As stated in the previous section about trust, participants expressed their own as well as perceived each other’s personalities, ways of doing things, preferences, and some inner thoughts during the activity. Seeing what the others drew made participants become more “curious about the other ones.” This insight was more obviously reflected in C3, where participants did undirected drawings in a distributed setting. Without knowing who they drew with, participants became more interested in the people they were “messing around together with,” which thus could make the others become more interesting.

### ***Emotions***

Figure 3.3 shows the average changes in all 20 emotions across all conditions. The overall trend shows that positive emotions greatly increased, especially “amusement,” “joy,” and “pleasure.” Negative emotions decreased especially for “fear,” “guilt,” and “sadness.” Those emotions are highlighted in Figure 3. Our interviews aimed to reveal how the changes in participants’ emotions occurred, as well as why the intervention had different effects in different conditions.

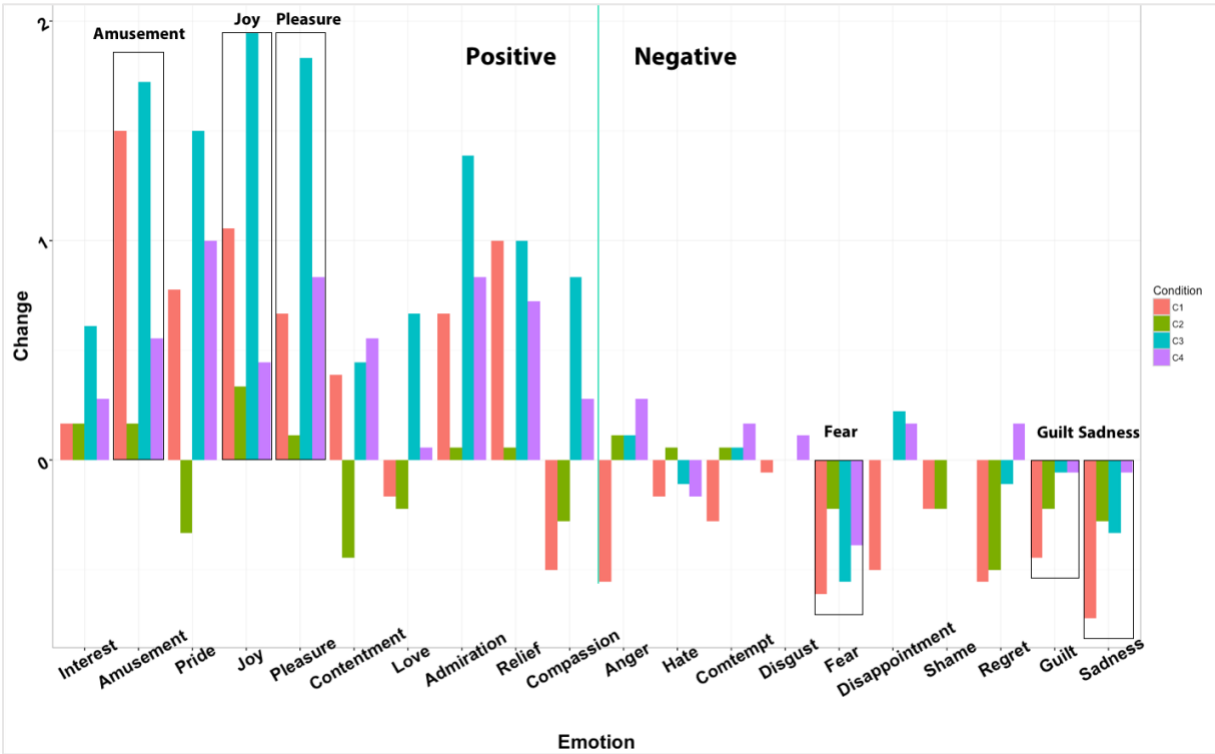


Figure 3.3 Changes of positive emotions and negative emotions across four conditions.

1. Participants tended to be accepting of mistakes and easy to be satisfied

The Groupboard service lacks an undo function, which simulates a natural experience of drawing. When participants made a mistake, they could choose to use the eraser but not undo. It happened frequently in our 24 study sessions that when someone accidentally filled up the whole canvas with a bright color and then realized there was no undo, the whole team laughed loudly. Even in distributed drawing conditions (C3, C4), our recordings show that participants laughed out loud when such mistakes happened even though they were physically drawing alone.

During the interviews, participants mentioned that making mistakes brought them positive emotions such as amusement, joy, and pleasure rather than negative emotions because: 1) it was a fun, low-risk activity so the tolerance of mistakes was very high; and 2)

they tended to be accepting under the context of “playing together.” Even if someone spoiled the drawing, participants would say “that’s fine,” “that’s ok,” or “it’s part of the art.” Meanwhile, when they themselves caused the mistakes, participants felt “frustrated,” “sorry,” “guilt,” and “disappointed.” This also explains why some negative emotions increased after the activity. But participants reflected that overall amusement was still greater than frustration. In addition, 3) the expectation was low about the final result. Participants were not chasing a masterpiece artwork; rather, they were “messing around together.” Therefore, most participants commented that they “did a good job” and thought “the drawing is very nice” even though not perfect. Low expectations brought high satisfaction and thus made participants happier.

## *2. Playing together made participants happier and relaxed*

It was common for participants to feel “fear” about the study at the beginning because they didn’t know what to expect, but after they had fun the “fear” decreased and they felt more “relaxed.” Even though the activity was a short, 20-minute session, the effect on emotional change was very obvious. Participants said: “it’s a fun activity to do in the middle of my work (school)”, and “we had fun, we had a great time.” As stated in the section on cohesion, drawing created a common ground to initiate conversations, and participants reflected that “talking to people made me happier.” From our study, participants talked about casual topics such as the choices they made in the drawing, topics initiated by the drawing, and side conversations inspired by the drawing. None of the conversations were serious or work-oriented; participants said the experience they had was “very similar to having a coffee or eating together.” Therefore, the intervention facilitated relaxing social-oriented interactions and helped participants become more positive overall.

### 3. Anonymity brought more equality for self-expression

Our results show that the intervention was more effective in distributed teams in terms of increasing positive emotions. Our interviews show that being able to anonymously draw was the reason.

We asked participants in C3 and C4 (distributed setting) whether they liked drawing without disclosing true identities or not, and most of them provided positive answers. Table 3.7 shows a synthesis of the advantages and disadvantages participants talked about in anonymous drawing. In general, participants could anonymously self-express without worrying about being judged or judging each other from names, genders, and other identities that are attached with social norms. The disadvantage relates to the inquiry about building trust.

Table 3.7 Pros and cons of anonymous drawing.

<b>Pros</b>	<b>Cons</b>
<ul style="list-style-type: none"><li>- More fun with less pressure</li><li>- Less worried about the results and responsibilities</li><li>- More willing to self-express</li><li>- More equal</li><li>- Less worried about being judged</li><li>- Less judgmental about collaborators</li></ul>	<ul style="list-style-type: none"><li>- Lack of information to build trust</li></ul>

### 4. Freeform drawing is more fun

Our results show that the intervention was more effective in undirected drawing in terms of promoting positive emotions. Our interviews show that it was simply because participants could have more fun with less rules or constraints in the activity, so they were freer to express, share, and converse with each other. Meanwhile, without an explicit goal, participants were less worried about the result. For example, in C1 and C3 (undirected



drawing), participants did not need to pay attention to the details in the reference we provided to make sure they drew the building correctly. Instead, participants expressed whatever was on their mind in the drawing, shared, and were able to see more aspects of each other. Figure 3.4 shows an example of distributed, undirected drawing.



Figure 3.4 “Spring is Coming” - the final drawing from a distributed team of undirected, freeform drawing.

### 3.4.4 RQ4: What is the positive, perceived experience in a playful drawing activity?

Based on the semi-structured interviews, we identified four facets of the experience afforded in the online playful drawing activities. Those four facets demonstrate a positive experience that an online playful activity could facilitate to promote positive effects in distributed teams.

## ***Expressive***

From the results, we found that it was more effective to use drawing to increase positive emotions in distributed teams. From the interviews, we found that the anonymity gave participants more freedom to reveal and express:

*P1: "I was less worried (about the result) because it's hard to recognize my crappy drawing from the abstract ID."*

*P2: "The anonymity encouraged me, e.g., if I drew something and turned out not to be as what I hoped, the anonymity released the pressure and the anxiety, and allowed me to try again and again."*

Drawing conveyed personalities, ways of doing things, and ideas and emotions beyond words, which communicate the soft side of teammates through non-verbal communications, even over a distance, as some participants mentioned:

*P3: "One of the other teammates is someone who has leadership, because he, or she, proposed to make a plan of what to draw and how to draw first."*

*P4: "P3 is creative, I can feel the other two are easy to work with." "I got to know how they behave in a team setting."*

*P2: "P1 is more freeform, P3 is more mathematical."*

The tolerated ambiguity and anonymity participants experienced to express and share in front of others made the undirected, freeform drawing and distributed drawing more effective, and the rich information participants received from the expressive drawing activity helped them to gain higher team cohesion and positive emotions.

## ***Reflective***

The facet of expressivity describes one side of the non-verbal communication drawing brings; being reflective is the other side of the complete communication channel. Drawing creates an open space for interpretations to allow people to express personal emotions without being limited by categories internal to the system. For example, one

participant can choose yellow to stand for happiness while the other participant may believe that red is linked to happiness. The explicit meanings are not the key to transmitting and communicating human emotions; it is the reflective process, when participants initiated to read, reflect, and understand what the other people are trying to tell them that affords an affective experience.

From our observation, Participants in the same team usually have different interpretations of the same drawing. They offered different readings of the drawings when they recalled their experience, showed a positive attitude when they narrated the experience to the researchers, and apparently gained reflections and understandings of each other, their own ways of cooperation, and so on, through this activity.

As a form of artistic and creative practice, drawing enables people to see and sense the world and the “self” through the tangible, sensual form, arousing a particular feeling or emotion and supporting reflections and new understandings through a ludic activity.

### ***Interactive***

Drawing successfully created a common ground among participants to initiate conversations. For example, P5 mentioned:

*“It gave us something in common to talk about. It’s easier to talk to the teammates because we are already working on something.”*

Similarly, P6 said:

*“It gives us something to focus on, if I just try to talk to someone and be friendly, there is no direction, you don’t know what to talk about, but here you can talk about the tasks, and even laugh about something.”*

Drawing in this way facilitates the interactions among teammates beyond everyday work in a relaxing and playful way.

After initiating conversations, seeing how others draw makes anonymous “teammates” interesting, which encourages participants to build on each other’s drawing and therefore enhances the mutual experience of working towards a common goal.

For example, like what P7 said:

*“The fun experience made us become more interesting. It made me very curious about the other ones.”*

And P8 said:

*“It brings all together and keep all together, engaged, attached.”*

In this way, the interactions afforded by drawing activity become longer and more stable. And participants become more cohesive in return.

### ***Playful***

In our study, both of the drawing modes were non-work-related and non-competitive. Yet, from the interviews we discovered that participants in the directed drawing mode cared more about the result because they had a visual reference to refer to while drawing. Therefore, their drawing could be judged by rules (copying the visual reference for the building) we did not intentionally promote. On contrary, in the undirected, freeform drawing teams, participants could spend their time enjoying the fun activity and therefore gained higher degree in positive emotions. P9 talked about having fun in freeform drawing with others:

*“Drawing with the others gave me alternative ideas, drawing alone may be less funny, if drawing alone, I would try harder because people may laugh at me (for not drawing well).”*

Drawing in a free form is enjoyable and simulates a relaxing social context, albeit in a virtual online environment. One of the participants mentioned:

*P3: “The experience was very similar to having a coffee or eating together.”*

The enjoyable experience itself could engender more happiness, fun, and other positive emotions.

## 3.5 Discussions

Our study demonstrated that online playful drawing successfully helped build up teams. By answering the research questions 1 - 3, we found out that playful drawing activity was more effective on distributed teams and through open-ended, freeform drawing. By answering research question 4, we identified the four facets of the positive, perceived experience afforded by the playful drawing activity. Below, I list insights obtained from this empirical study as evidences.

**E1 - Anonymous interactions boost positive emotions.** Our study demonstrates that supporting anonymous interactions successfully boosts more positive emotions and experiences because participants feel less pressured to express themselves. But a more flexible mechanism that supports the desired levels of transparency in self-expression is needed to build actual trust.

**E2 - Open-ended interventions encourage self-expressions.** The results demonstrate that it is more effective to build up distributed teams through freeform activities, especially when aiming to promote positive emotions. Interventions with fewer rules will help create a more appropriate environment for teams to have informal social interactions. It should provide coworkers an open space to initiate conversations, rather than a limited context with strict rules or certain goals.

**E3 - Subjective experience of affective expressions is supported in ambiguity.** The results demonstrate that by its nature freeform drawing could tolerate more ambiguity

than directed drawing. The ambiguity in drawing afforded participants to imagine, experience, and reflect on information they gleaned from the informal social interactions with each other, including emotions. The subjective experience of affective expressions through drawing makes the activity enjoyable and playful.

**E4 - Multiple sessions for enduring interactions are required for profound engagement.** From our interviews, participants reflected that the session was short; they wished they could “finish the drawing” or “hope[d] it was longer.” For future playful activities, longer and multiple sessions should be supported to create a longitudinal and engaging experience. We also need mechanisms to keep track of the teamwork in drawings gradually and visually present it to the whole team.

**E5 - Valuable experience and knowledge builds up through non-work-related tasks.** We have discussed how the unexpected no-undo experience highly amused participants. The ability to have some unexpected, surprising, funny, and even silly moments helped team members share a mutual, non-work-related experience. The knowledge they gain about each other is valuable, such as about the personal fun side of coworkers. Teams can mess around, make mistakes without worry, play, be silly, and then build connections under this relaxing social context.

**E6 - The holistic positive experience consists of four facets: expressivity, reflection, interactivity, and playfulness.** Beyond the first five insights, we also identified the overall four facets of perceived positive experience from this study. Designing playful online activities for distributed teams should refer to those four facets and embed characteristics into a holistic online experience. By implementing design affordances that help team members experience those four facets of experience, we are confident that the

overall activity and experience can positively influence the teams, such as by promoting trust and positive emotions.

### **3.6 Limitations**

There are two limitations in this study: 1) since our study was conducted with student subjects in a simulated co-located/distributed environment, we did not have the opportunity to observe people's behaviors and reactions in a natural teamwork environment; and 2) we did not investigate the changes in participants' trust, cohesion, and emotions over time, e.g., with a concrete, follow-up project.

### **3.7 Summary**

We empirically examined the assumptions based on insights from previous literature. We studied how playful, collaborative, online drawing as a group intervention helped build up distributed teams. Knowing from the literature that playful, non-work-related activities could support informal interactions, we argued that we should expect it to facilitate trust, team cohesion, and positive emotions. We thus evaluated the changes in trust, team cohesion, and emotions in a controlled study and compared the effects of the intervention in distributed versus co-located teams. We also compared undirected drawing with directed drawing to explore whether the mode of the activity influenced the effects.

The results showed that while participants' measured trust did not significantly change, there were significant increases in team cohesion and positive emotions. We also observed significant decreases in negative emotions. Regarding team cohesion, the intervention in distributed teams was as effective as in co-located teams; the intervention in the undirected mode was as effective as in the directed mode. Regarding promoting positive

Table 3.8 Summary of insights from study I.

<b>Insights</b>
E1 - <b><i>Anonymous</i></b> interactions boost positive emotions.
E2 - <b><i>Open-ended</i></b> interventions encourage self-expressions.
E3 - Subjective experience of affective expressions is supported in <b><i>ambiguity</i></b> .
E4 - <b><i>Multiple sessions</i></b> for enduring interactions are required for profound engagement.
E5 - Valuable experience and knowledge build up through <b><i>non-work-related tasks</i></b> .
E6 - The holistic positive experience consists of four facets: <b><i>expressivity, reflection, interactivity, and playfulness</i></b> .

emotions, the intervention was more effective in distributed teams, because without disclosing identities participants had more equality to express themselves and therefore experienced more positive emotions; the intervention was more effective in undirected drawing because participants had more freedom to express themselves with freeform activities and therefore had more fun and became more positive. We identified four facets of positive experience in an online playful activity: expressivity, reflection, interactivity and playfulness.

This study provided new empirical insights to help better understand the problem space. It also demonstrated positive results in our initial attempt to promote freeform, lightweight, playful, and informal social interactions for distributed teams through a specific artistic practice. By “having fun,” coworkers at a distance could shake off stress, be accepting and forgiving, be open-minded, enjoy “messaging around” together in a digital “playground,” enjoy social moments like what co-located teams do when having coffee and tea, and be more cohesive and happier as a team. The new insights, in the form of evidences summarized in



table 3.8, complement our initial insights and further guided our building of a theoretical model.

## Chapter IV.

# A Theoretical Model for an Engaging Online Playful Experience

According to Study I, we identified four facets of participants' perceived experiences in an online drawing activity. Together, the four facets comprise a holistic playful experience that influences team trust, cohesion, and individual emotions. In this chapter, we organize the insights by designing a theoretical model. Overall, we propose that online playful activities that aim to support informal social interactions in distributed teams should support four types of experience: expressivity, reflection, interactivity and playfulness. We expect that designing for those four types of experience could engage teams in an online playful experience that could bring positive effects to team trust, cohesion, and positive emotions. The section below defines the four facets of experience, explains how these facets could help increase team trust, cohesion, and positive emotions, and describes eight design guidelines derived from the model that could guide future mechanism/system design. Figure 4.1 presents the overall model.

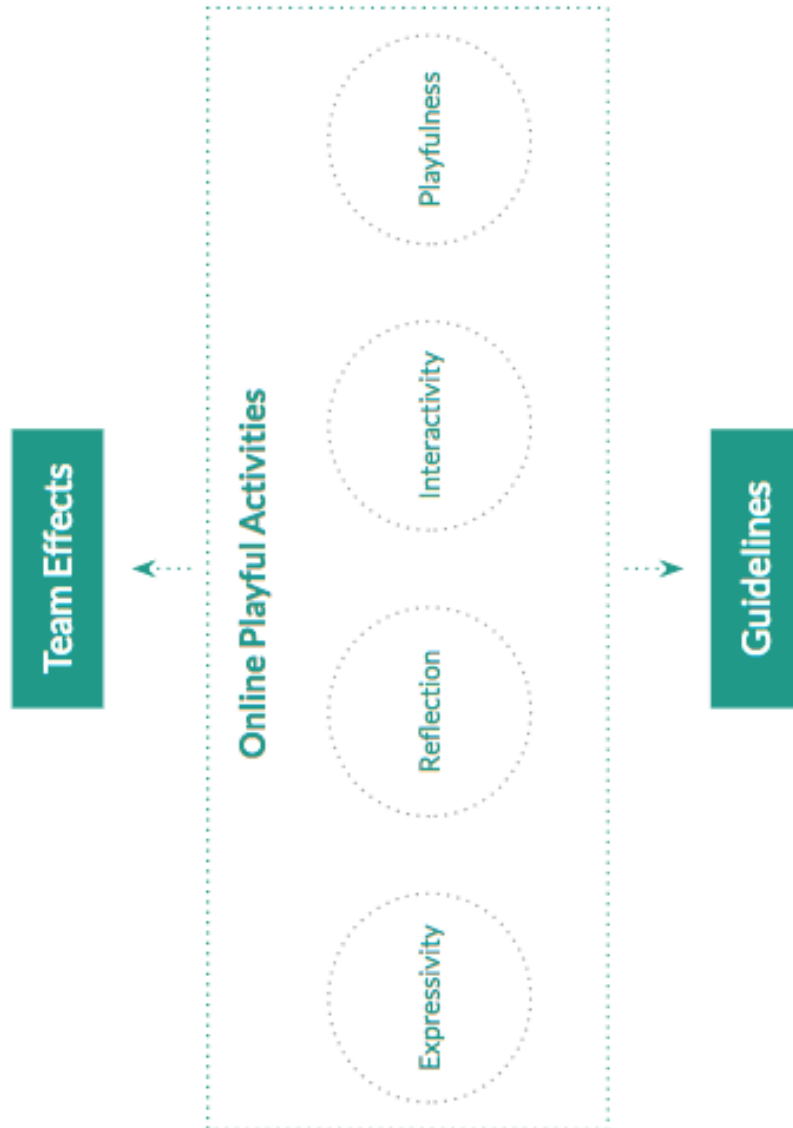


Figure 4.1 The theoretical model of four facets of online playful activities, team effects, and design guidelines.

## 4.1 Defining Four Facets of the Experience Afforded in Online Playful Activities

### 4.1.1 Expressivity

Previous work found the importance of non-verbal, emotional expressions at work and more generally in social interactions (Argyle 2013). To support implicit, non-verbal expression, work has been conducted around designing for digital expressions with a physical embodiment (Kleinman, Carney, and Ma 2014), and conveying sensor-driven data in an aesthetically encrypted way to address personal concerns (Moere and Hoinkis 2006). Other work explores the possibilities of “interactivity expressions” as a new form of self-expression in an online communication environment (D. Kim and Lim 2012). It was found that non-verbal, indirect aspects of self-expression during interactions in a social context provide accurate representation of that person to others (D. Kim and Lim 2012).

In this work, **we define “expressivity” as the experience of communicating through verbal and non-verbal self-expressions of thoughts, emotions, ideas, and preferences in an online playful activity.** For example, in the online collaborative drawing activity in Study I, participants emotionally expressed themselves through drawing. When they drew by texting, they explicitly expressed their thoughts and preferences through verbal communication. When they drew pixels, they implicitly expressed their preferences and other affective information such as values, thoughts, and emotional states with colors, shapes, and lines. Moreover, when they interacted with each other by drawing together, the non-verbal expressions were greatly supported and facilitated.

Therefore, the first facet of experience in an online playful activity should be around **supporting verbal and non-verbal expressions in a playful, informal social context.**

#### **4.1.2 Reflection**

The past decade has witnessed an emerging theme of reflective design in the field of Human-Computer Interaction (HCI) (Sengers et al. 2005). The research agenda of reflective design argued that “reflection on unconscious values embedded in computing and the practices that it supports can and should be a core principle of technology design.” Rooted in critical theory that “the world should be understood, not by accepting unthinkingly the teachings of authorities such as the Church, but through individual reasoning,” reflective design argues that “technology design practices should support both designers and users in ongoing critical reflection about technology and its relationship to human life” (Sengers et al. 2005).

In this work, inspired by the definition of critical reflections as “bringing unconscious aspects of experience to conscious awareness, thereby making them available for conscious choice” (Sengers et al. 2005), **we define “reflection” as the experience of turning unconscious knowledge received from online playful activities into conscious awareness of the self and others.** For example, the online collaborative drawing activity in Study I required a critical reflective process to interpret a drawing and understand the intentions behind the drawing. The new experience outside work-related tasks and relationships gave team members new understandings of their team, such as collaborators’ personalities, emotions, and the patterns of interactions they would have during a less serious activity. Reflections helped participants gain better awareness of themselves, their colleagues, and the relationship that they may have unconsciously neglected.

Therefore, the second facet of experience in an online playful activity should be around **supporting critical reflections on the self, others, and the relationship folded into the online playful activities.**

### **4.1.3 Interactivity**

A great deal of related work in HCI defines and researches “interactions” and “interactivities,” with a focus on studying the interface between users and computers (Dix 2009). More recent studies also research technologies that support interaction among a group of users, like an online community (D. Kim and Lim 2012). “Interaction” was defined as “a cyclic process in which two actors alternately listen, think, and speak” (Crawford 2002). Interactions involve a process of input, process, and output of information exchanged between two actors. Through the interactions, knowledge about each other builds up based on the exchanged information, impressions, and reflections (Klein et al. 2009b; Ilgen et al. 2005).

In this work, **we define “interactivity” as the experience of engaging with others through an online playful activity.** For example, in the online collaborative drawing activity in Study I, playful drawing facilitated interactions among co-workers because it visually presents the fun teamwork swiftly and can encourage further action to build the drawing. The activity created a common ground among participants to initiate conversations, and therefore to enhance interactions among people who otherwise do not talk much during their daily work.

Therefore, the third facet of experience in an online playful activity should be around **supporting a cyclic process in which participants interact with each other through online playful activities.**

#### 4.1.4 Playfulness

“Playfulness” is defined as a mental state of “being playful” in the context of other activities (Wardrip-Fruin and Harrigan 2004). In HCI, a research agenda around “ludic design” recognizes that playful or ludic activities are “not merely a matter of entertainment, or a waste of time, but can be a ‘mechanism for developing new values and goals, for learning new things and for achieving new understandings’” (Sengers et al. 2005). Playfulness is a common mental state that people can easily obtain from many daily activities, such as telling a joke, or creating nicknames for friends (Salen and Zimmerman 2004). A playful experience can be obtained when a spirit of play arises, but not necessarily during play (Salen and Zimmerman 2004). Previous work focuses on how to design for game play, a more structured playful activity with rigid rules (Salen and Zimmerman 2004), and ludic design (Gaver et al. 2004), which focuses on reflections and engagement through the experience of using the designed object.

In this work, **we define “playfulness” as the experience of a playful mental state during an online playful activity.** It should be intrinsically fun. For example, in the online collaborative drawing activity in Study I, anonymous playful drawing created pleasurable experience. The anonymous, non-work-related, non-competitive activity itself is intrinsically fun, which allows co-workers to have a mutual and engaging experience.

Therefore, the fourth facet of experience in an online playful activity should be around **supporting an intrinsically relaxing, engaging, and fun experience that can foster a playful spirit during online playful activities.**

Based on the definitions of the four facets of experience afforded by online playful activities, the sections below argue how the qualities of the experience, reflected in its four facets, could contribute to positive team effects in trust, cohesion, and positive emotions.

## 4.2 Hypothesis of Effects on Distributed Teams

This work focuses on team effects around trust, cohesion, and emotions. Before arguing why hypothetically designing the above four facets of experience could positively influence team effects, we restate the definitions of trust, cohesion, and positive emotions from previous work:

**Trust:** the “willingness to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party” (Mayer, Davis, and Schoorman 1995). Trust is influenced by the ability, benevolence, and integrity of the trustee, as well as the interactive dynamics between the trustor and trustee.

**Cohesion:** “the degree to which team members desire to remain in the team” (Cartwright 1968). Cohesion is primarily influenced by deep-level diversities such as values and beliefs.

**Positive emotions:** “individuals’ transient inner states of joy, interest, pride, contentment, and the like” (Fredrickson 2013). The focus on positive emotions in this work specifically lies on the individual level.

### 4.2.1 Expressivity and positive team effects

Expressions of personal affect help team members build knowledge of their co-workers’ personal sides. Self-expression helps team members share feelings rather than



information. Sharing implicit, emotional self-expressions can reduce the barriers to expressing feelings, which may eventually help team members develop unique intimate connections (Klein et al. 2009b). This kind of intimacy can lead to enhanced cohesiveness and trust among team members (Cross and Sproull 2004).

Self-expressions promote positive emotions (D. Kim and Lim 2012; H. S. Kim and Sherman 2007; Cowan 2010). Expressions of affective information also help share positive emotions such as fun, relaxation, and amusement, which potentially lead to emotional contagion in distributed teams (Bono and Ilies 2006). Therefore, we expect that the facilitated expressivity could enhance positive emotions.

#### **4.2.2 Reflection and positive team effects**

As discussed above, reflections could bring unconscious aspects of experience to conscious awareness (Sengers et al. 2005). During the online playful activities, reflections could help participants turn information they receive during play into awareness and knowledge about the self, each other, and the team. Such a process could reveal deeper level diversities in the team, such as values and preferences, which help team members develop a unique perception of intimacy by sharing feelings rather than information, therefore help build up trust and cohesion (Harrison, Price, and Bell 1998).

Reflections also contribute to a supported subjective experience of affect (Leahu, Schwenk, and Sengers 2008) that encourages more intuitive socio-emotional communication in teams, and is expected to promote positive emotions and emotional contagions.

### **4.2.3 Interactivity and positive team effects**

The informal social interactions fostered in the online playful activities help teams build trust (Dabbish 2008; Schumann et al. 2012; Wang and Redmiles 2015). Teams accomplish a low-risk, consequence-free task unrelated to their regular work. They can build common ground by doing something fun together at a distance, which helps make the team trusting and cohesive (Olson and Olson 2000).

The informal social interaction itself also has intrinsic properties to engage people in relaxing and fun communication that can generate positive emotions such as amusement and entertainment.

### **4.2.3 Playfulness and positive team effects**

The activity is ludic; as a dynamic and creative activity, it brings playfulness and enjoyment to its participants. Having a ludic experience intrinsically generates more positive emotions, among the many other benefits that playfulness can bring to teams (Ellis et al. 2008; Gallacher et al. 2015; Karl and Peluchette 2006).

It is also expected that the playful experience can make participants develop a playful spirit that encourages further engagement and more interactions. Through the interactions and communications in play, we expect team members create a team chemistry that is refreshing, energetic, and can ultimately contribute to trust and cohesion.

## **4.3 Design Guidelines**

In this section, we further develop eight guidelines for specific mechanism/system design that can empirically apply to distributed teams. Those design guidelines demonstrate a further step of developing the theoretical model and provide detailed design implications.

### 4.3.1 Designing for Expressivity and Reflection

Since expressions and reflections may happen synchronously, we came up with two guidelines to support the complete communication channel.

**G1 - Support anonymous participation:** future systems/mechanisms should support anonymous participation. By not exposing identities, people would be more free and willing to express and share their personal information, such as emotions and personalities. It would also be provocative to stimulate playfulness and reflections.

**G2 - Support open-ended, subjective affective expression in its ambiguity:** future systems/mechanisms should encourage subjective expressions that tolerate ambiguity, so people will have more chances to reflect, resonate, interpret, and understand each other, and therefore have affective experience and build emotional connections with each other.

### 4.3.2 Designing for Interactivity

**G3 - Easy access for distributed users:** to better support distributed teams who work from multiple locations globally, future systems/mechanisms should be easily accessible from different locations. For example, applications deployed to mobile can help teammates access the activities and participate whenever and wherever they would like to.

**G4 - Highly visible for distributed users:** visualizing the playful activities will engage team members at different locations. Distance makes it hard to have synchronized interactions, but accumulated visualization helps make the results asynchronous. Engagement will increase motivation and its positive effects.

**G5 - Longitudinal playful sessions:** future systems/mechanisms should support longitudinal sessions such as multiple sessions or asynchronous sessions. Team members

should be able to join sessions at will, but still interact in the activity because of its enduring characteristic.

### **4.3.3 Designing for Playfulness**

**G6 - Non-work-related:** this is crucial to fostering a low-risk, non-stressful, and playful experience. The experience team members have when they interact with each other in the system should be separate from their daily work, so they can worry less about results, performance, losses and gains, and confidentiality. They should be able to gain a more enjoyable experience aside from daily work routine and accumulate a more diverse knowledge about their distributed collaborators.

**G7 - Non-competitive:** similarly, non-competitiveness helps people spend more time expressing, sharing, interpreting without worrying whether their performance is “good” or “bad.” Such a mechanism would engender a truly playful experience and more positive emotions.

**G8 - Pleasurable/fun:** we cannot design an inherently fun experience, but we can design properties that afford a pleasurable or fun experience. To support the subjective nature of a fun activity, future system/mechanism design should support a rich set of user-defined parameters. When team members can express using a broad range of parameters, we expect their experience will be more fun.

In sum, in this chapter, we synthesize insights based on the literature review and an empirical study to develop a theoretical model, arguing why and how online playful activities could bring positive effects to distributed teams. This model as a research proposal summarizes the initial attempt to answer the research questions. This model also guided the

next step of designing and building an online system for distributed teams to have playful activities and build trust, cohesion, and positive emotions.

## Chapter V.

# DARTS: A Playful Drawing System

In Chapter 4, we outline the theoretical model around online playful activities for distributed teams. The model captures the key attributes that comprise the playful experience and its potential positive effects. We also developed eight specific design guidelines as implications for future mechanism/system design. In this chapter, we document and describe how we applied the design guidelines to create an application called DARTS. DARTS aimed to realize the research proposal in a concrete form, solve the problems described in Chapter 1, and was evaluated in our final study. By building our own application to support online playful drawing activities and conducting an evaluative study around the application with industry teams, we created knowledge through an iterative process. Keeping the key, concrete playful activity consistent across two studies also provides interesting contrasts in the results, as we can conclude what improved and what did not. The findings shed light on implications for a broader scale of online playful activities.

In this chapter, we apply the typical user-centered design method (Abrams, Maloney-krichmar, and Preece 2004) to describe the design process, including capturing the basic users' needs, use cases, system features, prototype, and finally, the system demo.

## 5.1 Goals and Use Cases

In this section, we apply use cases, an important and valuable technique that has been widely used in modern software engineering (Jacobson 1993) to define the interactions between users and DARTS. We chose to use the “casual” use case defined by Cockburn

(Adolph, Cockburn, and Bramble 2002) since the interactions in DARTS are not as complex as some other systems and are not fully addressed. The process starts with defining goals.

### 5.1.1 User needs and goals

Our intuitions about user needs were drawn from secondary research through literature review, as described in Chapter 2, and through the initial lab study, as described in Chapter 3. Although the theoretical model in Chapter 4 presents a highly synthesized system of insights, in this section we unpack the model and tease out the fundamental needs. Those needs built up based on insights from Chapter 2 and 3, but with a more specific focus on the actual users’ needs for the drawing application we designed.

Table 5.1 presents needs and the sources where they emerged from. Based on the needs, I took a bottom-up approach to synthesize the higher-level goals. This method is well applied in user-centered design and analysis (Abrams, Maloney-krichmar, and Preece 2004) and has been proven sufficient for ensuring positive user experience of a system. Table 5.2 presents the goals.

Table 5.1 Needs of building up a distributed team through playing online.

Need	Insight	Source
N1 - Users need to build common ground through drawing	I1 - The lack of common ground is a huge barrier to build up a trusting and cohesive team at a distance	Secondary research
N2 - Users need to know more about their team members through information from the drawing	I2 - Trust depends on knowledge about the individual team member, as well as the experience of working on something together	
N3 - Users need to know more about their team members through drawing together		

N4 - Users need informal social interactions beyond the formal work relationship	I3 - Informal social interactions can successfully help teams build trust		
N5 - Users need to get to know deep-level information about their team members	I4 - Team cohesion is associated with deep-level diversities such as attitudes, beliefs, and values		
N6 - Teams need to draw in a team building activity	I5 - It is promising to use team building interventions from offline to online in distributed teams to improve team cohesion		
N7 - Teams need to relax and have fun in drawing	I6 - Supporting distributed teams to have playful experience benefits teams but requires more explorations		
N8 - Users need to have user-selected parameters to express subjective feelings through drawing	I7 - It is beneficial for distributed teams to support socio-emotional communication via supporting subjective experience of affect		
N9 - Users need to have user-defined parameters to perceive subjective affective experience through drawing			
N10 - Users need to be able to freely express through drawing	I8 - Encouraging self-expressions helps build positive emotional contagions in the workplaces		
N11 - Teams need to be able to see the drawing built up for possible emotional contagions			
N12 - Users need to be able to hide identities in drawing	E1 - Anonymous interactions boost positive emotions		Empirical observations
N13 - Teams need rule-less drawing that is not subject to any objective evaluations	E2 - Open-ended interventions encourage self-expressions		
Same as N8 & N9	E3 - Subjective experience of affective expressions is supported in ambiguity		



N14 - Users need asynchronous sessions to draw at different times	E4 - Multiple sessions for enduring interactions are required for profound engagement	
N15 - Teams need non-work-related drawing tasks	E5 - Valuable experience and knowledge build up through non-work-related tasks	

Table 5.2 User goals.

Need	Goal
N1 - Users need to build common ground through drawing	UG1 - Obtain information stored in the system of team members
N2 - Users need to know more about their team members through information from the drawing	
N5 - Users need to get to know deep-level information about their team members	
N3 - Users need to know more about their team members through drawing together	
N4 - Users need informal social interactions beyond the formal work relationship	UG2 - Hide identity
N15 - Teams need non-work-related drawing tasks	
N12 - Users need to be able to hide identities in drawing	
N6 - Teams need to draw in a team building activity	UG3 - Draw collaboratively
N7 - Teams need to relax and have fun in drawing	UG4 - Draw less seriously
N8 - Users need to have user-selected parameters to express subjective feelings through drawing	UG5 - Define and select parameters at will
N9 - Users need to have user-defined parameters to perceive subjective affective experience through drawing	

N10 - Users need to be able to freely express through drawing	
N13 - Teams need rule-less drawing that is not subject to any objective evaluations	
N11 - Teams need to be able to see the drawing built up for possible emotional contagions	UG6 - Draw asynchronously
N14 - Users need asynchronous sessions to draw at different times	

### 5.1.2 Goals from design guidelines

In chapter 4, we discussed eight design guidelines to guide mechanism/system design for online playful activities. In designing DARTS, we also looked back and applied the guidelines to shed light on how to design for the four critical facets of an overall positive experience. We develop the guidelines in the scenario of an online drawing system as system goals, as shown in table 5.3. Since the design principle and the user need analysis are grounded from the same resources, they echo to each other with different levels and granularities. Therefore, we also organize and group the two different sets of needs and came up with a higher-level category as “Summary Goals” in table 5.4, defined in Cockburn’s style of use cases (Adolph, Cockburn, and Bramble 2002).

Table 5.3 System goals.

Goal	Design Principle
SG1 - Users don’t need to login or share their identities for participation	G1: Support anonymous participation
SG2 - Users can select drawing parameters at will	G2: Support open-ended, subjective affective expressions in its ambiguity
SG3 - The drawing should be freeform	

SG4 - The system should be mobile friendly	G3: Easy access for distributed users
SG5 - The collective drawing is shared with all participants	G4: Highly visible for distributed users
SG6 - The system should support multiple, asynchronous sessions	G5: Longitudinal playful sessions
SG7 - The drawing content absolutely separates from work	G6: Non-work-related
SG8 - There is no rules to judge the results	G7: Non-competitive
SG9 - The system is overall a fun application to play with	G8: Pleasurable/fun

Table 5.4 Summary Goals.

<b>User Goal/System Goal</b>	<b>Summary Goal</b>
UG1 - Obtain information stored in the system of team members	Go1 - Accurate trace of drawing
UG2 - Hide identity	Go2 - Anonymous drawing
SG1 - Users don't need to login or share their identities for participation	
SG7 - The drawing content is completely non-work-related	
UG3 - Draw collaboratively	Go3 - Asynchronous, collaborative drawing
UG6 - Draw asynchronously	
SG5 - The collective drawing is shared amongst all participants	
SG6 - The system should support multiple, asynchronous sessions	
UG4 - Draw less seriously	

SG9 - The system is overall a fun application to play with	Go4 - Freeform, less serious drawing
UG5 - Define and select parameters at will	
SG2 - Users can select drawing parameters at will	
SG3 - The drawing should be freeform	
SG8 - There are no rules to judge the results	
SG4 - The system should be mobile friendly	Go5 - Draw from laptop and mobile devices

### 5.1.3 Use Cases

Since the expected interactions in DARTS are less complex than other systems that have more levels of information architecture, the summary goals well represent users' needs and are worthwhile to analyze via use cases. Each use case below describes a scenario of interactions a user may have with DARTS to achieve a goal.

#### *Accurate trace of drawing*

**Description:** a user wants to see her teammates' drawing when she is away.

**Success guarantees:** DARTS can store accurate drawings so users can see the updates made when she is offline.

**Step:** a user visits DARTS, loads the team drawing canvas, and sees drawings that have sufficient details made by others.

#### *Anonymous drawing*

**Description:** a user wants to draw without letting others know who is drawing or which part they are drawing.

**Success guarantees:** DARTS does not ask for any identification information from the users, such as name, gender, age, race, nationalities, etc. Information such as IP address and device information is stored confidentially at the back end.

**Step:** a user visits DARTS without any login requirements, loads the canvas, and can draw.

### ***Asynchronous, collaborative drawing***

**Description:** a user wants to draw with her teammates on the same canvas.

**Success guarantees:** DARTS can support multiple users to draw on the same canvas at different times.

**Step:** a user visits DARTS, loads the team drawing canvas, and draws on a shared canvas with other users.

### ***Freeform, less serious drawing***

**Description:** a user wants to doodle a silly cat face using purple.

**Success guarantees:** DARTS offers a broad spectrum of color choices with an expandable canvas for freeform drawing.

**Step:** a user visits DARTS, chooses colors, locates a place on the canvas, and starts drawing.

### ***Draw from laptop and mobile devices***

**Description:** a user draws at first using her mobile phone and later checks the canvas from her laptop at work.

**Success guarantees:** DARTS is web-based and can be accessed from any devices using the same URL.

**Step:** a user types the URL of DARTS and visits the system from any device she is using.

In this section, we describe in detail the user needs, user goals based on their needs, system goals derived from the design guidelines, the overall system summary goals, and finally use cases for each summary goal.

## 5.2 Prototype

After defining the goals and use cases, we developed a prototype using Sketch.<sup>2</sup> The prototype focuses on experiences using mobile devices. Visiting from the laptop would echo the same flow and similar user experience since the system is a web-based application. The design process was iterative, with a few rounds of evaluation and redesign. In this section, we chose to describe the very last version of the prototype before a final usability test, which is described in section 5.3.

### 5.2.1 Welcome page with team information

Figure 5.1 shows the screen a user sees upon opening the application. ① shows the current team name, indicating with whom the user will draw. The team name refers to the team in the organization. For example, “GA-Global-E30” is the team’s name in the organization, drawing with this team means drawing with team members rather than random people from the same organization. ② is the welcome prompt, a message that encourages users to express feelings using a color. ③ is the button that leads to the next page to pick up an initial color to enter the drawing canvas.

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<sup>2</sup> <https://www.sketchapp.com/>

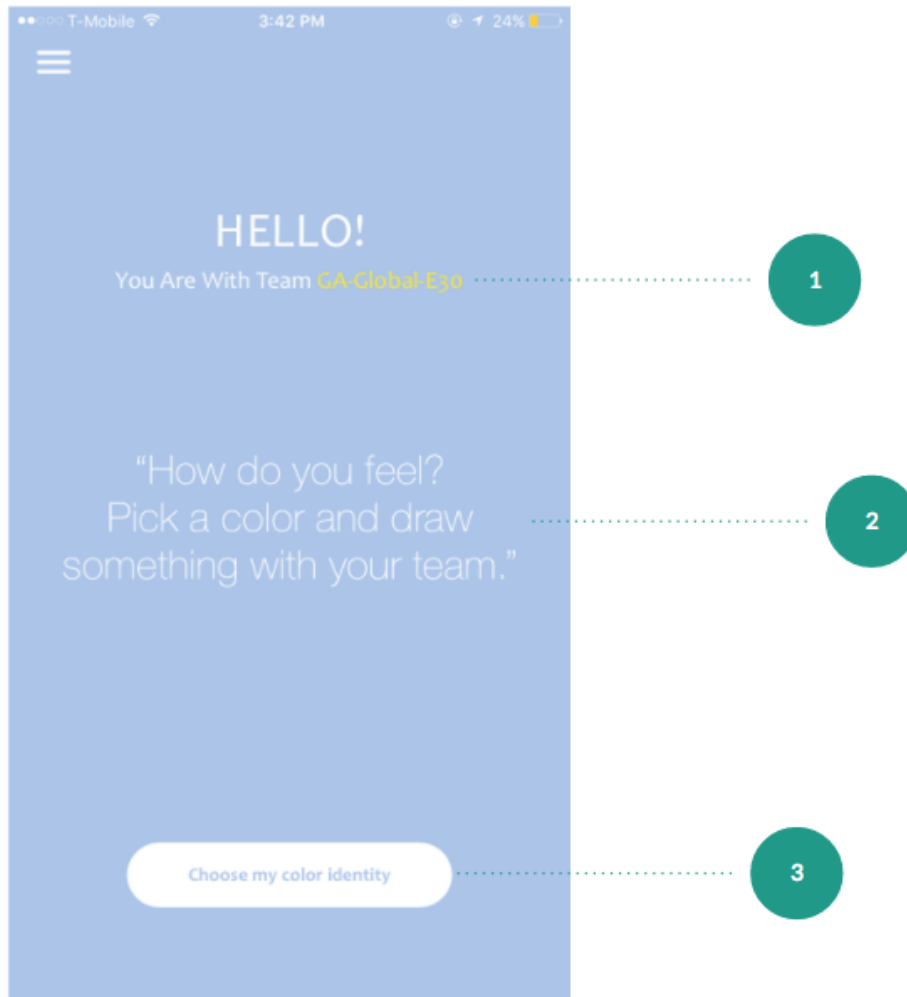


Figure 5.1 DARTS welcome page with team information.

### 5.2.2 Switching teams

Figure 5.2 shows the page a user sees when they click on the top left button (①) on welcome page. The sidebar shows other active canvas in the organization so users can join if they would like to. ② is the current team a user is drawing with, while ③ shows more available teams in a list. Users can click through to change a team. The selected one will be highlighted.



Figure 5.2 Switching team sidebar.

### 5.2.3 Color identity

Figure 5.3 shows the result page when a user clicks on the “choose my color identity” button on the welcome page. On this page, users can use one finger to slide left or right in the bubble (①) to view different colors. The interaction intends to be intuitive so once a user feels that color can stand for her/his current feelings, s/he can stop there and click through the drawing canvas by clicking on button ②.



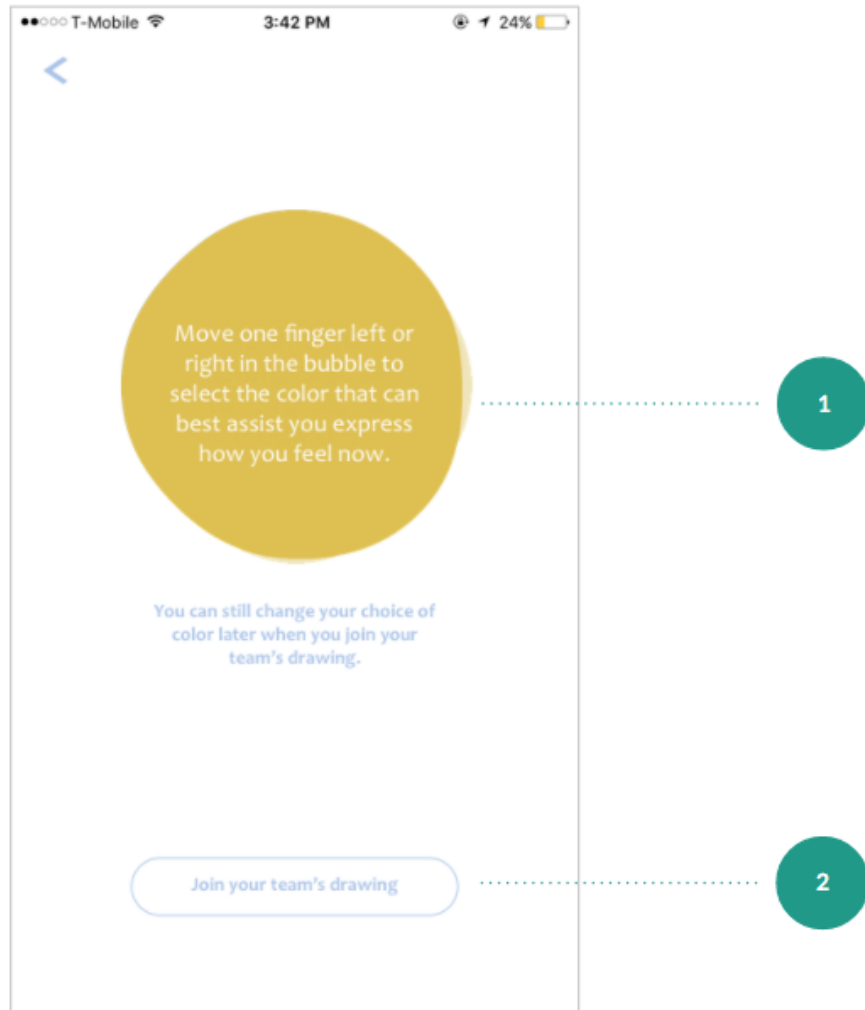


Figure 5.3 Color identity.

## 5.2.4 Team canvas

Figure 5.4 shows the team canvas page after a user selects a color and joins the team drawing. Button ① refreshes the canvas to show updates from other team members. ② is the chatbot that is automatically generated by the app based on activities on the canvas. The message intends to encourage participation and generate more fun. ③ is the main canvas, presenting the asynchronous drawing by different team members. ④ is the drawing toolbar where a user can change the thickness and color of the brush.

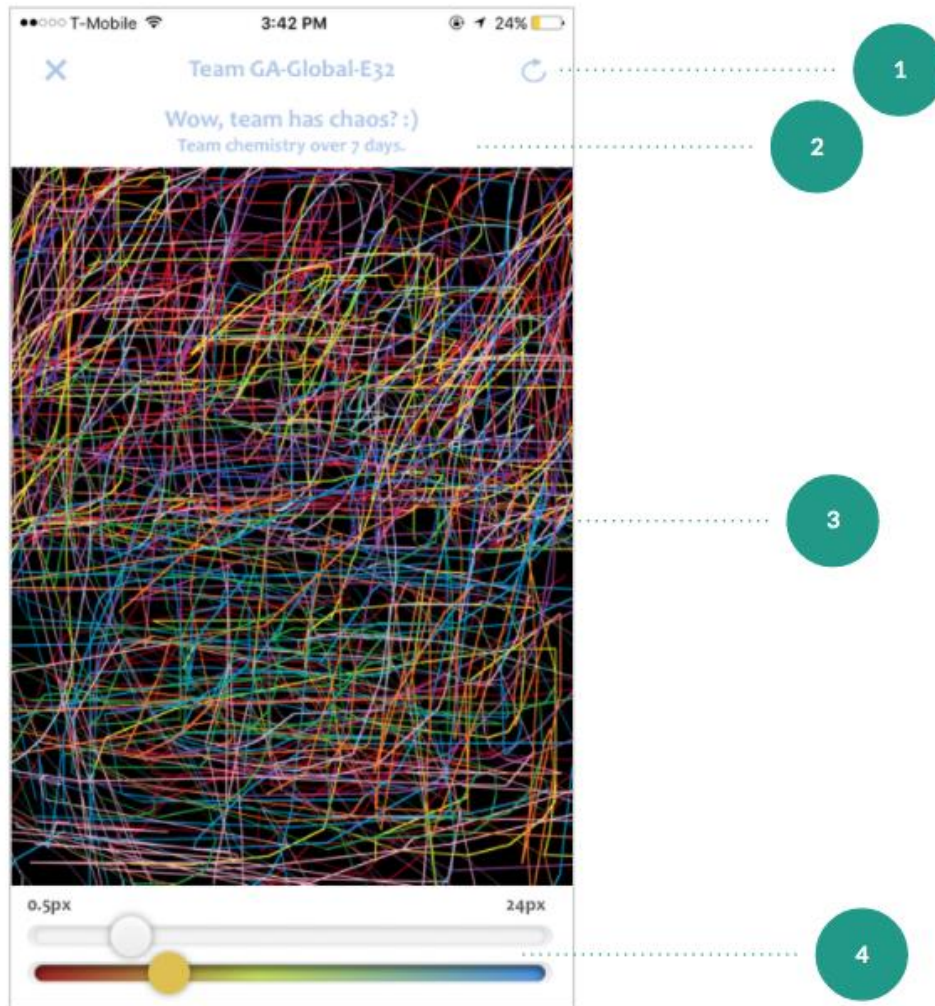


Figure 5.4 Team canvas.

### 5.2.5 Team canvas updates

Figure 5.5 shows a scenario in which the team drawing updates after a few days. In this scenario, the drawing evolves from lines, as shown in Figure 5.4, to one that has a more consistent story, shown as ②. Chatbot at ① responds to the development of drawing accordingly.

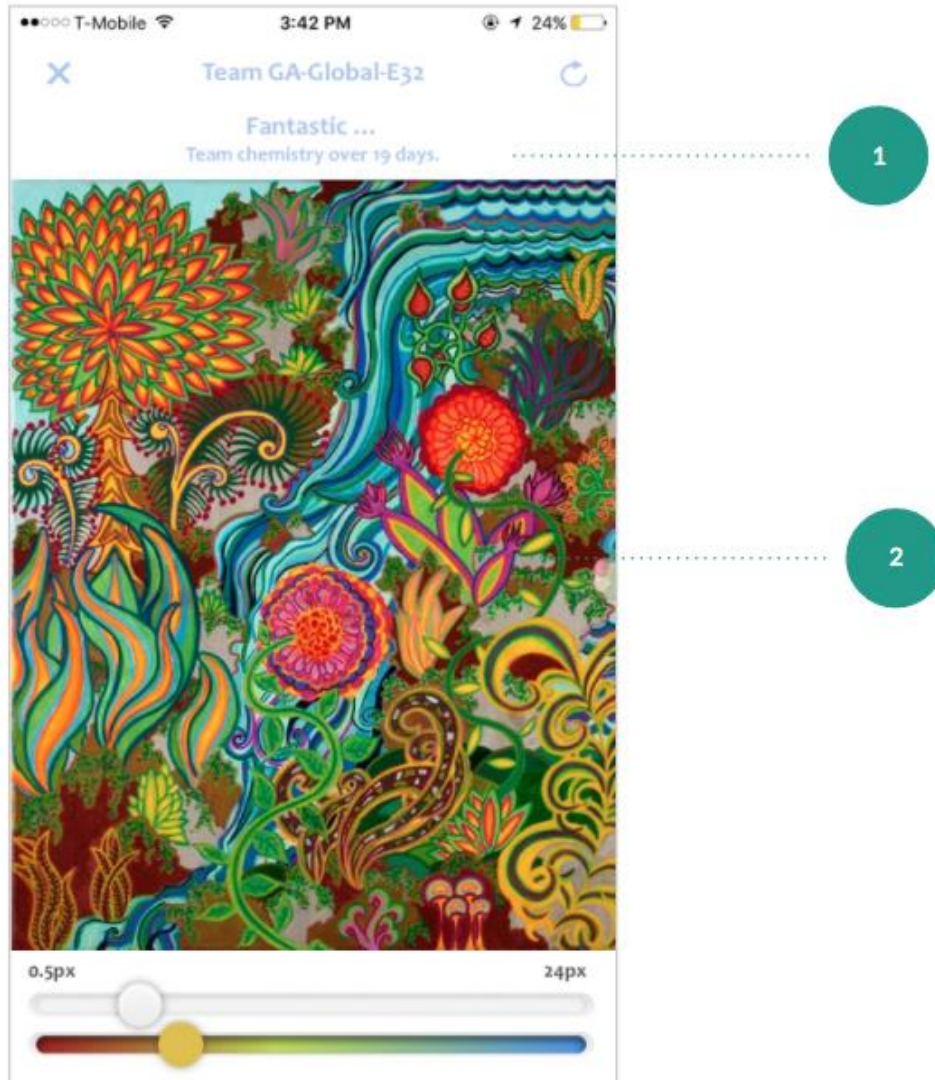


Figure 5.5 Team canvas updates after a few days.

## 5.3 Usability Test

After developing the whole first round of prototype, in order to evaluate the usability of the application, we did a usability test with five users. This study was relatively small and informal, with a goal to evaluate the basic user flow and interactions of the application, rather than the underlying effects on teams, which will be systematically and formally evaluated in the study described in Chapter 6.

In this usability test, we recruited five participants who had previous experience working with remote teams. Among the five participants, three were male and two were female. All of them had smartphones and had used web-based applications (e.g., visiting a webpage) on their smartphones as well as on laptops.

Participants were asked to accomplish designed tasks with open-ended questions at the end of each session to gather feedback. A working prototype with hyperlinks between pages developed using Invision,<sup>3</sup> which was available for the participants to click through and use in-situ. Each session lasted for 20-30 minutes. All conversations were recorded and transcribed.

### **5.3.1 Tasks**

There were five tasks for each participant. Each task involved screens developed with hyperlinks that can present the interactions and results responding to participants' interactions. If they interacted with any part in the prototype that lacked an embedded hyperlink, we asked contextually why they would do that and what they would expect to see.

#### ***Enter drawing canvas and draw a line***

Participants were asked to start the app, enter a drawing canvas, and draw a first line on the canvas.

#### ***Change drawing parameters using toolbox***

Participants were asked to change the parameters of the brush so they could draw in a thicker line and in a different color.

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<sup>3</sup> <http://invisionapp.com>

### ***View updates***

Participants were asked to check updates on the drawing canvas and indicate what was updated.

### ***Join another team***

Participants were asked to change to a different team named “Daydream” to draw with.

### ***Switching back to previous team***

Participants were asked to change back to the previous team “CRADL”.

## **5.3.2 Results**

In this section, we describe the results from the usability test, with a focus around the identified pain points. Those pain points mainly guided the redesign of the prototype.

### ***Too many steps before entering a drawing canvas***

All participants reported that the “color identity” button was confusing because they did not know why they needed to select a color before drawing. All of them asked if they could change the color after they entered the canvas. For two out of five participants, this step set a barrier for them to arrive at the drawing canvas.

### ***Changing drawing parameters was straightforward***

All participants successfully accomplished the second task of changing brush thickness and colors without any problems. They saw the process as intuitive and straightforward, and as not requiring much thought.

### ***Participants expected to see updates on the canvas automatically rather than manually***

All participants reported that manually clicking the update button to see updates was annoying. They worried that without seeing updates in real-time may cause conflicts in the

drawing, and this decreased overall playfulness and engagement. They suggested that the system should show real-time updates from different users so they know that they are drawing with someone else.

### ***Difficult to distinguish the concepts of “canvas” and “team”***

Four out of five participants reported that they found “team” and “canvas” interchangeable so having two concepts in one application was confusing. The other participant thought even with the same team users could have multiple canvas, but he had a difficult time making it work in the prototype. Participants suggested that we should redesign the feature of switching teams since they liked the idea of anonymous drawing and worried that switching teams may lead to a leak of personal information. They also suggested only using “team,” since users who can access to the same canvas naturally become a team in the system.

### ***Overall user experience with the application was smooth***

Participants found this application easy to learn and use. They liked the aesthetics of the application design. They suggested using icons with text to present features such as the tool box.

## **5.3.3 Redesign**

The usability test successfully helped identify some pain points that a user may have when interacting with the application, and helped with the final design of DARTS.

### ***Removing “Color Identity” feature***

The final design supports a user to enter the drawing canvas directly without any other steps. The experience intends to be straightforward and playful from the very beginning. A user can select colors at will from the toolbox while drawing.

### ***Real-time updates***

The application will enable real-time synchronization from multiple users. Users can see what someone else is drawing and decide what they would like to draw to cooperate.

### ***Teams share a drawing canvas via one unique URL***

The final design enables users to access to a shared drawing canvas via a unique URL. Users who have the URL can access the canvas to join the team drawing. Creating a new drawing canvas will generate a new, unique URL in the system; therefore, users can invite each other to the new drawing space by sharing the new URL.

### ***Incorporate basic features with drawing toolbox into a universal toolbox on canvas***

The final design is more concise in terms of the user interface design. We incorporated basic features such as brush, eraser, pan, and an entry point to access a survey for the final study into one universal toolbox. The toolbox is accessible on the canvas even when users expand the space.

## **5.4 System Demo**

The live system can be accessed via <http://35.196.179.171/>. In this section, we present the complete application development with a few screens with annotations to walk through the final system features.

### **5.4.1 Entering a canvas**

Figure 5.6 shows the welcome page a user will see when s/he visits the web applications for the first time. The left side of Figure 5.6 shows the result of visiting from a mobile phone, and the right side shows the result of visiting from a laptop browser. It requires the user to type the team name at ① and click the button at ② to enter the team drawing. The final unique URL contains the application URL with the unique team name. For

example, as shown in figure 5.7, when entering the “pilot,” the drawing canvas will be accessible by all users who have the URL of <http://35.196.179.171/pilot>. Figure 5.8 shows how to access two different drawing canvases via different, permanent URLs at ①.

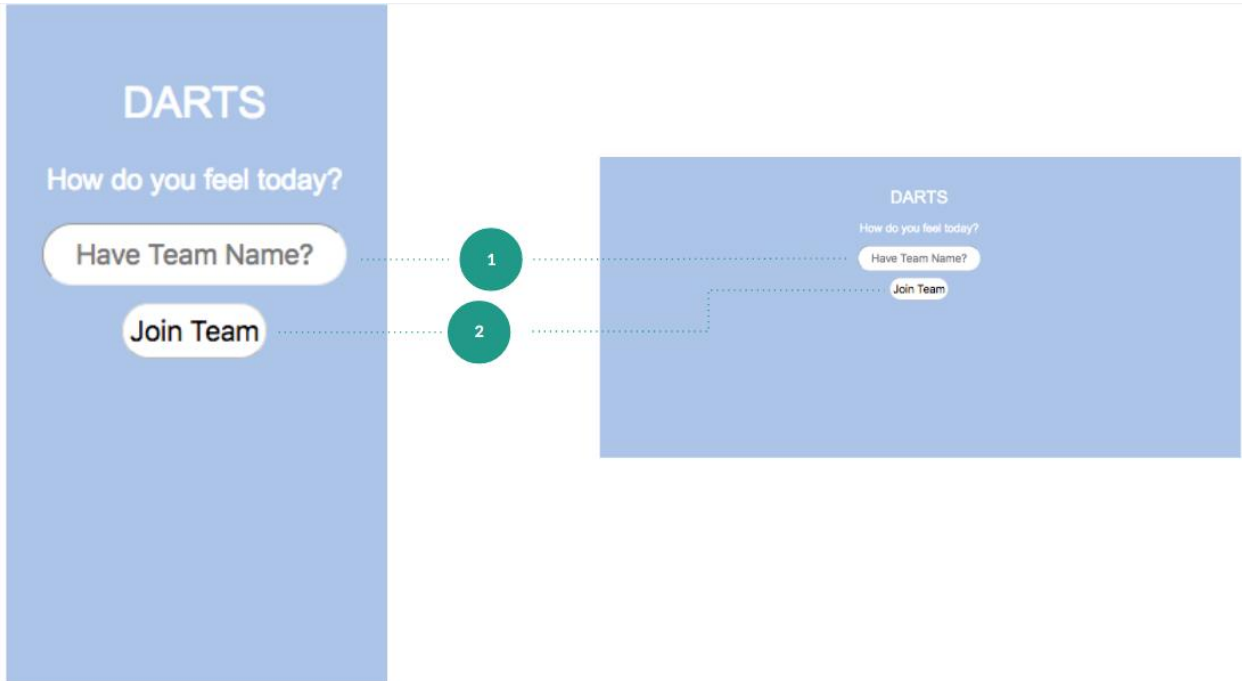


Figure 5.6 Welcome page, visiting from phone (left) and laptop (right).

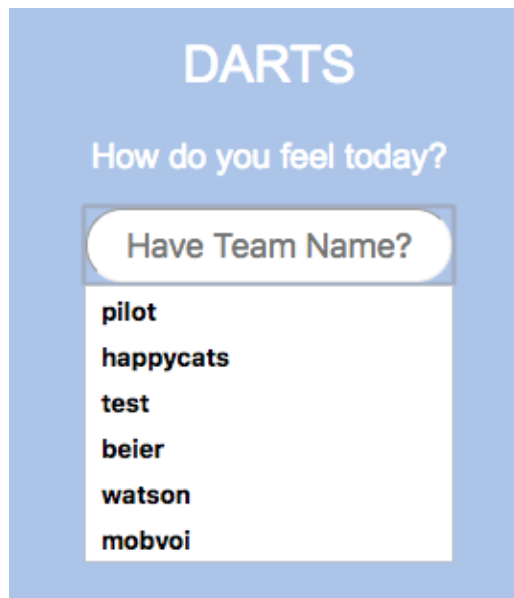


Figure 5.7 Dropdown menu showing previous joined drawings.



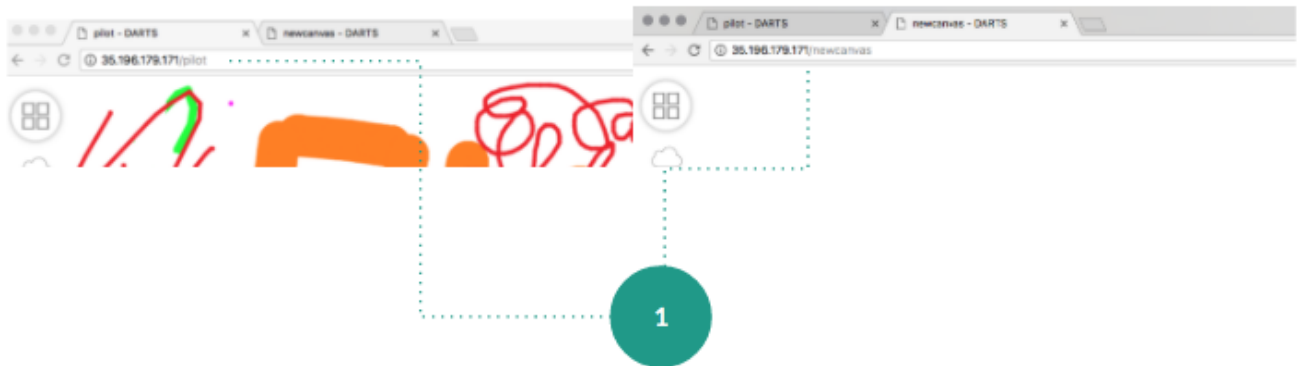


Figure 5.8 Each canvas has its unique, permanent URL.

### 5.4.2 Drawing canvas

Figure 5.9 presents the final design of the drawing canvas. On the left side of the canvas, users by default see the universal toolbox. Users can drag the toolbox at button ① to anywhere on the canvas so they can draw on the empty space. The button at ② leads participants in the final study to a survey. Brush and eraser are accessible from buttons ③ and ④. Figure 5.10 shows the pop-up menu when clicking on the brush button where users can choose the thickness and color. Users can drag and move the canvas at button ⑤ so they will have an expandable space to draw. Figure 5.11 shows a scenario in which a user drags the canvas and checks the part of canvas that is drawn by someone else. ⑥ shows the main canvas: the drawing space on which multiple users can draw collaboratively and asynchronously. Updates will show automatically in real-time.

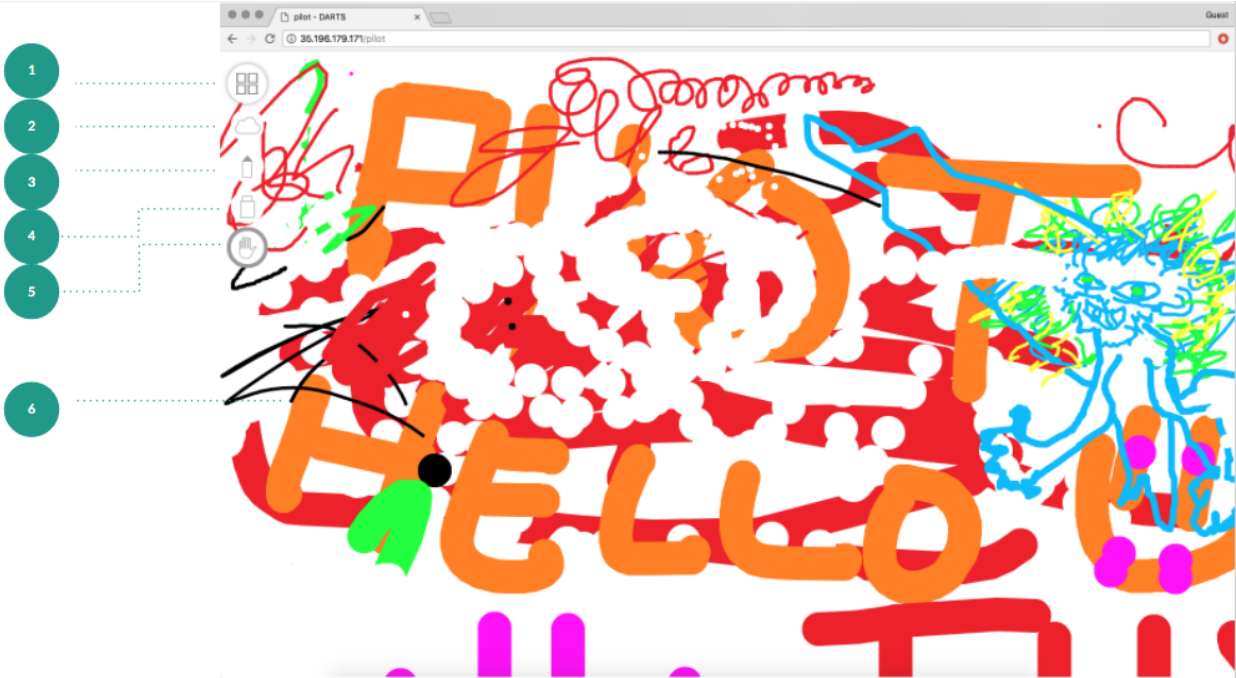


Figure 5.9 The drawing canvas.

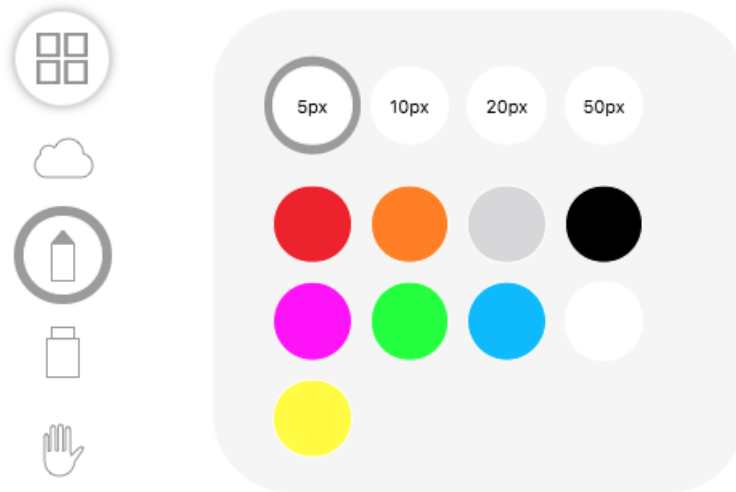


Figure 5.10 Brush parameters of thickness and color.

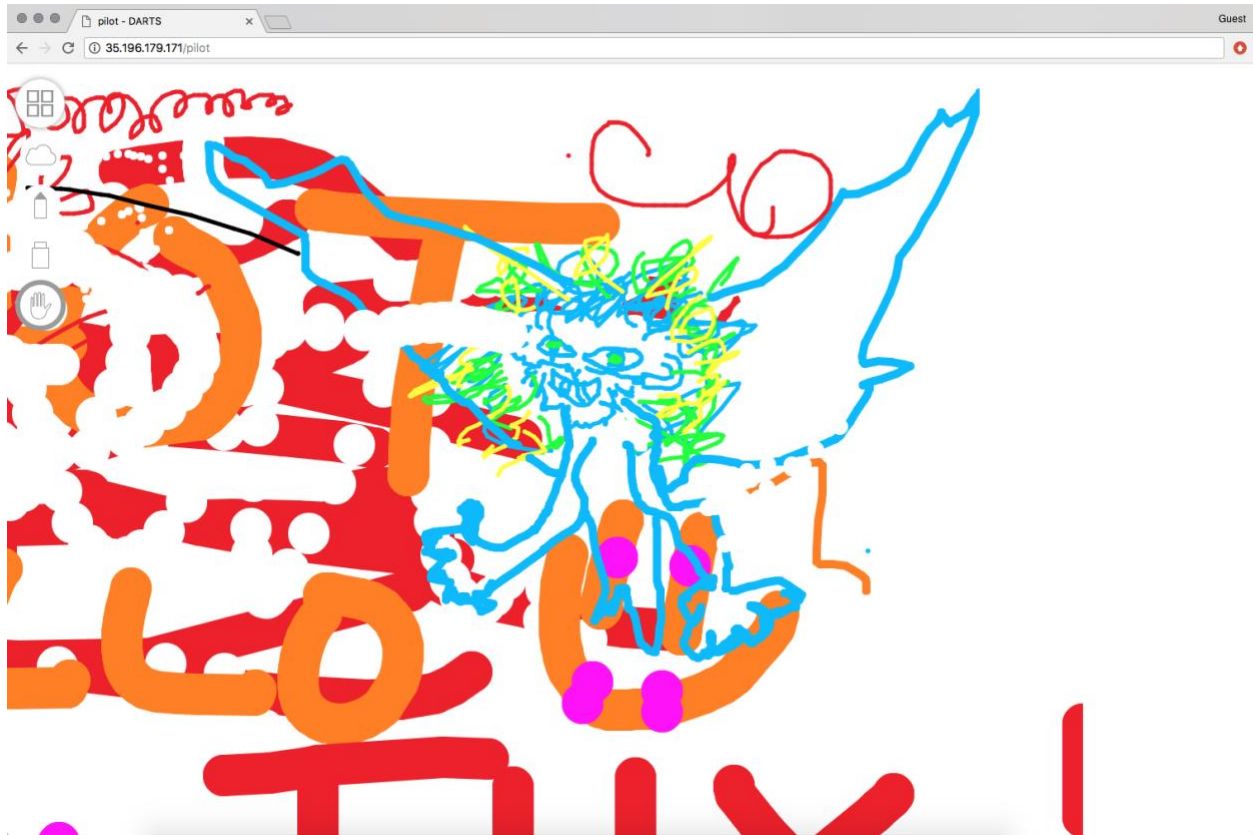


Figure 5.11 Canvas is extendable by dragging and moving.

## Chapter VI.

# Study II: An In-situ Study About DARTS in Teams from Industry

## 6.1 Motivations

In the previous chapter, we described in detail the design of the final product, DARTS, which aimed to apply the essence of the proposed theoretical model to help distributed teams build trust, cohesion, and positive emotions. At this point in this work we have discussed all the fundamental building blocks of the research proposal. But a final, yet critical step is to evaluate whether the proposal would work in a real-world scenario; and, if it works, to explore how the core concept—online playful activities—helps bring positive effects to distributed teams. We use a study of industry teams to draw insights that complement the theoretical model with empirical evidences.

We designed and conducted an in-situ study with teams from industry and asked teams to use DARTS for five days, report on their experience, and participate in interviews.

In this final study, we aimed to explore four research questions:

**RQ1:** What is the perceived experience of using DARTS in terms of expressivity, reflection, interactivity, and playfulness?

We sought to explore teams' perceived experiences while using DARTS for a few days. The goal was to evaluate the four facets defined in previous efforts. We predicted that having existing, professional teams from industry use DARTS over a few days would provide insight into how the perceived experience changes over time. Findings were expected to

complement the model and offer design implications for future online playful mechanism/system for longitudinal usage.

**RQ2:** How do team trust, cohesion, and positive emotions change with using DARTS for a few days?

We investigated the effects on team trust, cohesion, and positive emotions in a real-world scenario to collect empirical evidences. We sought to observe the application's effects on teams conducting normal work and life activities to reveal the real issues, challenges, and opportunities such an application meet.

**RQ3:** How does the experience of using DARTS contribute to team trust, cohesion, and positive emotions?

Ultimately, we wanted to explore the effects of the playful activity on teams. Theoretically we built a model of how the experience would change trust, cohesion, and emotions, but it needs empirical proof. Such evidence would reveal design opportunities for future mechanism/system around supporting online playful activities for distributed teams.

**RQ4:** Compared to the short-term teams in Study I, what different behaviors emerge in existing, longer-term teams?

I was also interested in understanding the different behavioral patterns that emerged in teams in a short time versus over a few days. By comparing the observations of team behaviors in Study I and the final study, insights could provide design implications for teams with different characteristics, such as the time of life, composition, and stability.

## 6.2 Research Study

To answer the above four research questions, we conducted an in-situ, observational study with five teams from industry.

### 6.2.1 Participants

Participants were recruited by word-of-mouth. First, we emailed contacts in industry and expressed our intention to recruit teams to participate in the study. For contacts who showed interest, we kindly asked them to spread the word to their remote teammates to see if they were also willing to participate. The criteria for recruitment were that participants should work naturally in the same organization and have collaborated on projects. They should be remote from each other during the study. They should have smartphones and feel comfortable drawing with each other.

We recruited five distributed teams of three persons from five different organizations. Among the 15 participants, seven were women and eight were men. Data collection from 15 participants over five days would be sufficient for an in-situ, observational study. Table 6.1 shows the information of the participants.

Among the five teams, three participants from team one had worked with each other for a few months. They were HCI researchers and report to the same research manager. They had some ongoing collaborative research projects within the organization. The three of them sat in different buildings and mostly used emails and instant messengers to communicate. They also took occasional coffee breaks. They saw their team as distributed since most collaboration took place asynchronously, without meeting in-person. Among them, P13 was the newest team member.

The three participants from team two had worked with each other for over a year. Two of the software engineers (P22, P23) worked at the headquarter in Beijing, China, and the other one (P21) worked from the research lab located in Seattle, Washington, in the US. The team belonged to a larger team in charge of the software development and research engineering work in Natural Language Processing (NLP) for the company. P21 managed P22 and P23 directly. The team held annual team building activities in Beijing that required P21 to travel and meet the team members in-person. They would have dinner and attend social events around the city as regular team building activities. The three of them believed they knew each other fairly well.

The three participants from team three had worked with each other for over a year. All of them were actuaries for team three and held semi-yearly conferences for actuaries in North America. They primarily communicated with each other through emails, and used phone calls when necessary. They only meet in-person twice a year during the conference. They would go for dinner or have coffee breaks at the conference. Among them, P33 was the newest team member.

The three participants from team four had worked with each other for over a year. One UX researcher was located in Seattle, US (P41), one UX researcher worked from Singapore (P42), and the research operation (P43) was located in San Francisco, US. The research operation supported the projects conducted by the two researchers, but the two researchers worked in the same larger research group. They mostly used video conference, email, and IM chat to communicate during work. They met in-person twice a year during the off-site events held by the larger research team. They also met in-person in Singapore when they conducted a research project in Asia. Among them, P42 and P43 considered themselves

Table 6.1 Summary of participants' demographic information.

Participant ID (PID)	Team	Age	Gender	Occupation
11	Team One	30 - 39	M	HCI Researcher
12	Team One	30 - 39	F	HCI Researcher
13	Team One	30 - 39	M	HCI Researcher
21	Team Two	30 - 39	M	NLP Manager
22	Team Two	30 - 39	M	Software Engineer
23	Team Two	19 - 29	M	Software Engineer
31	Team Three	19 - 29	F	Actuary
32	Team Three	30 - 39	M	Actuary
33	Team Three	19 - 29	F	Actuary
41	Team Four	19 - 29	F	UX Researcher
42	Team Four	19 - 29	M	UX Researcher
43	Team Four	30 - 39	F	Research Operation
51	Team Five	30 - 39	F	Account Manager
52	Team Five	19 - 29	M	Software Engineer
53	Team Five	30 - 39	M	Software Engineer

more familiar with each other than P41, since P42 and P43 collaborated more.

The three participants from team five had worked with each other for over a year. The account manager (P51) managed Human Resources related issues for the two software engineers (P52, P53), and was located in Seattle, US. One software engineer (P52) worked in Shanghai, China, and the other one (P53) worked in Beijing, China. During the study, P53 was relocating to Seattle, US, from Beijing. The three of them mostly used emails to communicate with each other and had occasional call conferences. They participated in team-building



activities in Shanghai and Beijing, with P51 traveling to China and meet them in-person. They had dinner, did karaoke, and played games. Among the three of them, P52 and P53 were not familiar with each other, but both of them had worked with P51 often.

Except for P23, all other 14 participants complete the study. P23 dropped out after one active study session.

## **6.2.2 Methodology**

The goal of the study was to capture how teams used DARTS, what their experience was with DARTS, and how DARTS changed the teams. Therefore, we designed a digital observational study (Lazar, Feng, and Hochheiser 2017) to collect both of qualitative and quantitative data. We also wanted to observe the change of behaviors and team effects over time, so the study was designed as in-situ. In sum, this study is a mixed-method, in-situ, observational study.

Each team was observed for five days, which was Monday through Friday for most of the participants. Teams were instructed to work as normal while using DARTS on a daily basis. We used a combination of multiple data collection methods, including surveys and interviews. More details are described in section 6.2.3.

The observational data was mostly collected through Experience Sampling (Hektner, Schmidt, and Csikszentmihalyi 2007) surveys, triggered by each use of DARTS. Participants were asked to fill out questions designed to measure their experience, trustworthiness, perceived cohesiveness, and emotions. Participants were also asked to report their minutes using DARTS, screenshot of the latest drawing, and their perceived experience with DARTS. More details about the measurement is discussed in section 6.2.4.

All participants were informed that their data would stay anonymous and only be reviewed by the researchers. No sensitive information about their organization was required or collected during the study.

### **6.2.3 Study Procedure and Data Collection**

#### ***Pre-study brief meeting***

All teams were scheduled for a pre-study brief meeting via video conference. During the meeting, we played an instruction video to the participants, explaining the study goals, procedures, and incentives. We also demonstrated the system in the meeting, showing how to use it and how to draw collaboratively. At the end of the meeting, we asked about the date the team agreed on to start the study and confirmed that they would receive the incentives only after they completely finished the final one-on-one interview.

#### ***Study sessions***

All teams were scheduled to complete their own study sessions on different weeks. During the five days for each team, participants received an email scheduled through Boomerang<sup>4</sup> at the beginning of day one, stating that their team session had started. In the email, we also reminded them to use DARTS as often as they liked. They were completely responsible for determining the content of drawing and the time they wanted to spend drawing. There was no hard requirement about what they should draw, or how the team should proceed in the system.

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<sup>4</sup> <https://www.boomerangapp.com/>

In the first email, we also embedded a link to the first experience sampling survey to collect the baseline information about each participant. The survey asked about their mood, trustworthiness, and perceived cohesiveness with the other two team members.

For each use of DARTS, participants were required to click through an experience sampling probe installed on DARTS. The probe led participants to a survey that collected data around trustworthiness, perceived cohesiveness, and emotions. The survey also asked participants to self-report their usage time in minutes and the current state of the drawing canvas in screenshots. Moreover, participants were also asked to rate their experience with DARTS.

At the end of day five, we sent out another email to all participants, stating that they had successfully completed the study. We embedded a link to a survey that asked about their mood, trustworthiness, and perceived cohesiveness, as the afterwards fact measurement.

### ***Exit interviews***

After day five, we scheduled one-on-one interviews with each participant. The interviews were audio-recorded and lasted from 45 to 75 minutes. The semi-structured interviews explored the following four sets of questions:

- How did the individual and the team approach the final drawing?
- What were the perceived experience with DARTS in terms of expressivity, reflection, interactivity, and playfulness?
- How did the team change after using DARTS in terms of trust, cohesion, and emotions?
- How did using DARTS influence their relationship in existing teams at work?

## **6.2.4 Measures**

### ***Trust***

Since the existing teams were already working on collaborative projects in their organizations, it was difficult to determine the point at which to measure early trust as defined by Javvenpaa et al. (Jarvenpaa, Shaw, and Staples 2004). Therefore, in this study, we chose to use the original measurement of trust designed by Schoorman (Mayer, Davis, and Schoorman 1995). The participants answered four questions using a 5-point Likert scale to measure trustworthiness. The questions are described in table 6.2.

### ***Cohesion***

In this study, we used the same measurement for perceived cohesiveness as in Study I. Participants answered four questions using a 5-point Likert scale. The questions are described in table 6.2.

### ***Emotions***

In this study, we chose to use Russell's circumplex model (Russell 1980) to measure emotion. In Russell's model, there are two dimensions in a human emotion: valence and arousal (Figure 6.1). Since we are only interested in understanding participants' positive and negative emotions, we selected to use valence as a measurement to capture them. In the experience sampling surveys, participants were asked to select a number from -100 to 100 to represent their feelings, wherein -100 indicated the most negative and 100 the most positive the participant was feeling. Using valence to measure emotions is well validated and proven accurate for describing a person's negative/positive emotions (Stephens, Wardle, and Marmot 2005).

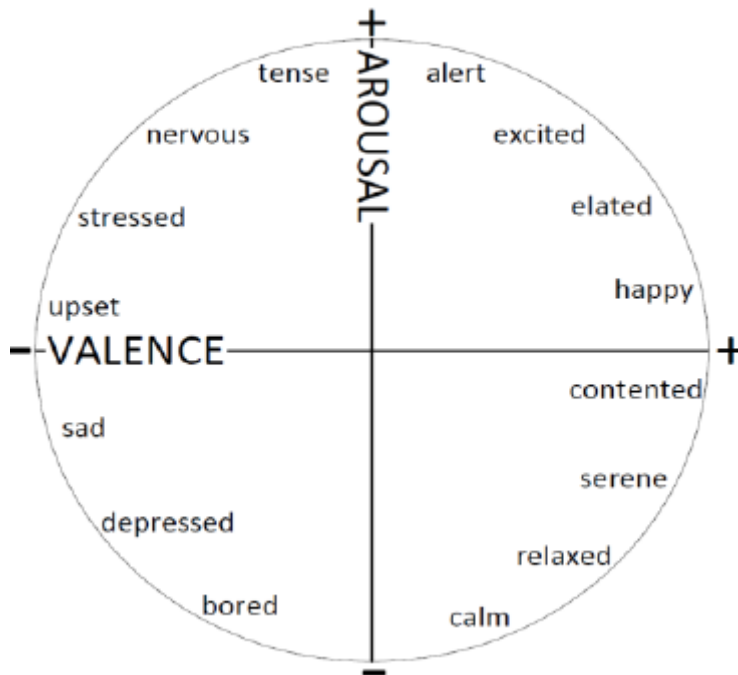


Figure 6.1 Russell’s circumplex model of human emotions (Russell, 1980).

***Perceived experience of using DARTS***

In the experience sampling surveys, we also asked about the participants’ perceived experience during the activity. The questions were specifically around the four facets of the playful experience that DARTS was supposed to afford. For each facet, participants were asked to measure the degree to which they felt “expressive,” “reflective”, “interactive,” and “playful” in using DARTS via a 5-point Likert scale. Definitions of the four facets were explained to participants during the pre-study brief meeting so they would share a consistent understanding about the definitions of the experience.

Table 6.2 Summary of measures explanations and questions asked in surveys.

Measure	Explanation	Questions in surveys
Before/After Study Surveys		
Trust	Participants’ trustworthiness with their teams based on their working experience.	- I feel comfortable depending on my team members for the completion of the project.

		<ul style="list-style-type: none"> <li>- I feel that I will not be able to count on my team members to help me.</li> <li>- I am comfortable letting other team members take responsibility for tasks which are critical to the project, even when I cannot monitor them.</li> <li>- I feel that I can trust my team members completely.</li> </ul>
Cohesion	Participants' perceived cohesion with their team members based on their working experience.	<ul style="list-style-type: none"> <li>- I feel that I am a part of the team.</li> <li>- My team works together better than most teams on which I have worked.</li> <li>- My teammates and I help each other better than most other teams on which I have worked.</li> <li>- My teammates and I get along better than most other teams on which I have worked.</li> </ul>
Emotions	Participants' positive/negative feelings.	On a scale from -100 to 100, where -100 represents "negative" and 100 represents "positive," how would you rate your feeling right now.

#### DARTS Experience Sampling Surveys

Trust	Participants' trustworthiness with their teams based on their experience of drawing on DARTS.	<ul style="list-style-type: none"> <li>- I feel comfortable depending on my team members for the completion of the project.</li> <li>- I feel that I will not be able to count on my team members to help me.</li> <li>- I am comfortable letting other team members take responsibility for tasks which are critical to the project, even when I cannot monitor them.</li> <li>- I feel that I can trust my team members completely.</li> </ul>
Cohesion	Participants' perceived cohesion with their team members based on their experience of drawing on DARTS.	<ul style="list-style-type: none"> <li>- I feel that I am a part of the team.</li> <li>- My team works together better than most teams on which I have worked.</li> <li>- My teammates and I help each other better than most other teams on which I have worked.</li> </ul>

		- My teammates and I get along better than most other teams on which I have worked.
Emotions	Participants' positive/negative feelings of drawing on DARTS.	On a scale from -100 to 100, where -100 represents "negative" and 100 represents "positive", how would you rate your feeling right now:
Experience of Using DARTS	Participants perceived experience in terms of expressive, reflective, interactive and playful in using DARTS.	<ul style="list-style-type: none"> <li>- How expressive were you on DARTS just now?</li> <li>- How reflective were you on DARTS just now?</li> <li>- How interactive was your team on DARTS just now?</li> <li>- How playful was your experience on DARTS just now?</li> </ul>
Active Time	The number of minutes a participant used DARTS in the most recent session.	How long was your latest session using DARTS? (Please provide an approximate number of minutes. E.g., if just now you used DARTS for 20 minutes, put 20 below.)
Drawing	The state of drawing before a participant quits DARTS.	Please take screenshots of the current state of your team canvas and upload the screenshots.

### 6.2.5 Data Analysis

To answer research questions 1 through 3, we analyzed both the quantitative data collected through surveys and the qualitative data collected through interviews. We first cleaned up and organized the survey data in Microsoft Excel. We performed confirmatory factor analysis in R to compute the factor scores for cohesion and trust. Next, we conducted descriptive statistical data analysis, which could provide an overview of the data. After understanding the “facts” from data collected from participants, we did a qualitative content analysis of 14 interviews (Bauer 2007). All interviews were transcribed, based on which we used an iterative process to read through the transcriptions and generated insights. All first-

level insights were ground up into clusters of second-level insights, and then the clusters grounded the findings. Finally, triangulated the survey data, interviews, and drawings. By looking through all sets of data we gained a holistic understanding about what happened during the study, and the possible reasons behind it (Hoffart 2000). During the analysis of team drawing, text messages in Chinese on canvas were translated in English by the lead researcher.

To answer research question 4, a second round of data analysis of all collected qualitative data from condition 3 in Study I was conducted. Teams in condition 3 did freeform drawing remotely and had the most identical team setting to the teams in this study; so, it is ideal to compare the data with the final study.

The data analysis of condition 3 in Study I involved team effort from the research group. In order to obtain findings about the behaviors, we analyzed all collected, qualitative data including screen recordings, drawings, chat log, and interviews. To analyze the screen recordings, we used Atlas.ti to code all videos. First, two researchers individually reviewed one team's videos and then generated a set of codes that summarized the representative actions of participants during the drawing activity. Later, two researchers compared and discussed the code theme with each other, and then improved the common code until they reached 90% agreement. Finally, one researcher coded the remaining of the videos based on the agreed scheme in Atlas.ti and visualized in Tableau to generate Gantt charts for an easier overview of behavioral patterns.

Similarly, to analyze the interview data, two researchers first individually analyzed the interview transcriptions with notes and developed insights. Two researchers met later



to do an affinity diagramming session to conjointly generate clusters of insights. The clusters of insights were then grouped into a higher level of themes, which led to final findings.

The research group worked together to triangulate analysis from all sources of data. We investigated emerging themes through video and chat analysis, and referred to interview insights. For a more holistic understanding, we also looked at the team drawings along with the other sets of data.

## **6.3 Findings**

### **6.3.1 Overall activity**

The total active time, which includes the time participants spent drawing and excludes the time participants spent for a quick check for updates, was 458 minutes. The total active sessions, again including only the sessions in which participants drew, was 55. The average active time per active session was 8.3 minutes across all participants. The average active sessions per participant across the study was 3.7.

The most engaged sessions were the first three. Eight participants quit after three active sessions, with one participant (P33) quitting after one session, two participants (P12, P52) quitting after two sessions, and five participants (P11, P13, P21, P23, P42) quitting after three sessions. One participant (P43) quit after four active sessions, five participants (P22, P31, P32, P41, P51) quit after five active sessions, and one participant (P53) quit after six active sessions. The active sessions were all asynchronous and occurred across different time zones. Therefore, participants in the same team may have different numbered active sessions even on the same day.

In general, the total active time increased over five days (see Lowess line in Figure 6.2). It indicates that participants became more engaged with DARTS each visit as time passed. The reasons are discussed in section 6.3.4.

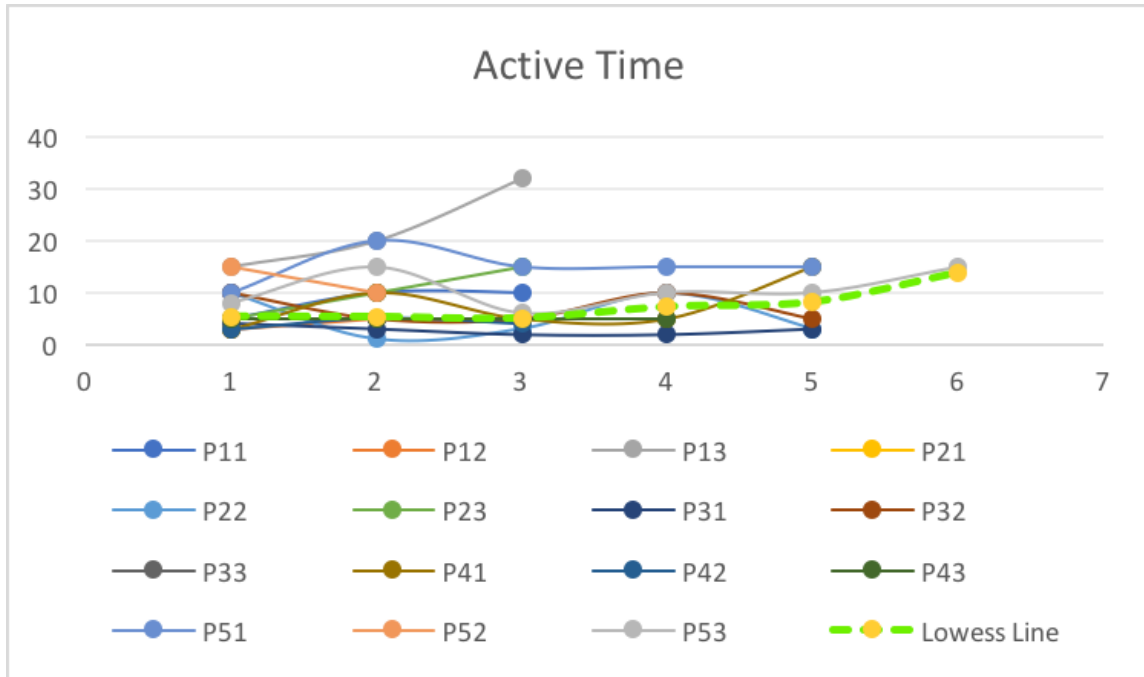


Figure 6.2 Active time on DARTS across all participants.

### 6.3.2 Drawings

In this section, we present the final drawings of the five teams, which helps better illustrate some key insights that will be described in the following sections. We also describe in narratives how the drawings evolved based on the interviews, focusing on how participants drew as individuals as well as a team.

#### *Team One*

Figure 6.3 shows the final drawing of team one. The drawing by P13 in his final active drawing session spans across a large space. Figure 6.4 presents the upper left corner of the drawing, which was the main drawing space for all team members. Figure 6.5 presents a closer look at the upper right corner, which is a maze drawn by P13.

The drawing started with random pieces of a river, a sun, and a robot drawn by P11, P12 and P13 in different sessions. Then P12 drew a decision tree with “AI” on top of it, which referred to a joke she heard in a meeting in the organization. P13 added a fire on “AI,” intending to show that Artificial Intelligence (AI) is a hot topic, as teams in their organization wanted to apply it in many products. He also added lasers to the robot attacking “AI.” P11 crossed “DNN” and wrote down “human,” expressing that they should also consider the human factors, rather than only focusing on AI—the technology only. Besides developing the main story on canvas, participants added new small pieces of drawings, such as a panda, a moon, bamboo, etc. Participants also added details to each other’s drawings, for example, adding sunglasses on the sun. In his final session, P13 started to use the “pan” feature to expand the canvas to allow more space to draw. He finished his drawing of the maze first and then added a few arrows to indicate to team members that there was more to see on the right of this canvas.

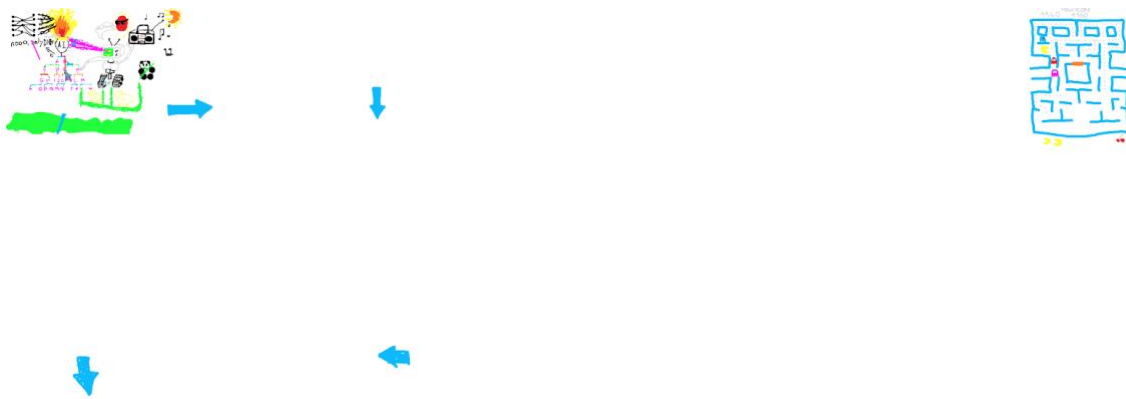


Figure 6.3 Final team drawing of team one.



Figure 6.4 The main space that the team drew in.



Figure 6.5 A maze drawn by P13.

## Team Two

Figure 6.6 shows the final drawing of team two. Figure 6.7 and 6.8 show the details that were erased in the end. The drawing started by P22 drawing a dog face. P21 wrote “Jason Williams,” which was his online name on Wechat<sup>5</sup>, and is also a name of a basketball player. Wechat is a popular chat application used by the team for daily communication, so P22 and P23 would understand what “Jason Williams” meant. The next day P21 drew a figure playing basketball to respond to “Jason Williams.” P23 started by writing down text messages such as “What’s the topic,” “valid session,” and “一起画一样东西吧” (“let’s draw something together;” translated by researcher). The team then used the canvas to communicate about what they would like to draw via text messages, such as “clear? @ all”, “投票 +10086” (“agree times 10086;” translated by researcher). During the time, P21 also added a Tiananmen square, followed by P22 adding more details such as the water in front of the square and the people at the palace. After realizing the space was insufficient, P22 wrote “画不下了” (“no more space to draw;” translated by researcher) and started to erase some of his own drawings, including the dog face and the figure playing basketball.

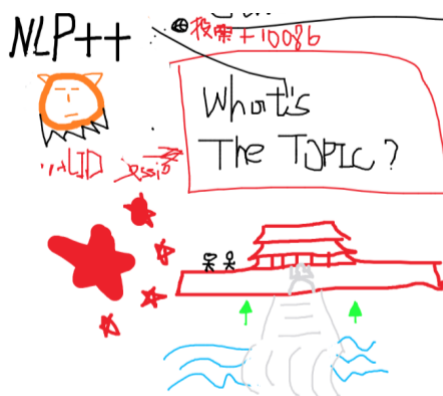


Figure 6.6 Final team drawing of team two.

<sup>5</sup> <https://web.wechat.com/>

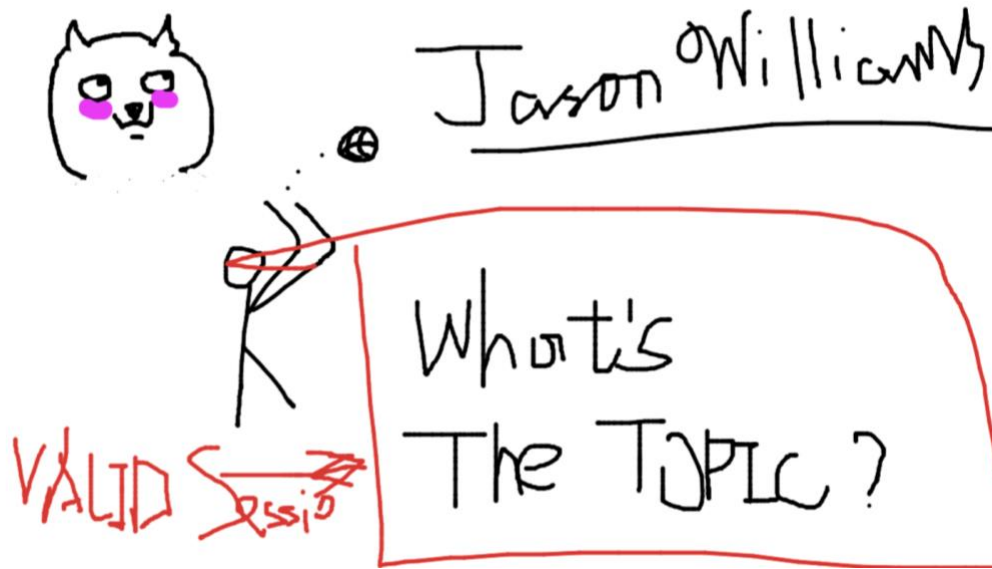


Figure 6.7 Early drawing that got erased later.

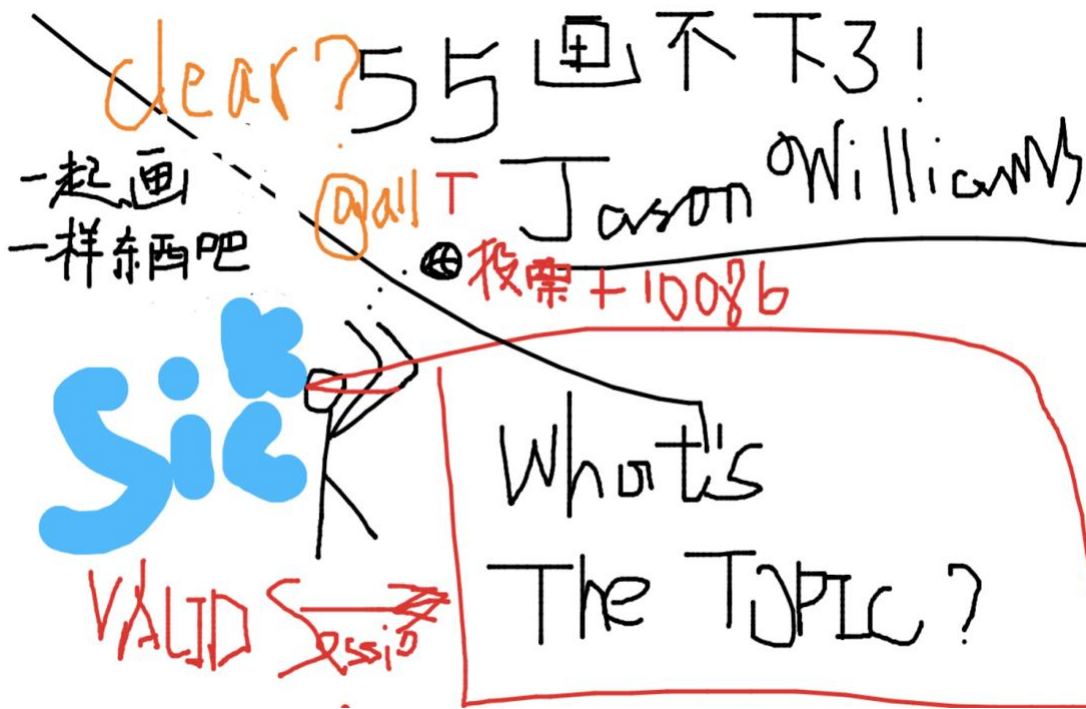


Figure 6.8 Some text messages that got erased later.

**Team Three**

Figure 6.9 shows the final drawing of team three. The team started with a random square on the canvas. P32 drew a little tree and then P33 started by writing "Happy Holidays!"

P31 then added small gifts under the tree and assigned them to the three of them. P32 finished the first big square by making it into a wrapped gift with a bowknot, and then started to work on a snow globe. P33 dropped the study after her first session, but P31 and P32 actively finished the drawing by adding more details under the holiday theme. They cooperatively drew a snowman, a reindeer, a wish list, a snowflake, and a Santa. During the drawing session, P31 and P32 also worked on some random pieces, such as an elephant out of a white elephant activity P31 had worked on that day, and some colorful circles with dots in them by P32. The two of them added more details to the random drawings from the others for touch up. For example, P32 added water near the elephant; P31 copied what P32 did by drawing a set of circles with dots in them and wrote “what are these?” During the process, P31 and P32 did not notice the absence of P33.



Figure 6.9 Final team drawing of team three.

### *Team Four*

Figure 6.10 shows the final drawing of team four. The team drawing started with P41 and P42 sketching some random shapes on the canvas, as shown in figure 6.11. P43 started by filling colors into the shapes. After P41 saw what her team members did, she realized that could be the way they drew together. Then P41 started to fill colors into the shapes drawn by P42 and P43. The team also did some random drawings at the same time, including the moon and water. Instead of composing a concrete story, this team's focus and efforts were focused more on the details of the visuals, including colors and shapes.



Figure 6.10 Final team drawing of team four.





Figure 6.11 The starting point of team drawing for team four.

#### ***Team Five***

Figure 6.12 shows the final drawing of team five. The team's drawing started with P53 adding a mountain and then filling up the space on the top using blue for sky and the space at bottom using green for grass. P51 then added details such as a sun, trees, birds, flowers, and houses. P52 independently started on the right side of the canvas by drawing a wall. P51 then wrote down "Merry Christmas" on the mountain, as shown in Figure 6.13 but erased it later when the drawing was more complete. P52 responded by making the right piece of drawing into a typical symbol of Chinese culture for celebrating new year. He added "New Year," a red symbol of "fortune," and some peppers on the wall. The team then wrote down some text messages to communicate with each other about new year's resolutions. The messages were later erased when the drawing was more complete. P53 then added the road in front of the wall and extended it to the left to connect the two parts of the drawing. Finally, P52 started at the bottom of the canvas by drawing an ocean. P51 and P53 then added creatures in the water.

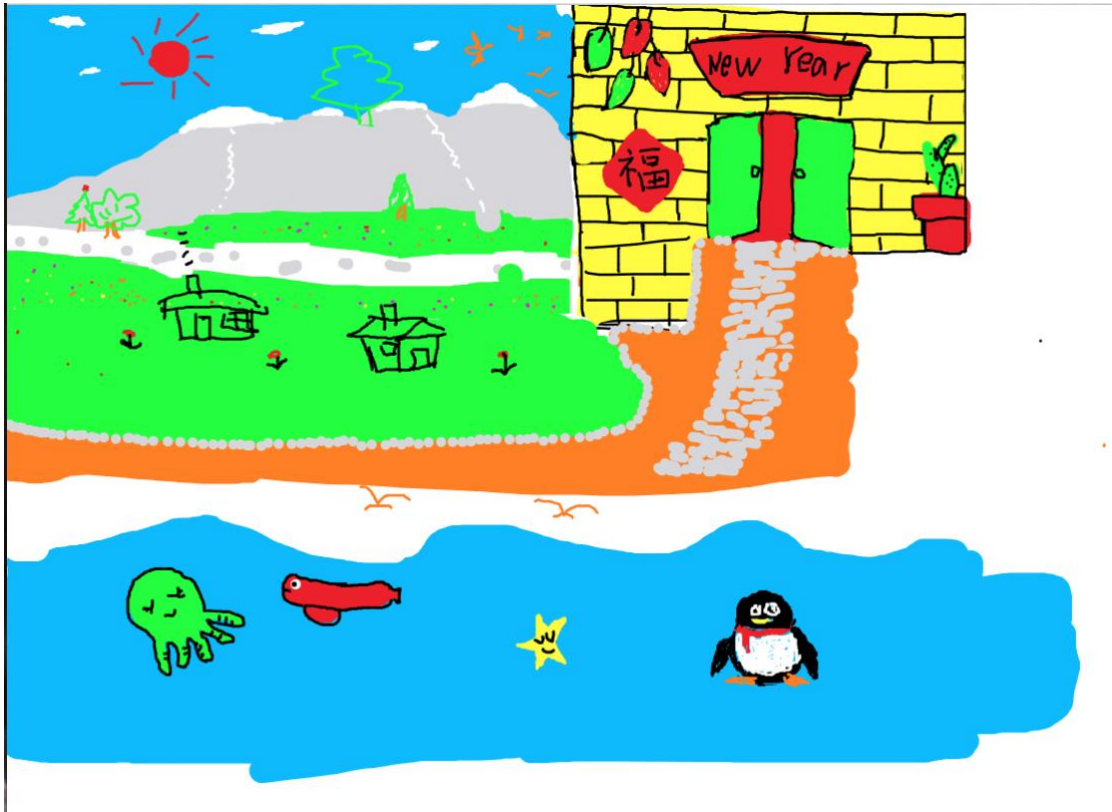


Figure 6.12 Final team drawing of team five.



Figure 6.13 Text messages that got erased later.



Figure 6.14 Text messages that got erased later.

### 6.3.3 Drawing behaviors

According to the interviews, we found that teams were completely asynchronous in drawings. No synchronized drawing session occurred at any time in any team during the study. All participants visited the systems at different times to build up the drawing.

Based on the interviews and observational data, four types of behaviors emerged from the drawing activity, among which three were individual level, and one was team level.

#### ***Building***

Building describes an individual-level drawing behavior wherein a participant focused on their own contributions to the larger drawing, without creating meaning to connect to the team drawing. Building usually resulted in random drawings on the canvas. Building does not usually encourage team effort, either because the creator did not have that intention, or because it was difficult to develop a longitudinal story out of the random, small pieces. Building happened frequently at the beginning of the activity, since teams did not yet know what to draw and how the team would proceed together.

For example, in team one, the sun, moon, and panda were drawn by individual participants at different times. Their creators did not intend to use the drawings to arise team effort. The pieces are simple, straightforward, and not provocative enough to stimulate the creation of a larger story.

### ***Complementarity***

From the analysis, the second type of individual-level behavior was identified as complementarity. Complementarity describes the behavior in which an individual participant drew on top of someone else's drawing, adding details to the element to make it more concrete. Complementarity started when more pieces of drawing emerged from building. Participants started to look at each other's pieces and thought about how to interact with their team members through drawing.

Complementarity makes the drawing more complete. For example, for team five, after P51 complemented P53's original building of a landscape, the drawing showed more vivid details, such as birds in the sky, flowers on the grass, and houses on the mountain. Such a behavior could bring more interactivity among the team members and encourage further interaction. For team four, the participants did a lot of complements with filling in colors to the shapes, so their final drawing turned out to be greatly expressive in colors.

### ***Matching***

Matching is the third type of identified individual-level behavior. Matching describes the behavior when an individual participant created pieces of drawings to echo someone else's pieces. Participants usually used colors or shapes for visual matching. They also created pieces to echo meanings for value matching. Matching also started after pieces of drawing emerged from building. Participants performed matching at the same time as they

started to complement each other's drawings. The difference between complementarity and matching is that complementarity is about building on top of each other's drawing pieces, while matching is about building on top of each other's meanings in drawing.

Matching brings more content to the team drawing. For example, team three did a lot of matching behaviors by adding in holiday themed elements. When someone drew a Christmas tree, the next one drew a gift list, followed by a Santa, a reindeer, etc. They did matching to echo the meaning of the pieces and finally made the whole drawing consistent under the theme of Christmas.

### ***Growth***

Based on the three individual-level behaviors, one team-level behavior was identified as growth. Growth described the holistic team effort that eventually led the team drawing to develop gradually and consistently after building, complementing, and matching. Growth started when a story in the drawing began to emerge. Growth usually stimulated more complementarity and matching, since once participants saw a potential story from their drawing, they started to work along the theme.

Growth was very obvious in teams one, three, and five. For team four and two, growth occurred, but the stories were less obvious. For team four, the final drawing was abstract and visually consistent. For team two, more conversations in text messages drawn on canvas emerged than actual buildings of lines, shapes, or colors. This team still grew their drawing by "chatting" and joking with each other, but without creating a drawing of a story that is easy to interpret.

Figure 6.15 abstractly presents the behaviors of building, complementarity, matching, growth, and the relationship between them. Figure 6.16 presents the timeline of behavior of building, complementarity, matching, and growth.

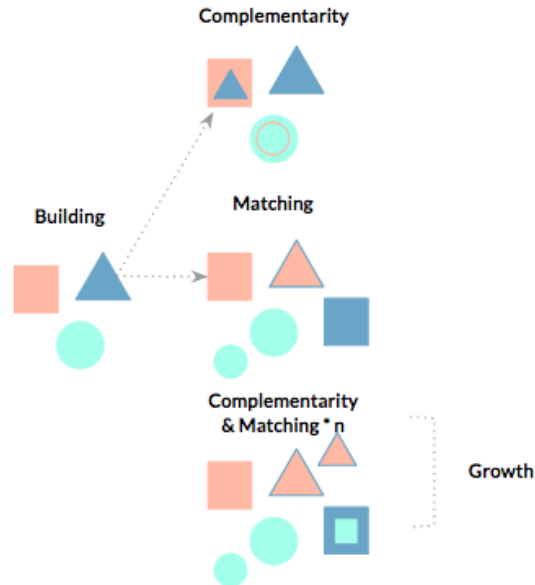


Figure 6.15 Drawing behaviors of building, complementarity, matching, and growth.

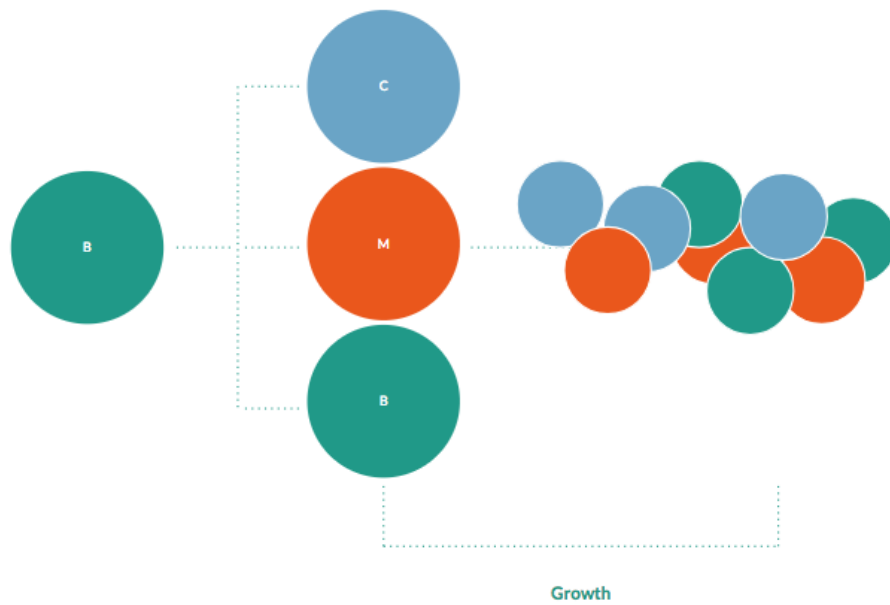


Figure 6.16 Timeline of drawing behaviors to emerge.

### 6.3.4 Perceived experience

This section synchronizes results from the experience sampling survey data that measured the experience of using DARTS, as well as insights from interviews.

Table 6.3 Average scores of the perceived experience.

Facet of DARTS experience	Average Score (1 - 5)
Expressivity	1.8
Reflection	1.4
Interactivity	1.8
Playfulness	2.4

#### *Overall changes of perceived experience*

Table 6.3 summarizes the overall average scores of the four facets of participants' DARTS experience. The scores reflect on average the degree to which participants felt a specific facet of the experience. Overall, participants experienced a higher level of "playfulness" than the other three.

Figures 6.17 through 6.20 show the changes of perceived experience across different active sessions. Each line in each chart presents one participant's change in felt experience, with the Lowess lines representing the overall trends. All four Lowess lines increased in the first five active sessions, which means that overall, for all participants, the more they engaged in the activity, the more expressive, reflective, interactive, and playful they felt. The Lowess line of expressivity continued to increase in the 6th session, while the other three Lowess lines decreased. This indicates that "expressivity" was the experience least influenced by the engagement of other team members. In other words, when all the other team members quit, a participant could still feel a higher degree of "expressive" experience than previous

drawing sessions, while the other three facets were influenced by the absence of team members.

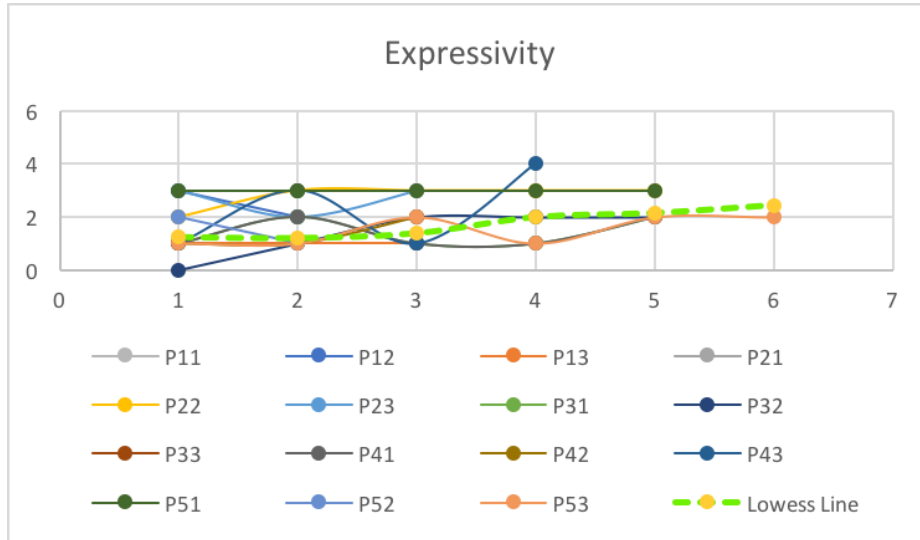


Figure 6.17 Changes in perceived experience of expressivity.

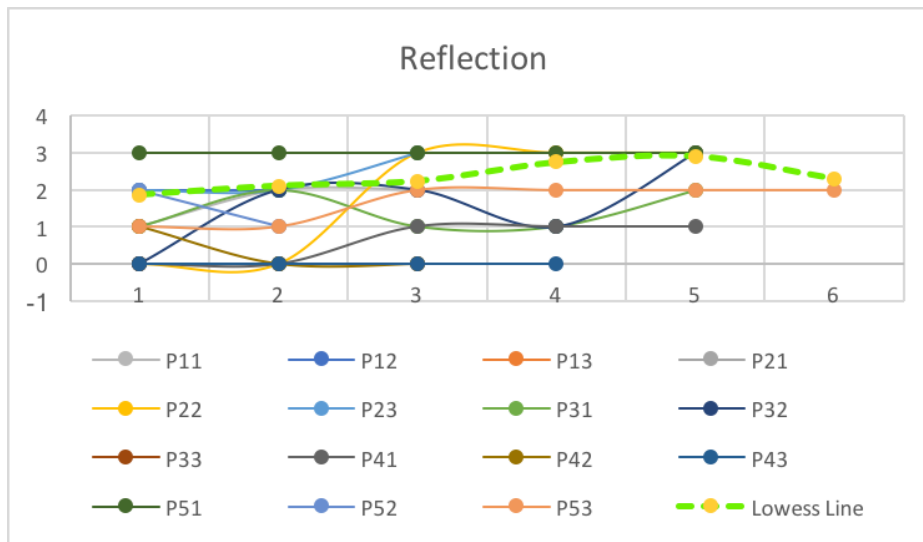


Figure 6.18 Changes of perceived experience of reflection.



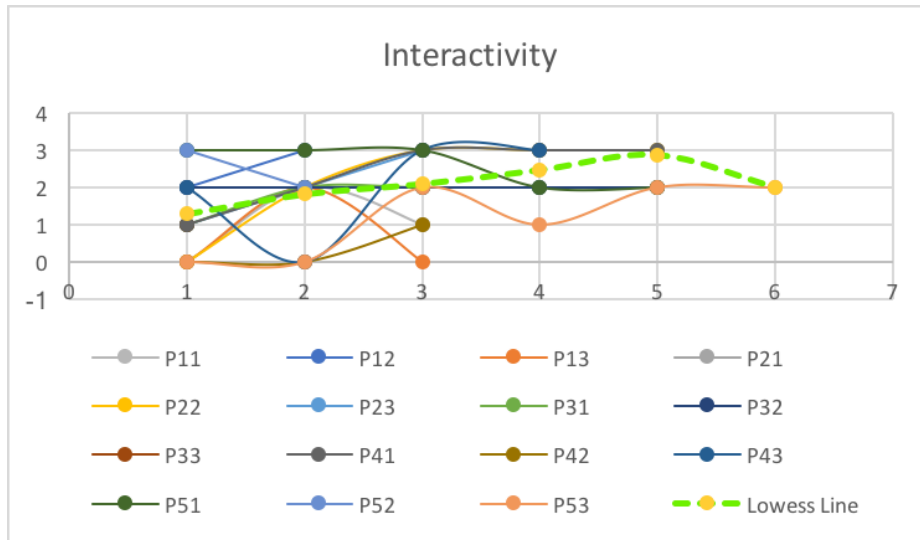


Figure 6.19 Changes of perceived experience of interactivity.

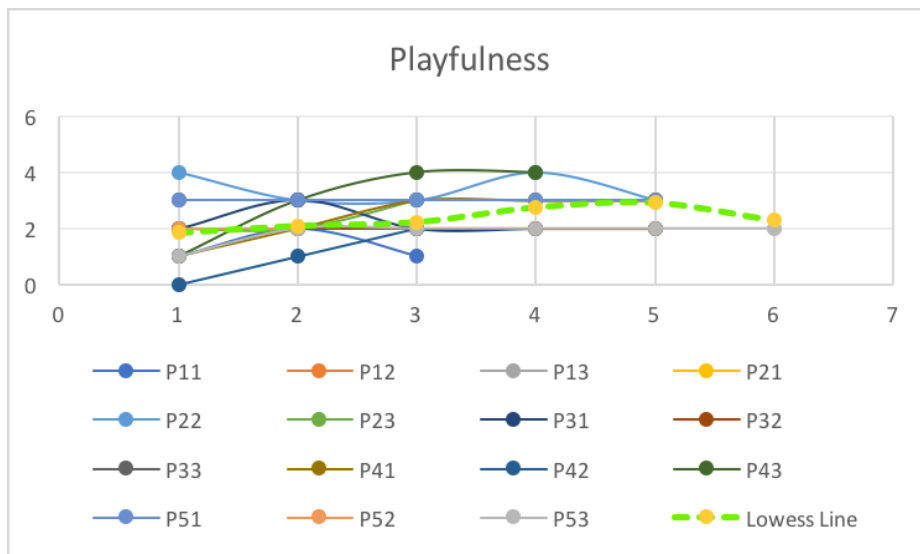


Figure 6.20 Changes of perceived experience of playfulness.

### ***An engaging playful experience - a net of four facets***

In the previous section, we described the findings from the survey data, which showed increased levels of perceived expressivity, reflection, interactivity, and playfulness. In this section, we discuss how participants felt the change in experience at different sessions, and the relations between the four facets.

#### ***1. Expressivity***

First of all, we found that initially the ideas participants wanted to express through drawing originated in individuals, but that as time went on they built off each other's ideas.

Some participants described why they made the initial drawings:

*P31: "It's Christmas time, just the first thing came to my mind. I drew an elephant, because we had a white elephant on that day so I drew that. Pretty much the first things came to my mind."*

*P32: "First of all I didn't know what to draw, I opened it up and saw a box there, and I thought about Christmas and did a Christmas tree, and put boxes under it. Someone made the three boxes to the three of us as Christmas gifts, and turned that big box into a Christmas gift. From there it kind of went into the holiday theme."*

*P53: "Nothing specific. The first thing came to my mind when I opened the canvas was about sky, cloud, river, etc."*

Individuals drew whatever came to their mind without a lot of deliberation, such as a transient, emotional status, a joke heard from a recent meeting, feelings about an upcoming holiday, etc. Gradually, seeing each other's drawing became the main inspirations, as some participants describe:

*P23: "My drawing is to respond [to] everyone else's drawing. I tried to 'comment' [on] their drawings [with] my drawings."*

*P41: "I don't have a true expression, just according to the things existing, what would make sense to add on top of them."*

*P43: "I didn't know what to draw but when I opened it and saw the others' drawing I would add on to their drawings. I did 50/50 of new initiations and building on others' drawings. The heart and moon were new initiations, the green and mountain were someone else's outline. I colored the lines on the left, I didn't draw them."*

Reflections on what someone else was trying to draw and express encouraged actions of complementarity and matching. The increased interactions encouraged further actions, content, and therefore expressivity through drawing. Thus, the first finding around

expressivity is: **interactivity and reflection inspire expressivity; the facets of interactivity and reflection positively contribute to the facet of expressivity.**

Secondly, we found that participants express through drawing differently than through emails or IM messages. In this drawing activity, participants did not hesitate to share an incomplete draft that demonstrated thinking while drawing; no expression needed to be a well-rounded product, as some participants put it:

*P32: "Other channels like email are more formal, thoughts laid out there. You want to have [a] draft, put ideas there, well rounded thoughts, save it up for a day or two, and then send in one email. But this activity - drawing, you can put things there while thinking."*

*P43: "I really have a hard time during the offsite, there are things that I can do here that I couldn't do during the team offsite. In the offsite, you contribute you have to share, and if you say or do something you can't go back and correct them. But what I do here is if I make some mistakes, I can come back and correct that. I feel like I don't need to put a finished product here, I can erase things."*

Therefore, the informal social context encouraged expressions around things participants did not usually express in daily work, such as personal affect, values, and fun facts about themselves:

*P11: "Communicating with drawings is different. In other methods, we may chat about work, company, research, movie, drink, etc. common cheap chat or work-related topics. But in drawing, very different than what we talked about. E.g., we would never say we want to burn AI and bring human back."*

*P21: "Personally, I think it's very [much] like moments in Wechat, that I post things that I am too lazy, or don't have the chance to express in my daily life. Drawing gives me the opportunity to express those things and share them. I drew Jason William 55 to explain the meaning of my Wechat name. I also drew Tiananmen Square to show that I am missing my country."*

As a result, team members were able to learn informal, non-work-related information expressed by others about, for example, personal affect:

P12: “Some of them are happier, e.g., the sun and music can tell.”

P32: “I think they were doing fine, and they really look forward to Christmas. I think they felt pretty good, ready for Christmas.”

Such informal expressions grounded informal social interactions, wherein team members express and share personal affect and thoughts less for a goal, but rather for the playful, relaxing experience, like how P31 said:

P31: “Communicating information through other channels [is intentional]. The goal for the activity is not really for communicating, but more for playful interactions”.

The playful interactions based on each other’s expressions through drawing sparked participation, since they enjoyed it and had fun. Therefore, the second finding around expressivity is: **playfulness motivates expressivity; the facet of playfulness positively contributes to the facet of expressivity.** Figure 6.21 presents the relations around “expressivity.”

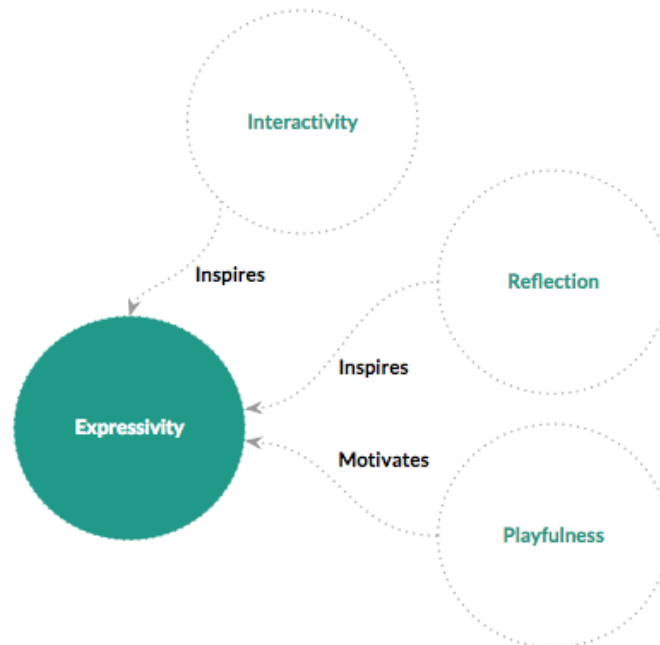


Figure 6.21 Relations between expressivity and the other three facets.

## 2. Reflection

First of all, we found that drawings could reflect an individual team member's affect, such as their preferences, emotions, mood, likes, and dislikes, as discussed above. Participants also reflected on their team values and on each other's expressions and interactions via drawing. They gleaned their team values from the actions of complementarity, matching, and from gradually seeing the growth in the drawings. They could sense team spirit in the way they supported each other:

*P41: "I have never [had any] doubt about the team before, but this made me know more about the team, it's playful and fun, and made me enjoy working with the team more."*

*P43: "I understand that they really want cohesive[ness] rather than individualism, they were creative and fun."*

Reflections also added a fun tone to team members' relationship. Participants got to know how their team would function in a setting of play and how their team members would behave during an informal, non-work-related task, as described by P22:

*"We don't have that [many] constraints here, but at work, you need to consider more things. Here you are basically just playing with each other. You can erase and redo."*

Even though through playing participants did not discover a large amount of information about their team members, enjoying each other's fun side was precious since they had rare opportunities at work to gain knowledge about their co-workers' personal sides. Some participants described it as:

*P13: "I don't think it fundamentally changed my understanding of my team members other than they too are willing to be a bit silly at times."*

*P23: "They are still like themselves in drawing, just more fun, relaxing, it's like seeing who they are in their daily life, not at work."*

*P31: "It added the fun part to my understandings about them. They are more fun in drawing."*

*P51: "I guess there is one person that has some talents in drawing. He looks very creative and fun. That's something I didn't know before. I thought they are just engineers, now I know they have fun parts as well."*

Therefore, the finding around reflection is: **expressivity, interactivity, and playfulness ground reflections; the facets of expressivity, interactivity, and playfulness positively contribute to the facet of reflection.** Figure 6.22 presents the relations around "reflection."

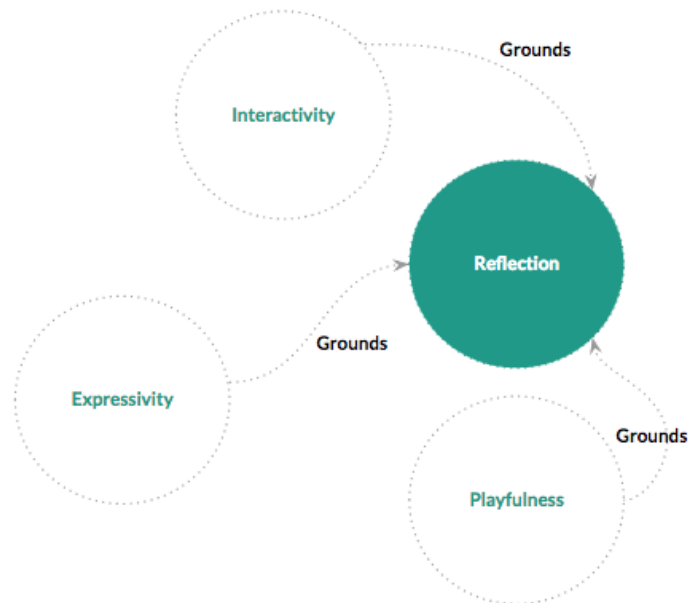


Figure 6.22 Relations between reflection and the other three facets.

Moreover, we found that reflections have different levels of influence over team members with different maturity of relationships. Participants behaved consistently in drawing and in work; as they described it:

*P23: "I behave pretty consistently, I think the other ones do as well. Like, the dog probably is done by P22, basketball is probably done by P21. P21 has a profile picture on Wechat that's really like that part."*

*P32: "I was more inclined to modify the others' drawing, more using it as a theme, I don't want to draw over others' drawings. Yes, it's consistent with how I would work with them. I wouldn't discard someone's work without talking to them first. I think about what I do before I do, so it was a little wired to begin with. I don't draw over people's stuff, and I know that's my personality. I'd rather talk to people and discuss any plan before taking any action."*

Beyond the individuals, teams also functioned consistently even under a different, more playful context:

*P11: "We would compromise [with] each other, and interact with each other, it reflects pretty constantly in drawing. E.g., people would erase the picture to incorporate the others."*

*P53: "The activity is pretty much like how we work together. We build things together from scratch, we build on top of each other's work. I did it in the same way [as] how I work."*

Therefore, the new understandings about team members and teams reinforced rather than replaced the impressions participants already had about their teams. They applied their existing knowledge to guess who drew which drawings, and once the behaviors met their expectations they believed their assumptions and saw the activity less anonymously. For example, P21 used his existing understanding about P22 and P23 from managing the other two at work, and accurately guessed who did which pieces:

*"It reinforces the impressions I had of them. P23 is more geeky and creative, so I guessed he drew the more formal parts. P22 is more cooperative, so he may have drawn the basketball part. That's following my drawing of Jason William, P22 may want to continue the topic, that's like how he cooperates with us."*

Participants who drew with less familiar coworkers were able to gain new understanding about their colleagues. For example, P43 described how she got to know P42 through this activity:

*"I didn't work much with P42, I know he is a great guy. Now I feel he supports my ideas, is open, creative, expressive. That's what I got about him."*

The reinforced, or new understanding contribute[d] to an enhanced team-level knowledge and shared awareness.

### *3. Interactivity*

Team interactivity was embedded into the four types of drawing behaviors discussed earlier. Based on the data, no discussion around drawing outside the activity happened in any team. Therefore, the interactivity that happened during the activity reflected how the virtual team, consisting of the same team members with existing teams, interacted and proceeded in an enclosed online activity.

First of all, based on findings, team interactivity increased as time went by and as individual expressivity gradually built up. As shown in Figure 6.16, building started to fade after the overall first two active sessions, while complementarity and matching started to show up among team members after the first two asynchronous sessions. Gradually, the growth in drawing visually represented the “product” of team interactivity embedded into drawing. Therefore, the first finding around interactivity is: **expressivity facilitates interactivity; the facet of expressivity positively contributes to the facet of interactivity.**

Secondly, we found that the interactivity in drawing could reflect daily interactions but distinct from daily work. Participants reflected that the way they behaved during drawing matched how they would behave at work. It was consistent with their personalities and the way they would work with each other at work and daily life:

*P11: “I guess the way I interacted with them in the drawing activity is pretty much the same compared with our daily interactions.”*

*P41: “It probably is consistent in the way that P43 and I work together. I usually start a project and consult her and she add[s] pieces. E.g., I started a project plan, and she commented from a perspective of recruiting.”*



But the interactions during drawing also differed in some ways and were separable from work. Since the “task” in this online, playful activity was much simpler than projects at work, the patterns of interaction during the activity were simpler than coordinating at work.

Below is one example of how participants experienced the differences:

*P43: “We collaborate [on our] own time, I like it that when someone made changes I wouldn’t see it immediately because it would be distracting. I can see in a work environment it would be valuable, but I like this way. I don’t need to rush, or follow a schedule, disrupting or borrowing their time, and I really like it. Similarity is that we know each other, they know what I do and I know what they do.”*

Participants were motivated to have casual interactions under an informal social context via playing. While “playing” with each other, the relationship became risk-free and consequence-free. As in a playful activity, participants were more casual and less careful than how they interact and behave at work:

*P12: “We are definitely more playful. That was really engaging.”*

*P13: “DARTS was a moment of silliness in the day which rarely if ever happens in the workplace. It also showcased some of the latent artistic talent among our team.”*

*P21: “It separates from our work. We didn’t talk about the drawing during our normal work. And when we draw, we have the opportunity to express things that we don’t have a chance to express at work.”*

*P42: “This is a simple project, we will do different projects differently. I would be more careful if the project is more complex. No one would be fired because of the drawing so I was not that careful. I could have fun there.”*

Therefore, the second finding around interactivity is: **playfulness motivates interactivity; the facet of playfulness positively contributes to the facet of interactivity.**

Figure 6.20 presents the relations around “interactivity.”

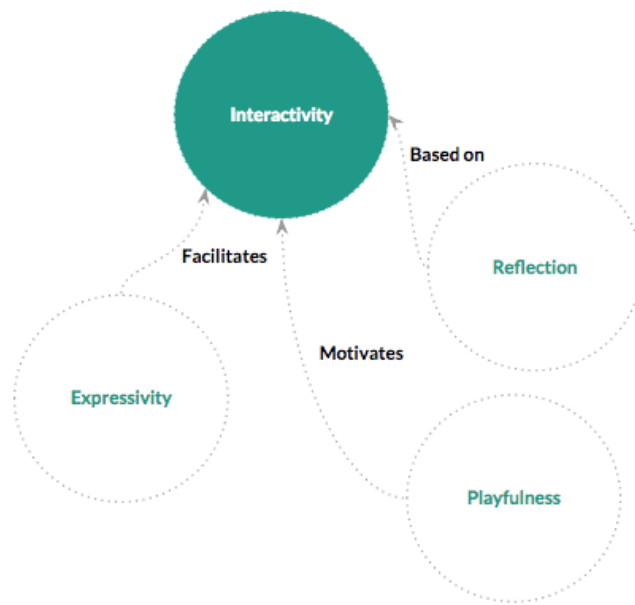


Figure 6.23 Relations between interactivity, expressivity, and playfulness.

Moreover, based on the team interactions, we found that team members during the drawing activity had different roles than existing teams at work. Specifically, there were only two types of roles identified in the study.

**Cooperator (C):** a cooperator was a team member who helped complete the team drawing by complementarity and matching. Based on the observations, all participants, no matter how many active drawing sessions they had, participated as cooperators at different times. There was no participant who solely built pieces of drawings without interacting with the other team members. Teams proceeded in this online drawing system with autonomy that was independent from their organizations.

**Attempted leader (AL):** while every participant played the role of cooperator during the online playful drawing activity, another type of role emerged in team two. An attempted leader was an individual who attempted to lead the team drawing and explicitly called on the others to draw something together. For example, P23 from team two tried to initiate

team drawing under a common theme by writing down text messages such as “what is the topic?” and “let’s draw something together.” According to the interview with P23, he not only tried to communicate via text, like some other participants did in other teams, he was trying to explicitly drive the team to draw something together. He did not feel satisfied with just complementarity and matching, since he could not see a clear theme emerging from the drawing. In actual work, P23 was an individual contributor in their team, while P21 was the manager. According to all interviews with the team, it is found that the roles in the virtual team during the online activity corresponded to the participant’s personalities and ways of doing things, rather than their formal team roles. Attempted leaders would try to lead, but they may or may not successfully lead the virtual team. In team two, even after P23 initiated a team drawing, the other two continued complementing and matching until the end of the study. Figure 6.24 presents the transition of roles in team two.

Based on data analysis, the reason why only one attempted leader showed up during the study was that it was not long enough to reveal conflicts. Based on discussions in section 6.3.2, except for team two and team four, all other teams had consistent drawings for growing a story. The virtual teams functioned well enough during the active sessions, and there was no obvious conflict or breakdown. Cooperators experienced a satisfied and happy feeling from their drawings, and no one disrupted the harmony. For team four, even though no consistent story had developed, the drawing was visually detailed and satisfying. Participants in that team still felt the mood of happiness and enjoyment, so they did not break the progress to seek out something else. But for the team two, the drawing was visually more abstract and random than the other teams. There was a moment of dissatisfaction for P23, who decided to propose something new:

*“I responded their drawing in two ways. I tried to echo to their drawings first. Then after a couple of days, when I still could not figure out what we were trying to draw, I tried to propose things to draw.”*

But since drawing afforded collaborations under a relaxing and consequence-free social context, even though the drawing was abstract, and less consistent in terms of a common theme, it did not influence the building of cohesion and trust in team two, which is discussed in section 6.3.5.

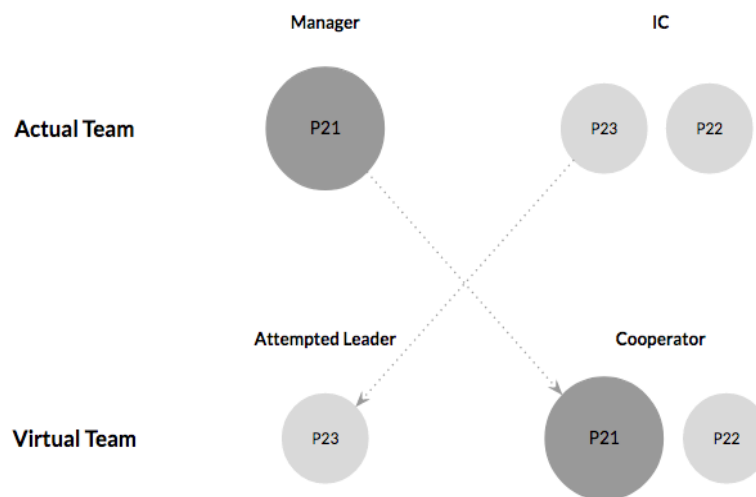


Figure 6.24 Role transitions of team two in their virtual team.

#### 4. Playful

First of all, playfulness developed from expressions and reflections. We found that participants could express affective information through drawing, which made them feel entertained, as P53 said:

*“First of all, I found the app very simple, with basic and limited functionalities. But after some time, I found that I was still able to express something, and then I felt it was more fun.”*

Through reflections, participants heard echoes via implicit communication, which made the process unexpectedly playful, as some participants described:

*P11: “Most of the playfulness came from there, when I tried to find out what others were doing and thinking. Seeing the picture is one aspect, seeing others’*

*drawing and trying to find out what others were thinking had some echo with mine. E.g., the robot in the middle was just about AI, but then someone drew the fire on AI, that is interesting. Quite interesting. Apparently one of the others thought AI is popular and on fire. Or [maybe] another person put the fire on AI and want to burn AI. Either one fits our recent situation of the reorg. I crossed the DNN and wrote down 'human' to show that AI should also think about human beings."*

*P53: "It was also more fun after being able to see someone else's drawings and to get what they are thinking behind what they drew. For example, the wall and the pepper on the wall, for the new year theme, I found it interesting."*

Via reflections, participants could identify each other's fun side, which generated playfulness. Participants viewed the drawing activity as a unique experience of playing with colleagues; as participants described:

*P13: "DARTS was a moment of silliness in the day which rarely if ever happens in the workplace. It also showcased some of the latent artistic talent among our team."*

*P23: "As colleagues, we spend about 80% of our time talking about work. But this time, we didn't need to talk about work. It's probably because of the casual context, in which we don't need to be serious. And because it's doodling, you can't really be serious and too formal."*

Drawing provided a rare opportunity to see each other's fun side outside their work context that made each other feel enjoyable:

*P12: "We didn't know P13 that long, so we didn't see his playful side before, that's kind of interesting."*

*P13: "I enjoyed the playfulness of the system and wanted to use the system to encourage play with my colleagues."*

Therefore, the first finding around playfulness is: **expressivity and reflection engender playfulness; the facets of expressivity and reflection positively contribute to the facet of playfulness.**

Second, playfulness derived from the interactions. Playfulness increased as time passed and more interactions were embedded into the drawing through complementarity

and matching. Participants viewed complementarity and matching surprising and fun. The echo from building on top of each other's work or meaning afforded mutual feelings that could provide a fun experience. For example, participants described the fun from drawing as:

*P11: "It's much more playful after the other started the drawing. It was extremely boring the first time I opened the website when there was nothing there. Every time I opened it, there were things [that] quite surprised me."*

*P31: "Great to see others' drawings, interesting, I think it's a good way to see how others are drawing the same theme without communicating about it. That is the fun thing."*

Ultimately, the growth in drawing out from asynchronous interactions was unexpected and surprising, like P41 said:

*"It was more fun to be asynchronous, because people just leave something and you come interact with it, you come back and find things different. I realized that oh maybe we should be more explicit about working together. ... It was way more fun than what I thought. E.g., the mountain, I drew the red line, when I came back and saw someone drew a green line, so I decided to fill it with green. So, there are parts that you can add to, or take it to another direction."*

Moreover, playfulness in return facilitated further and continuous engagement, which facilitated further growth in the team drawing and therefore promoted more playfulness, such as how P32 described it:

*"Yes, I didn't expect that I would open it up every day, but [it] ended up that I enjoyed it."*

Therefore, the second finding around playfulness is: **interactivity engender s playfulness; the facet of interactivity positively contributes to the facet of playfulness.**

Figure 6.25 presents the relations around "playfulness."

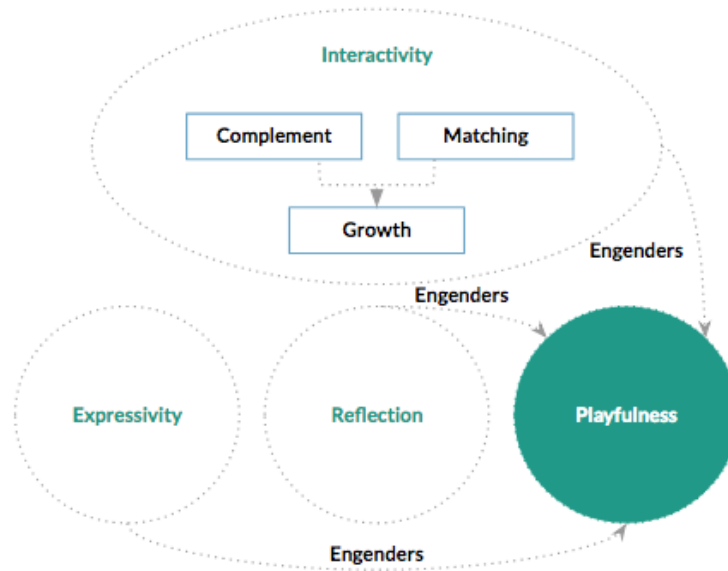


Figure 6.25 Relations between playfulness and the other three facets.

In summary, Figure 6.26 shows the complete relations between the four facets of participants' experience, including how each facet influences the others and the overall net.

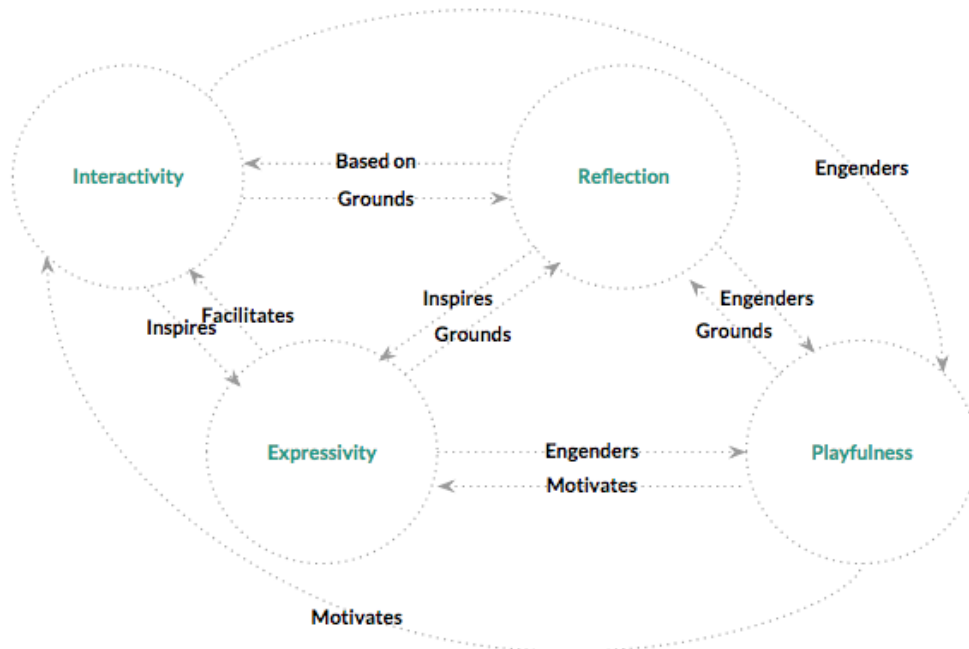


Figure 6.26 The net of four facets of experience during the online drawing activity.

### 6.3.5 Team effects: trust, cohesion and emotions

Based on the interviews and observations, we found that the overall experience, consisting of the four facets, influenced the building of team trust, cohesion, and individual positive emotions.

#### ***Trust***

We found that **trust built upon the growth of the team drawing**. In the activity, participants were able to accomplish something together outside of work. The final “product” of teamwork gave the participants confidence that the team was a capable group of individuals that they could count on. The task was low-risk, and therefore it was easier to obtain a satisfying result; this made the activity effective for building confidence and trust towards each other, as participants said:

*P41: “I always trust the team, this is very low risk, so I think yeah I definitely trusted them to do it. Towards the end maybe it increased a little because it’s better than what I expected.”*

*P51: “I feel I trust them more. I trust them already at the beginning. They are capable, they are good folks. I was a little concerned that they may not participate that much but after I saw their drawing, I felt very good about them.”*

*P52: “We accomplished a ‘goal’ anyways, so we did a thing together, I feel more trust.”*

We also found that **trust built upon new knowledge about each other**. The new experience of accomplishing something fun together brought new reflections about team members and the team. New team-based knowledge built up based on the reflections, which were grounded in expressivity and playfulness. This helped the growth of trust:

*P21: “I think trust increased. Because you get the chance to know them better. The more you know about your colleagues, the more trust you have.”*



P31: “Definitely help building the relationship because we don’t really do playful things like this. We know each other pretty well, we already have a pretty good relationship, we tell jokes. But this is like a new experience with each other. It’s good to see them drawing.”

P53: “I think so. Especially with P52. We didn’t really know each other before. But we did something together this time, it helped me get to know more about him, so the trust builds upon that.”

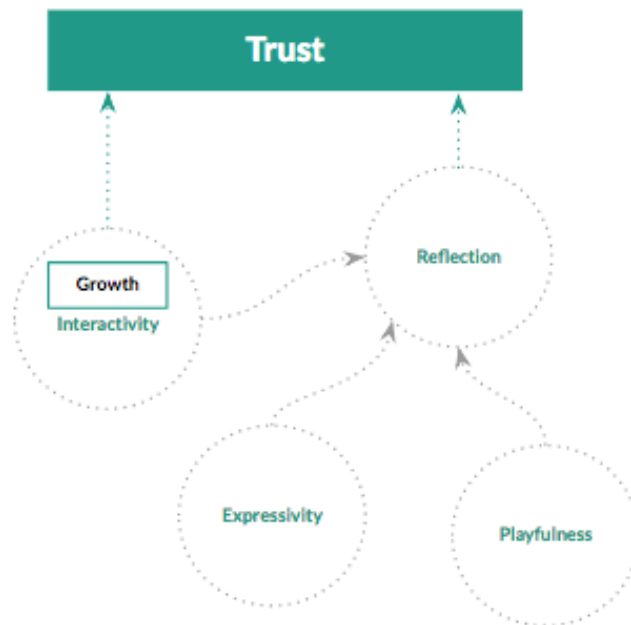


Figure 6.27 The four facets of experience positively contribute to trust building.

### **Cohesion**

We found that **team cohesion built upon team spirit generated by the growth in team drawing**. As discussed above, teams were satisfied and happy about what they accomplished together outside work. The ease of accomplishing something fun, aesthetic, attractive, engaging, and smooth generated a high team spirit, as participants said:

P12: “I think so, I think that helps. I didn’t know P13 well, but after we built on top of each other’s things it felt closer to him.”

P42: “Before we never had that much cohesion because I worked with P43 and P41, not together. I didn’t doubt about the cohesion, it’s low risk, I don’t have doubt that this is not cohesive. In real life, I have a lot of trust that we work well together. Emotionally I think we are more cohesive.”

*P52: "I think the cohesion increased. Even though our drawing doesn't look beautiful, it's something we did together. It is the first time for me to draw something after school. I feel pretty good."*

*P53: "We didn't have that much cohesion at beginning, but now after finishing this project yes we have some. With P52 it's from zero to some, with P51, it's about some new understandings about her."*

We also found that **team cohesion built on the anonymous expressions and reflections**. Participants were more inclined and comfortable to express themselves in a low risk and casual social context. They did not need to worry about the consequences on actual work or even think too much, since their identities were not apparent to each other. Being able to express themselves and seeing expressions from their team members made them feel closer to each other:

*P22: "During team building, your work relationship continues, you may still talk about work. But in this activity, it's far from work, you don't talk about work. You play together, you have your personal space to express."*

*P32: "Being anonymous helps. You don't need to worry who you are drawing with, it's the CEO? Your manager? You may want to behave better and impress them. So, I'd rather be anonymous."*

Moreover, **team cohesion built upon experiences of team members playing with each other and having fun**. The drawing activity provided a precious experience apart from work for team members to spend time together and create some good memories with each other. While it is difficult for distributed teams to experience genuinely enjoyable team building activities, online activities fill the gap, as P22 noted:

*"We don't actually have that much time doing team building. So, if we have some time do something like this, it would be nice. Like playing together. Our team building activities are very traditional, like karaoke, grabbing dinner, or board games. Nothing very well designed like this activity."*

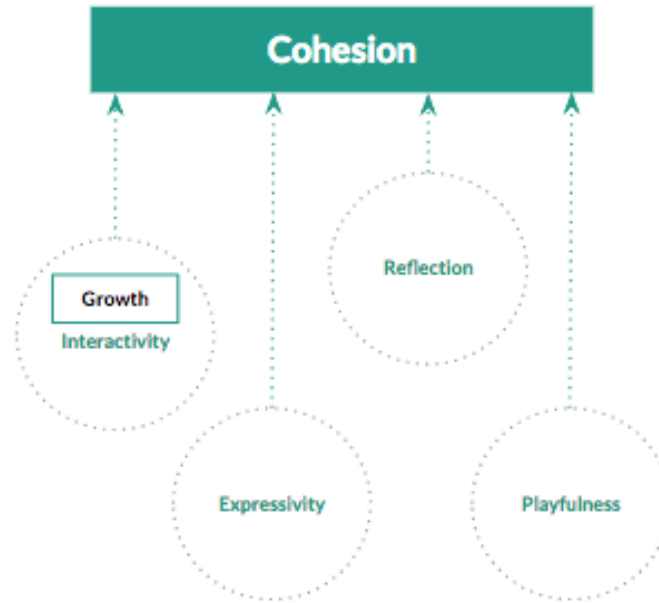


Figure 6.28 The four facets of experience positively contribute to team cohesion.

### ***Positive emotions***

We found that only good emotions occurred during the activity. Participants reported positive emotions such as: interest, joy, curiosity, happiness, surprise, awesomeness, fun, excitement, entertainment, creativity, playfulness, affects, and relaxation. Those positive emotions came from several sources. **Positive emotions emerged from seeing asynchronous team members' updates.** As discussed above, seeing the updates team members made when a participant was offline were surprising and entertaining. The asynchronous interactivities indicated the engagement and willingness the others wanted to put into this team activity. P11 described his experience as:

*“Because seeing something new on canvas every time, didn't expect the others' drawing, so felt pretty entertained. That's what made me pretty interested.”*

**Positive emotions also came from seeing the drawing develop.** The outcome was in nature unexpectedly fun and aesthetically appealing. Seeing the drawing evolving into a

good form indicates the team endeavor was working and effective, which made participants feel satisfied and excited; P53 shared:

*"After each draw[ing], it looks better and better, I feel very content."*

**Positive emotions also came from the good feelings about team members.** As in early discussions, drawing provided an opportunity to reveal each individual's fun side. Drawing also provided an opportunity to highlight the creative minds in the group. Participants were likeable in this activity because they were creative, fun, attractive, unexpected, and friendly; as P52 put it:

*"I felt very surprised when I saw new things, I think my teammates are awesome, they did it so well."*

**Positive emotions also derived from the informal social interactions.** Taking a mental break and playing online with team members fostered positive feelings. Participants compared this activity to some other casual activities they usually do at work to take a break such as having a coffee break, browsing social networks, or having informal conversations with colleagues. We found that the drawing activity online was highly effective in terms of releasing tension and stress; as participants described it:

*P13: "For me, it was a moment to unwind and be a little bit less serious. I enjoyed the time I got to play with DARTS."*

*P21: "It's very much like posting on social media, it brings good feelings."*

*P23: "It's like the three of us were asked and sent to do a special secret project, fun and not related to work."*

*P32: "It was an enjoyable task. Fun to see other folks' drawing and adding on the drawing, and see what they would draw to go with the theme. I kind of like the snow globe, so I am happy about that one. This is an enjoyable small task."*

Such experiences brought good feelings overall to the participants:

*P22: "I really enjoyed it when I drew, overall it is very positive."*

*P43: "I had only good emotions. First of all, I didn't expect good emotions, because I felt sensitive about drawing. But I felt better, I can be creative and felt free to express myself, there wasn't any rules."*

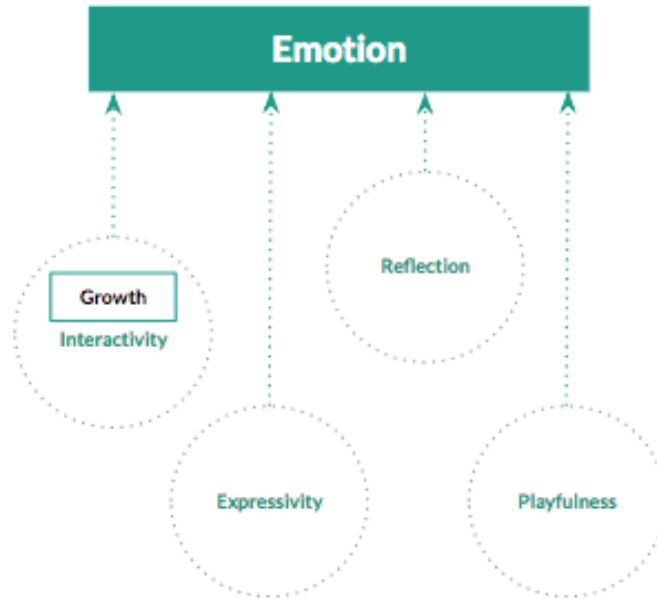


Figure 6.29 The four facets of experience positively contribute to positive emotions.

### ***Longitudinal effects on existing relationship***

During the interviews, we asked questions around how long the effects lasted. Based on our conversations, the built-up trust and cohesive feelings towards the team could last long into participants' existing relationship at work, while the positive emotions were more transient and only enabled participants to have a fun break at work.

The trusting and cohesive feelings based on the new knowledge about their colleagues, the playful experience they went through, and the experience of supporting each other's thoughts and ideas collectively contributed to a lasting positive relationship. Some participants reported it as:

*P43: "Definitely not only just in the activity. It carried through the next task I did. The cohesive feeling also lasted longer."*

*P52: "If the other one doesn't do anything to decrease our trust, the feeling (trust) should last long."*

Therefore, we concluded that the online playful drawing activity could successfully help distributed teams build trust and team cohesion through the online playful activities, which last longer into existing relationship in their organizations, but are vulnerable to breakdowns in existing teams.

Most of the participants reported that the good feelings occurred more when they felt amused by the drawing or during the drawing; however, when they entered actual work, the good feelings received in the activity were more fragile than trust and cohesion and were easily impacted by distractions. Some participants described how the positive emotions faded away:

*P11: "Sometimes it made me smile once, but when shifting to work, might forget what I saw on the canvas."*

*P31: "I think it's just at that moment. Maybe within a few minutes the influences went away gradually."*

However, it could be assumed that if the activity becomes routine in the organization, with teams building up the habit of "playing" to take breaks, we could expect the positive emotions to at lighten up moments at work. Overall, we could expect that collaborative drawing could positively influence daily mood. Some participants mentioned that a longer participation would help with a longer-term effect on emotions:

*P12: "It's hard to say if it can transition to work. Maybe it's too short."*

*P23: "It was too short, so we didn't put in enough time and effort yet."*

## 6.4 Comparing with Teams in Study I

Based on the two studies, we discovered interesting findings around different behavioral patterns in drawing. In the above sections, we discussed the four types of drawing behaviors in Study II. Similarly, based on data analysis, we identified individual-level and team-level behaviors in Study I.

The sections below report our observations of how teams in condition 3, Study I, gradually developed, proceeded, and accomplished the drawings, both individually and collaboratively.

### ***Behaviors***

Based on our observations, we categorized behaviors that emerged during the drawing activities into seven types: build, declaration, initiation, feedback, response, complementarity, and match.

#### *1. Build*

A “build” describes a participant’s action of drawing independently without referring to a common theme with any other team members. For example, in Team 2, all three participants drew lines, filling the canvas with colors, but they did not discuss their own plans. In this case all three team members were “building.”

#### *2. Declaration*

A “declaration” describes when a participant explicitly tells the other team members what s/he would like to draw independently. The difference between a “declaration” and a “build” lies in whether the participant tells the team what s/he is going to draw. For example, in Team 1, P1 made a declaration before he drew a pig by chatting “let me draw a pig to entertain you.”

### *3. Initiation*

“Initiation” describes when a participant initiates a theme, or a single element for the whole team to work on together. The difference between an “initiation” and a “declaration” is whether the proposed drawing is for the individual or for the whole team. For example, in Team 4, P1 initiated drawing a beach and the other two team members agreed on the theme.

### *4. Feedback*

“Feedback” describes when team members comment on each other’s drawings. For example, in Team 1, after P1 drew a pig, P2 commented by chatting: *“looks like a tiger.”* Participants gave feedback either by chat or by texting on canvas.

### *5. Response*

“Response” refers to the way participants react to team member’s feedback. In the example of “feedback,” P1 in Team 1 typed “this is not a tiger!” beside his pig as a way to respond to P2’s comments. Response is also in either chat or text message on canvas.

### *6. Complementarity*

A “complementarity” describes a participant’s action when s/he tries to intentionally add to the other team member’s drawing. Such action could complement drawings by filling a color, adding a shape, etc. in order to make the drawing more complete. For example, in Team 3, working towards a drawing of a house with a backyard, P2 drew a lot of “complements” to make the house that P1 was drawing more complete with more details, such as windows, doors, and figures in the windows.

### *7. Matching*

“Matching” describes a participant’s action when s/he intentionally draws an independent element to match elements from other team members. The difference between



a “match” and a “complementarity” is whether a participant is building on a team member’s drawing. For example, in Team 6, P1 started to draw the logo of Windows after he saw P2 drew the logo of Chrome. “Matching” could help the overall drawing be more consistent with different but matching elements.

## ***Roles***

### *1. Leader (L)*

The “Leader” was the person who did an “initiation,” which ultimately influenced the team drawing. For example, P1 in Team 4 initiated drawing a beach, which became the theme of their teamwork.

### *2. Cooperator (C)*

The “Cooperator” was the person who did not “initiate” a theme but was willing to contribute with a “complementarity” or “match.” For example, P2 in Team 1 drew another pig to “match” P1’s first pig, and therefore was acting as a “cooperator.”

### *3. Individual contributor (IC)*

Differing from a “cooperator,” an “individual contributor” was the person who basically and mostly contributed a “build” rather than a “complementarity” or “match.” For example, P3 in Team 5 did not really participate in P1 or P2’s group drawing; she mainly focused on her own drawing on the shared canvas.

We found that different than participants in Study II, roles were less stable in Study I during the sessions. Team 1 and Team 6 had clear role transitions. In Team 1, the IC (P3) started to “complementarity” the details P1 and P2 drew and became a “cooperator.” In Team 6, the L (P1) contributed more “complementarities” and “matches” after he first initiated the

theme to draw and tried to lead at the beginning. In Team 3, P3 stopped his “building” action in the second half of the session, so we describe it as a role transition to “idle.”

### ***Team Coordination***

Based on the individual and team-level behaviors, both explicit and implicit team coordination mechanisms defined in previous literature (Espinosa, Lerch, and Kraut 2004) developed in all teams in condition 3, Study I. Different than the absolutely asynchronous collaboration and mostly implicit coordination in Study II, more diverse coordination mechanisms developed in Study I.

#### *1. Explicit coordination*

Participants used chat, text on canvas, or directly drawing words to “declare” or “initiate” what they wanted to draw, provide feedback, or respond to comments made by other team members. The actions of “declaration” and “initiation,” together with “feedback” and “response,” helped a team to develop a plan and execute with explicit communication.

For example, P1 in Team 4, the leader, mentioned how their team proceeded quickly after a brief group discussion at the beginning: *“we discussed to draw a landscape, and it’s our goal to draw the discussed theme, the group just built upon it.”*

#### *1) Chat amount reflects how explicitly coordinated a team was*

We found that teams that chatted more (Team 3, 4, 5, 6) were more explicitly coordinated. Those teams chatted about the progress towards finishing the task so the amount of chat could reflect how explicitly coordinated a team was. Moreover, we found teams used cheap talk to come up with inspiration for their drawings. For Team 1, asking about each other’s emotions led to a “declaration” from P1 that he would draw a pig to entertain the team and made them happier. For Team 6, chatting about each other’s

background ended up in P1 as the leader in “initiating” drawing something related to the field of Informatics and Computer Sciences.

### *2) Leaders communicated explicitly and facilitated explicit coordination*

We found that leaders would communicate explicitly by initiating what to draw. During the short activity sessions, an initiation easily became the plan the team proceeded with. Therefore, teams that had a leader would end up with more explicit coordination and a themed drawing (Team 3, 4, 6).

Based on the interviews, we found that since the task became more goal-oriented after teams having an agreed theme to draw, team members sensed higher team spirit because they would feel that they were working toward the same goal. For example, P1 in Team 4 said: *“we all agreed on the theme. I could see people were doing things, in this situation I got more engaged in the team.”*

### *3) Individual contributors and cooperators communicated least explicitly with different intentions*

Individual contributors and cooperators communicated less explicitly than leaders, but their intentions differed. Individual contributors focused more on their own drawings; the little explicit communication resulted in more individual drawings rather than cohesive team drawings. The team that had the most individual contributors (Team 2) is the least explicitly coordinated team. From the interviews, we found that individual contributors had the least sense of “being a team” and fewer positive emotions. For example, P1 in Team 2 said: *“I prefer to have a personal space to draw.”* P3 in Team 1 also mentioned he would prefer personal space, and *“when people were building on each other’s stuff, I got a little frustrated.”*

For cooperators, they did not communicate explicitly but they cooperated implicitly. We cover related findings in the next section around implicit coordination.

## *2. Implicit coordination*

Besides building team-based understandings and knowledge through explicit coordination mechanisms, we also found that shared knowledge developed implicitly in teams. Participants gained awareness of what was going on in teams, the status of the team drawings, intentions of team members' actions, and expectations for next steps. Participants used "complementarity" or "matching" to contribute to teamwork based on their understandings about their team status.

For example, P2 in Team 6 described how he followed the others to work on their team drawing: *"when I saw what others were drawing, I saw the trend, and I followed, it happened very quickly."*

### *1) Cooperators contributed to teams mostly through implicit coordination*

We found that cooperators relied more on implicit coordination to understand their teams. They observed what was going on in the team drawing on the canvas, understood the current status, and added "complementarities" or "matches" to make the drawing more complete and consistent.

The actions cooperators took made a team more cohesive since a "complementarity" or "match" could make a team drawing more complete and consistent, which could make the other team members feel more like a team. For example, P2 in Team 1, the cooperator, described why he drew the second pig on the canvas to "match" P1's first pig: *"I drew the second pig because I didn't want the first one to be lonely, they should be a team."* And P3 in Team 5 said: *"the feeling of being together is important."*

## *2) Playful drawing facilitated implicit coordination*

For implicit coordination mechanisms, participants did not explicitly chat or text about plans, next steps, expectations, or feedback. Rather, the ongoing collaborative drawing, which is highly visible on a shared canvas, helped maintain a common understanding and for the team to proceed effectively. Team members could easily see the updates and actions from the drawing, and team awareness and shared knowledge built rapidly without explicit communication about progress.

## *3) Implicit coordination built more in the second half of sessions*

Moreover, we found that implicit coordination mechanisms became more pronounced during the later stage of the drawing activity. There were more “complementarities” and “match” actions in the second half of the drawing sessions when the goals became clearer and the drawings better developed. Team members could complete the details in drawings without explicitly talking about them. They proceeded with the accumulated, shared knowledge in the team. Such shared team knowledge could also facilitate individual contributors to transition to a role as cooperators. For example, P3 in Team 1 started to “complement” a lot during the second half of the drawing session by filling colors into blank shapes made by P1 and P2, and adding details to the seaweed made by P1 and P2.

In sum, in Study I we found that an explicit coordination mechanism was easily developed at the beginning when teams needed to discuss task themes and plans, and was commonly facilitated by “leaders” through “initiation,” mostly via “chat.” It gradually built up afterwards through “declarations,” “feedback,” and “response.” Implicit coordination was easily developed at a later stage when there was more shared team knowledge, and mostly

occurred through “complementarity” and “match” actions by “cooperators.” Freeform, playful drawing facilitated the development of both mechanisms via its nature of high visibility; as an outcome of good team interactivity and coordination mechanisms, team drawings were completed smoothly and rapidly in 20 minutes. Moreover, implicit coordination mechanisms supported the building of knowledge and understanding amongst team members.

Compared to Study I, the sessions in Study II were asynchronous and longer, but the behaviors were more simplistic and the leading attempts were fewer. In other words, **team interactions in Study II were milder**. The longer and asynchronous sessions dissipated the tension of creating something into sequential attempts. Participants had more time and more sessions to observe the growth of a drawing and engage in the activity. While shorter sessions with synchronized interactions would lead to intense interactions and greater focus on the outcome, sequential sessions would help focus on results to dilute and lead to greater engagement in the process. The slow, unexpected, yet surprising process was treasured more than the result the teams achieved.

Overall, **team coordination in Study II was more implicit**. As discussed, team interactions were milder, since there was less direct communication and intense focus in Study II, so participants were willing to take time and implicitly share thoughts through incremental drawing. Moreover, while chat was disabled in Study II, participants could still use text drawn on canvas to communicate explicitly, but it was seeing each other’s drawing that led to growth.

## 6.5 Discussions

The findings from this study support the proposed theoretical model in this work, providing empirical evidences around why this intervention would work and suggestions on how to make it more effective for existing distributed teams. Since this study was ultimately successful in terms of providing a playful experience over several days that helped teams build trust, cohesion, and temporary positive feelings, it demonstrated the rationality of the design guidelines discussed in Chapter 4. The design implications described below either expand a principle with more depth or replace a principle to reflect new findings that shed light on a broader scale of system/mechanism for online playful activities.

### 6.5.1 Design for an engaging online playful experience at work

Based on the findings, we reveal the relations between four key facets of experience afforded in an online playful activity: expressivity, reflection, interactivity, and playfulness. The complete, proposed theoretical model identified that expressions, reflections, and interactivity engender playfulness. This provides a new perspective on how to design for an engaging online playful experience at work for remote teams. The details complement G8 in Chapter 4 around pleasurable, fun experiences.

#### *Support mixing and matching expressions*

We suggest considering supporting freeform expressions, and anonymously mix and match expressions from individuals that ultimately help ground a playful experience. For example, for mechanisms other than drawing, effort should be made to encourage team members to freely express via different senses without the constraints or anxiety that can emerge from the working relationship.

### ***Support reflections via multiple senses***

We suggest considering supporting provocative reflections via different human senses that ultimately help ground a playful experience. For example, effort should be made to stimulate reflections via different senses, including sight, hearing, touch, etc., to help gather reflective information from the group activity. Specifically, this implication could replace G4 in Chapter 4, since it covers suggestions beyond the sense of sight and can apply to a broader scale of system design other than drawing.

### ***Support asynchronous interactions***

We suggest considering supporting asynchronous interactions that ultimately help ground a playful experience. For example, by mixing and matching the expressions and reflections in sequential sessions either via computing or asynchronous participations, we could expect increased interactivity to emerge from the activity. Specifically, since this implication touches on the aspect of offering flexible, asynchronous interactions, it could replace G3 in Chapter 4.

## **6.5.2 Design for continuous participation**

Previous work has proposed that play should be voluntary (Gillin 1951), and playfulness is mostly non-instrumental. For the context of distributed workplaces, the activity should greatly focus on creating intrinsic motivations for continuous participation to gain natural playfulness. Otherwise, it is fundamentally difficult to install any online instrument to distributed teams and “require” team members to participate in and enjoy it.

Asynchronous interactions in Study II showed their power to engage participants over time. The unknown part of the team member’s creativity and team energy happening when team members were offline enhanced the willingness for continuous participation.



Curiosity, and stickiness of the moment of surprise or excitement were the main drivers for team members to come back and check the canvas. Seeing updates from team members stimulated further complementarity and matching that grow the drawing. Compared to the intense single session in Study I, teams focused less on the result and more on the fun that was possible in an extended process. Team members tended to be less aggressive and the role distribution tended to be stable. The “unfinished” status of the teamwork motivated participants for repetitive visits rather than a quick blast of happiness in a one-time practice.

However, even in Study II, teams still showed interest in a longer length of time participating in a drawing. It is unknown how long it takes for teams to build a habit of natural participation and when conflicts would happen and diminish the positive effects of the activity. Therefore, the findings from this study could shed light on design implications around designing for an intrinsic motivation for continuous participation, but with limited understanding about the longitudinal effects.

### ***Encourage uncertainty***

We have discussed the benefits to teams that uncertainty brings in online playful activities. Based on findings from Study II, it is also vital to design for uncertainty in results to maintain team member curiosity and activity attractiveness. Transient outcomes from team activities should yield a more uncertain outcome in the longer term, rather than shut off possibilities for change. For example, for a drawing system, the canvas could: 1) be extendable to offer more space for more possibilities; and 2) present only a part of the accumulative drawing to stimulate imagination to continue the work.

### ***Stimulate intrinsic motivation***

We suggest considering properties of the activity that appeal to aspects beyond intrinsic motivations. The impulse for participating could be to get to know the secret fun side of a person one has been working with for one year, or some other natural desire to know more about the team. Raising people's awareness of the unknown parts of the team, as well as the ability of doing the collaborative activity together, could contribute to an increased intrinsic motivation. For example, the organization could first send out surveys to identify people who are curious and eager to know about their distributed colleagues, ask them to participate, and report positive results about the team effects. They could then use it as a good example for motivating more teams to participate.

### ***Support spontaneity***

We should design for spontaneity in online playful activities. Open-ended free-play could jumpstart creativity to bring more excitement and reveal more unknown parts of the team. Unplanned, non-scripted play should be supported so teams can engage more. A deeper engagement would lead to a stronger stickiness and contribute to a stable, continuous participation. For example, the online activity should support autonomy so team members can self-plan and organize the activity, like creating an interest-driven group in Slack or a parenting channel through email list, but also serve as a free-play experience that could ultimately contribute to building trust and cohesion.

The above three implications expand G5 in Chapter 4 around how to design for longitudinal playful sessions.

### **6.5.3 Design for transitioning effective virtual teams at play to work**

Previous work in the field of team building identified the influences of team building interventions in organizations, and found that process and affective outcomes were most improved (Klein et al. 2009). Findings from this study showed positive results of using an online playful activity to build team trust, cohesion, and positive emotions. This fills the gap of studying how online team building intervention might work in a distributed team. However, it is still vital to tackle the challenges around how to transition the positive effects from virtual teams at play to actual work for a longitudinal influence in actual organizations. Section 6.5.2 discussed how to design for longitudinal engagement, which closely relates to suggestions for the challenge, since with continuous participation we could anticipate the activity to become routine, with its effects transitioning into actual work. Implications below cover additional aspects.

#### ***Individual level: grow awareness from play to work***

We found that participants received knowledge about colleagues, their teams, and themselves from playing online. It is important to accumulate and share the subtle knowledge, not only through subjective reflections, but also through more official channels for recursive reflections and references. Since being distinct from work makes the overall experience playful and engaging, we should consider novel but effective ways of sharing the team knowledge gathered from play. For example, we found that team members would act out different roles than their actual roles in their organizations. It is possible to track the growth of the virtual role at play for the individuals, and provide suggestions around career growth, personalities, role matching, etc. in an informal, but insightful way.

#### ***Team level: turning conscious awareness into additional team knowledge***

Although the context of this work is for distributed teams, we also suggest combining offline events with experiences from online play to make the intervention more effective. While organizations could still organically hold team offsite events, they should rely on the insights from the online playful activities and perhaps design team building events for in-person interactions. This does not need to change the intervention's characteristic of anonymity for online playful activities, but the information and insights can be used by managers to design events or even strategies to grow the team. We should consider designing mechanisms to translate the team information, such as how it proceeded, the roles, the effectiveness, the levels of trust and cohesion, the moments of happiness, the conflicts, and the resolution of conflicts, into useful suggestions for the development or maintenance of existing teams.

## **6.6 Summary**

In this study, we holistically investigated two aspects of an online application, DARTS, which supports playful drawing activities for distributed teams: 1) participants' perceived positive experiences with the system; and 2) team effects of trust, cohesion, and positive emotions. We conducted an in-situ, observational study with five teams from industry. Each team had three team members who had already built a relationship with each other in their organizations. In this study, we distributed DARTS to the teams and observed them for five days of usage. We asked participants to fill out experience sampling surveys whenever they used DARTS. We measured trust, cohesion, and emotions, as well as four facets of online playful experience: expressivity, reflection, interactivity, and playfulness. Drawings and

active drawing sessions were captured by self-reported screenshots and usage time. We also conducted interviews to collect qualitative data and help understand the overall experience.

Based on both quantitative and qualitative analysis of collected data, we identified a complete net of relations between the four facets of experience. We found that expressivity, reflections, interactivity, and playfulness influenced each other and cannot be separated; they constitute a holistic playful experience afforded by the system. As time passed, participants were more engaged in the online playful drawing activity, with increases in expressivity, reflection, interactivity, and playfulness. We also found that team trust, cohesion, and positive emotions increased after five days of using DARTS as a team building intervention for all distributed teams. Team members built new knowledge about each other, the team as a whole, and themselves, which helped build trust. Teams successfully accomplished something fun outside of work, which helped build cohesion. Furthermore, the asynchronous interactions brought unexpected surprise and excitement, which promoted transient positive emotions at work and an in-situ engaging experience with the drawing activity. Moreover, we found that the team behaviors and roles tended to be simpler and interactions tended to be milder and less aggressive than teams in Study I, in which teams were asked to conduct short-term, single-session drawing activities online with an enabled chat function. Teams in this study accomplished the drawing via more implicit communication and coordination mechanisms, but it extended the tension to accomplish a goal. Multiple sessions in this study ultimately did not diminish engagement as time went by, but rather they brought intrinsic interests and motivations.

The complete relations between the four facets of the experience complement the proposed theoretical model around designing online playful activities for distributed teams.

The findings around how trust, cohesion, and positive emotions were influenced provided empirical evidence to prove the rationality of the proposed concept. Moreover, the design implications provide complementary details to complete the design guidelines we developed earlier, which shed light on a future, broader scale of mechanism/system design for distributed teams to play online at work. Figure 6.30 presents the final theoretical model proposed in this work.

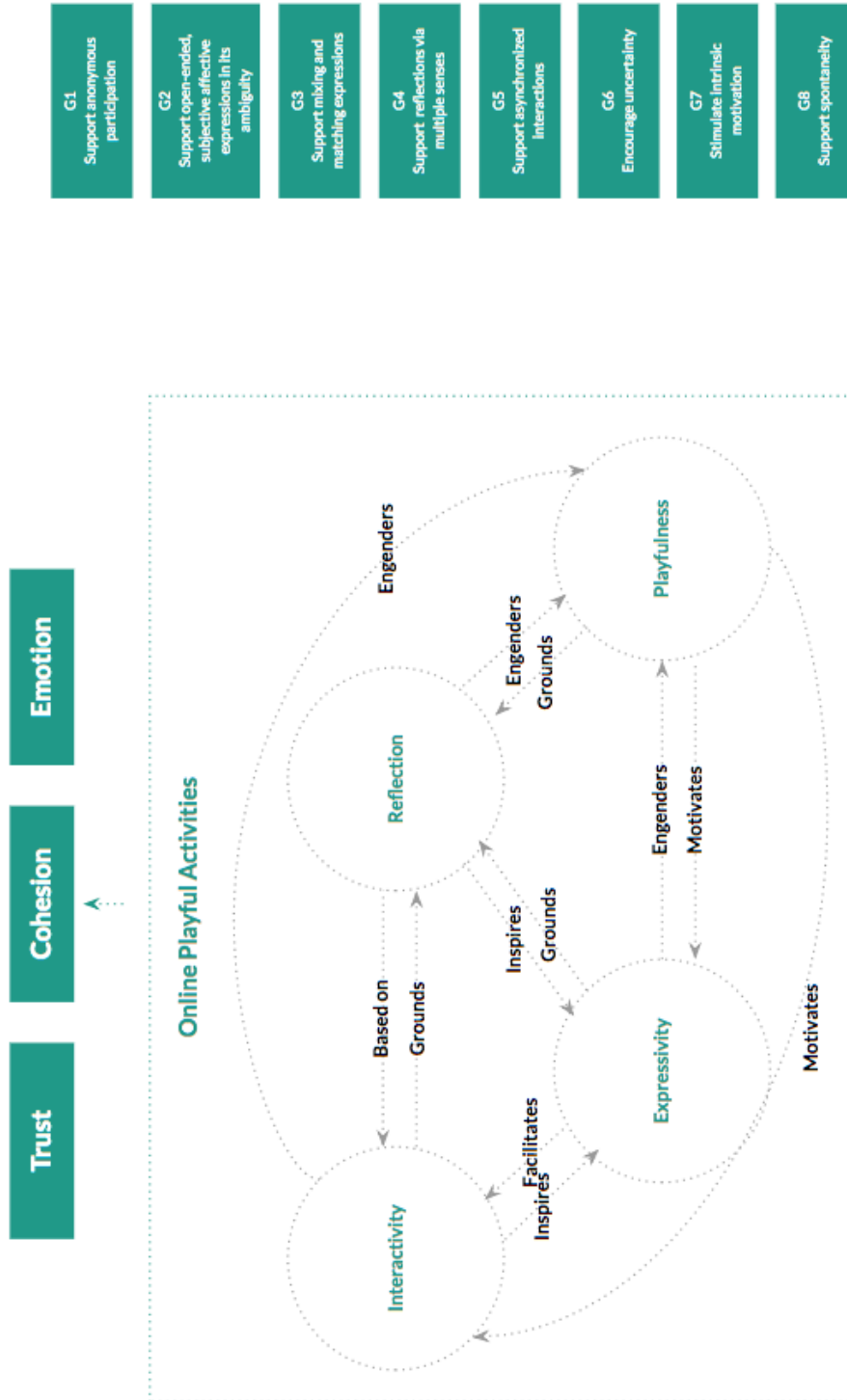


Figure 6.30 Final model for designing online playful activities for distributed teams.

## Chapter VII.

# Summary and Conclusion

## 7.1 Summary

In this dissertation, we explored how to build up teams at a distance to increase trust, team cohesion, and individual worker's positive emotions. We propose leveraging online playful activities through ICTs to support, encourage, and facilitate socio-emotional communication through informal social interactions among distributed team members.

By summarizing previous literature in the fields of CSCW, play at work, and human emotions at work, we found eight related insights that grounded the initial "intuitions" toward developing a concrete solution: 1) lack of common ground is a huge barrier to building a trusting and cohesive team at a distance; 2) trust depends on knowledge about the individual team member, as well as the experience of working together; 3) informal social interactions can successfully help teams build trust; 4) team cohesion is associated with deep-level diversities such as attitudes, beliefs, and values; 5) it is promising to use team-building interventions from offline context in online contexts so distributed teams can improve team cohesion; 6) supporting distributed teams to have playful experiences benefits teams, but requires more explorations; 7) it is beneficial for distributed teams to support socio-emotional communication via subjective experiences of affect; and 8) encouraging self-expression helps build positive emotional contagions in the workplace.



From those insights, we were initially interested in understanding what potentials online playful activities could bring to teams. An online playful activity is ludic, can take the form of a team building intervention, and should be able to: create a common ground; build knowledge through a new experience; jumpstart trust through informal interactions; build cohesion with revealed deep-level understandings about team members; and support subjective affective expressions and experience. We chose online drawing activities as a specific case study with 36 student teams in Study I, investigating the effects on teams of two drawing modes: open-ended, freeform drawing; and directed drawing. We compared the effects drawing had on two types of teams: distributed and co-located. We collected both quantitative and qualitative data and performed a mixed method of data analysis. The results revealed that open-ended, freeform drawing was more effective in increasing team cohesion and positive emotions, and it was more effective in distributed teams. The findings identified the potentials of using open-ended online playful activities to effectively build up distributed teams. Specifically, it provided six findings to complement the insights from the literature: 1) anonymous interactions boost positive emotions; 2) open-ended interventions encourage self-expressions; 3) subjective experiences of affective expression are supported in ambiguity; 4) multiple sessions for enduring interactions are required for deep engagement; 5) valuable experience and knowledge build up through non-work-related tasks; and 6) the holistic positive experience consists of four facets: expressivity, reflection, interactivity and playfulness.

The 14 insights in further guided the proposal of a theoretical model around how to design for online playful activities and why the intervention might work to strengthen distributed teams. The core concept is to design around four facets of experience in online

playful activities: expressivity, reflection, interactivity, and playfulness. “Expressivity” is defined as the experience of communicating through verbal and non-verbal self-expressions of thoughts, emotions, ideas, and preferences in an online playful activity. Designing for expressivity desires supports verbal and non-verbal expressions in a playful, informal social context. “Reflection” is defined as the experience of turning unconscious knowledge received from online playful activities into conscious awareness of the self and others. Designing for reflection desires supports critical reflections on the self, others, and the relationship folded into the online playful activities. “Interactivity” is defined as the experience of engaging with others through an online playful activity. Designing for interactivity desires supports a cyclic process in which participants interact with each other through online playful activities. “Playfulness” is defined as experiencing a playful mental state during an online playful activity. Designing for playfulness desires supporting an intrinsically relaxing, engaging, and fun experience that can lift up a playful spirit during online playful activities. We argued why designing for those core experiences would bring positive effects to team trust, cohesion, and positive emotions based on findings from previous literature. To guide specific system/mechanism design for online playful activities, we developed eight design guidelines, arguing that design should: 1) support anonymous participation; 2) support open-ended, subjective affective expressions in its ambiguity; 3) easy access for distributed users; 4) be highly visible to distributed users; 5) have longitudinal playful sessions; 6) be non-work-related; 7) be non-competitive; and 8) be pleasurable/fun.

To realize the research proposal, and to further verify the proposed solution, we designed an application—DARTS. DARTS support asynchronous, freeform drawing for distributed users. We applied an iterative design process to realize the design of the

application, including prototyping and a usability test. DARTS is a concrete example of what an online playful activity could look like and how it might work. It also provided the ideal platform to conduct an in-situ, observational study, since it merely afforded the design guidelines offered by this work.

Finally, we conducted a short-term, in-situ study in which five teams from industry used DARTS for five days and measured their experience with the system, as well as the change in trust, cohesion, and emotions. Interviews and artifacts collected also offered opportunities to qualitatively investigate the experience and the reasons behind the effects on teams. We found that participants successfully experienced increased trust, cohesion, and positive emotions from using DARTS for a few days. The engagement increased as time went by, with an overall higher level of expressive, reflective, interactive, and playful experiences. Findings provided complementary details to complete the proposed theoretical model of the four core facets of online playful experience. The final model contains a complete net of relations among the four facets, which provided insights about how one facet could influence the others. The findings also provide insights about why trust, cohesion, and positive emotions increased, which helps us better understand the positive effects of the intervention. A revised set of design guidelines were developed from the findings to inspire a future, broader scale of mechanism/system design for online playful activities for distributed teams, which should: 1) support anonymous participation; 2) support open-ended, subjective affective expressions in its ambiguity; 3) support mixing and matching expressions; 4) support reflections via multiple senses; 5) support asynchronous interactions; 6) encourage uncertainty; 7) stimulate intrinsic motivation; and 8) support spontaneity. Moreover, two additional implications were offered to ensure the effective relationship extends beyond the

virtual teams at play: 1) grow awareness from play to work at the individual level, and 2) turn conscious awareness into knowledge at the team level.

The three contributions of this work are discussed below.

### **7.1.1 Implications to research**

This dissertation work contributes new knowledge about distributed teams to several research agendas:

**Computer-supported cooperative work (CSCW):** this work provides new knowledge about how to support team building activities via information technology at a distance for distributed teams. Individuals were found to behave consistently with their real-life personalities and ways of doing things. But the virtual team behaviors at play reflect a simple, yet effective approach to accomplishing a low-stressful, low-risky, non-work-related and non-competitive task. The casual, informal social interactions jumpstarted through the online playful activities could successfully help teams build a higher level of trust, cohesion, and transient positive emotions. The findings echo results from previous research around the effectiveness of informal social interactions in building trust and cohesion in teams (Wood and Robinson 2014; Kleinman, Carney, and Ma 2014; Bradner, Kellogg, and Erickson 1998; Zheng et al. 2002; Wang and Redmiles 2015) with complementary knowledge from a specific approach of playing at work. The two studies provide a rich set of data that can be explored to understand socio-emotional communication in informal social interactions in teams in an online playful practice. This work demonstrates how teams interact and proceed outside work in an online playful setting at a distance, and how the expressivity, reflection, interactivity, and playfulness supported in the virtual team at play influence their existing relationship. By contributing to the research around supporting informal social interactions

in teams to produce positive team effects, this work is expected to further inspire more research inquiries and studies in this direction.

**Play at work:** previous literature (Gillin 1951; Caillois 1961) defined the three categories of play as game play, ludic activities, and playfulness. A great number of works have focused on designing features for game play, such as rules, variable, valorization of outcome, player effort, player attached to the outcome, negotiable consequences, among other parameters (Juul 2011). A gap remains around “open-ended adult interaction in non-narrative based interactive installation,” and there is also “a lack of an overarching framework or language for free-play” (Morrison, Viller, and Mitchell 2011). Specifically, much more exploration is needed to identify how to design for open-ended free-play for adults at work, as well as how to design for distributed teams and support open-ended ludic, playful, free-play via online systems. Findings from this study could provide rich insights as design implications to fill these knowledge gaps. The theoretical model and the design guidelines provide a framework to suggest mechanism/system design in this direction, and thus contribute to the research by design implications based on empirical observations.

**Emotional well-being at work:** previous literature has discussed the benefits of positive affects in the workplace (George 1991; Bono and Ilies 2006; Seligman, Martin E P et al. 2005), and an emerging research agenda focuses on positive computing (Calvo and Peters 2014). Information technologies have been applied to promote positive emotions and therefore to improve emotional well-being (Chen, Mark, and Ali 2016). This work demonstrates one concrete approach with a design idea to promote positive emotions in the workplace. The success of the proposed concept has been proven by empirical studies and contributes insights around a valid approach. It is proven that playful activities such as open-

ended, freeform drawing can promote positive emotions in the workplace and make team members generally feel good about the team and each other. This work contributes new knowledge to the research question around how to promote emotional well-being at work.

**Affective computing at work:** Sengers's work inspired a research agenda in this direction to support subjective experience of emotions through affective computing (Boehner et al. 2005; Leahu, Schwenk, and Sengers 2008). This approach sees emotions as “culturally grounded, dynamically experienced, and to some degree constructed in action and interaction” (Boehner et al. 2005). The focus shifted from making computers smart enough to capture the “right” human emotions to helping humans experience subjective affect. Previous research suggested to use user-selected parameters in an affective computing system to support subjective experiences of affect. This work follows these directions by proposing an open-ended playful space among team members and supporting the expressions and reflections of affective information in ambiguity and uncertainty. Through play, teams communicate socio-emotional information, but not in an explicit way that accurately exchanges information about a specific feeling; rather, team members are encouraged to express and process each other's expressions of personal affect in a highly interactive approach. Through the interactions, people get to know each other's personal, casual, and emotional side. This work fills the gap by providing knowledge around a valid approach in the workplace that successfully supports ambiguous, implicit, and subjective experiences of sharing affective information.

### **7.1.2 Implications to design**

The proposed theoretical model in this work provides a good framework for designing online playful activities for distributed teams. It is proven that expressivity,

reflection, and interactivity can engender a great degree of playfulness. The four facets of the holistic experience influence each other and positively contribute to a higher degree of engaging experience with the activity. Therefore, this framework could guide mechanism/system design that intends to provide an engaging, playful experience. For example, the four principles around the four facets and the final eight design guidelines can be directly applied to a concrete design, or as a heuristic to evaluate a system aiming to provide a playful experience for distributed participants.

Moreover, DARTS, as a concrete example, demonstrated its ability to facilitate building trust, cohesion, and positive emotions at a distance for distributed collaborators. The design process and the details reflected in DARTS present one case to apply the model toward a mechanism/system design.

### **7.1.3 Implications to practice**

At the end of Chapter 6, we developed two implications for transitioning the team knowledge gathered from play to actual teams at work, aiming to ensure the positive effect that teams receive from the playful activities can be influential and longitudinal at work. Those two implications offer a direction for when, where, and how to apply this work.

## **7.2 Limitations and Future Work**

In this dissertation work, in both of the reported studies, teams were investigated for only a short term. For future work, we would deploy the intervention to teams and observe long-term impact.

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## APPENDIX A: Measurement in Study I

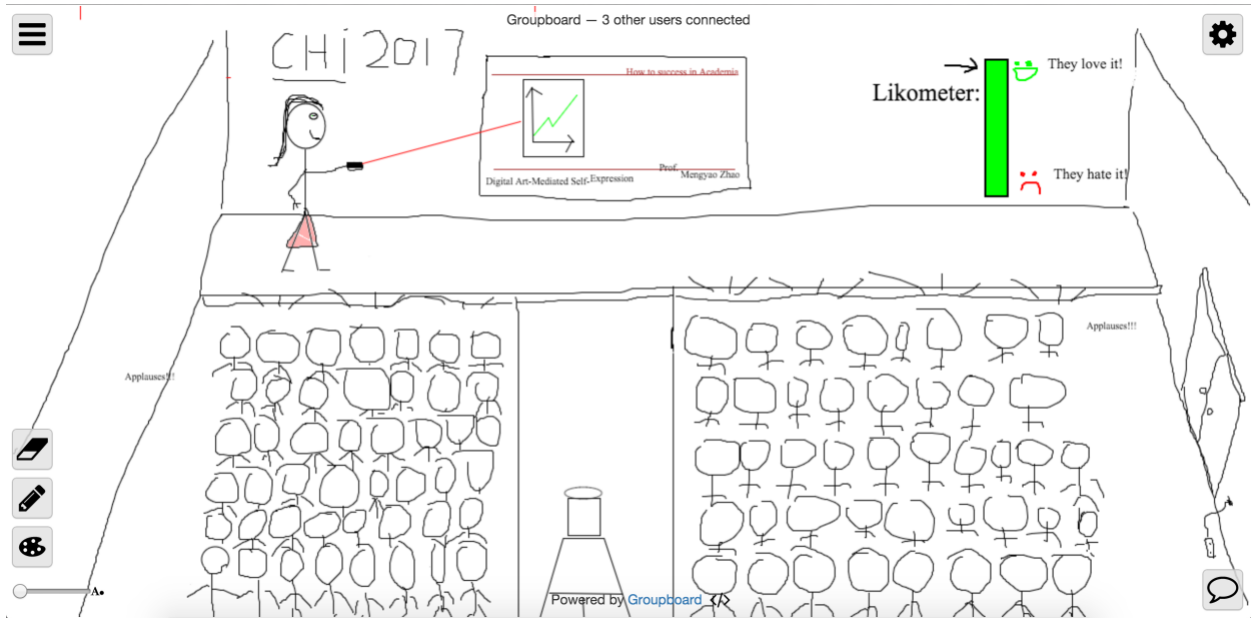
Effect	Questionnaire Items
<p>Initial Trustworthiness (All of the items were measured on five-point Likert scales)</p>	<ul style="list-style-type: none"> <li>• We will have confidence in one another on this team.</li> <li>• I will be able to rely on those I work with in this team.</li> <li>• * There will be a noticeable lack of confidence among those I will work with.</li> <li>• Overall, the people will be very trustworthy.</li> <li>• We will usually be considerate of one another's feelings in this team.</li> <li>• The people in my team will be friendly.</li> </ul>
<p>Early Trust (All of the items were measured on five-point Likert scales)</p>	<ul style="list-style-type: none"> <li>• I feel comfortable depending on my team members for the completion of the project.</li> <li>• * I feel that I will not be able to count on my team members to help me.</li> <li>• I am comfortable letting other team members take responsibility for tasks, which are critical to the project, even when I cannot monitor them.</li> <li>• I feel that I can trust my team members completely</li> </ul>
<p>Team Cohesion (All of the items were measured on five-point Likert scales)</p>	<ul style="list-style-type: none"> <li>• It was important to the members of our team to be part of this project.</li> <li>• * The team did not see anything special in this project.</li> <li>• The team members were strongly attached to this project.</li> <li>• The project was important to our team.</li> <li>• All members were fully integrated in our team.</li> <li>• * There were many personal conflicts in our team.</li> <li>• There was personal attraction between the members of our team.</li> <li>• Our team was sticking together.</li> <li>• The members of our team felt proud to be part of the team. • Every team member felt responsible for maintaining and protecting the team.</li> </ul>
<p>Positive Emotions</p>	<p>Interest, Amusement, Pride, Joy, Pleasure, Contentment, Love, Admiration, Relief, Compassion.</p>

(All of the items were measured on six-point scale for intensity from 0=not at all to 5=extremely strong)	
Negative Emotions (All of the items were measured on six-point scale for intensity from 0=not at all to 5=extremely strong)	Anger, Hate, Contempt, Disgust, Fear, Disappointment, Shame, Regret, Guilt, Sadness.

\* = reverse coded item



## APPENDIX B: Final Drawings in Study I



C1T1



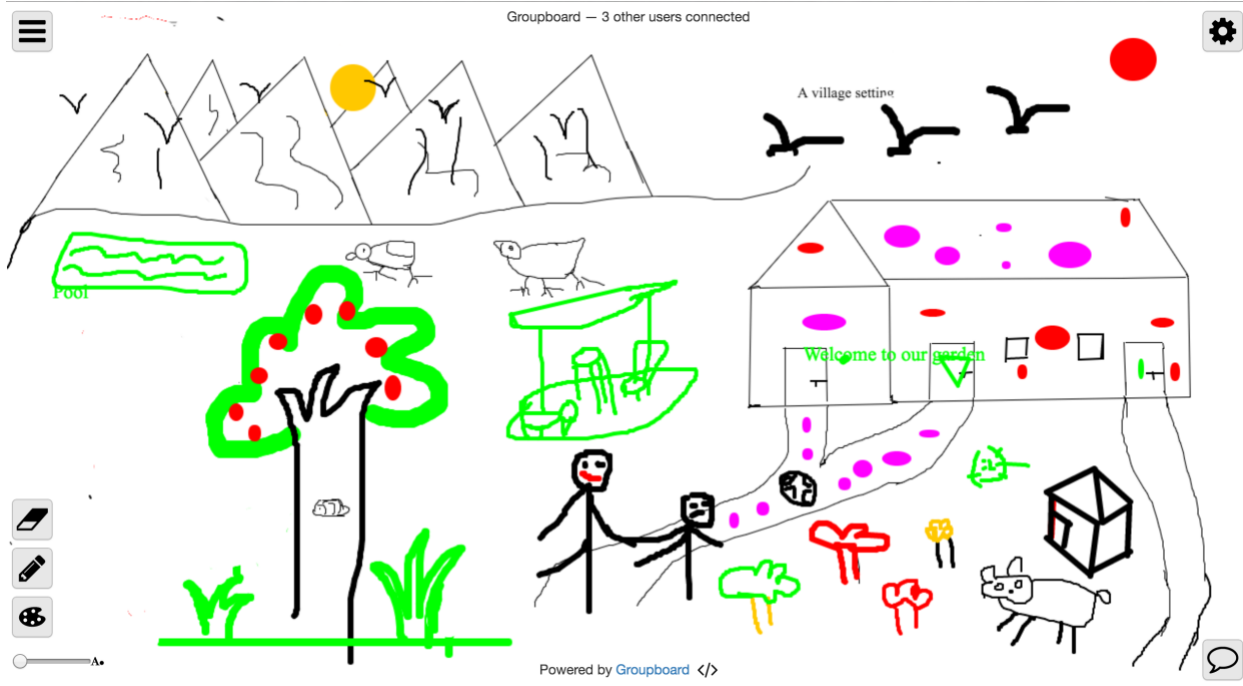
C1T2



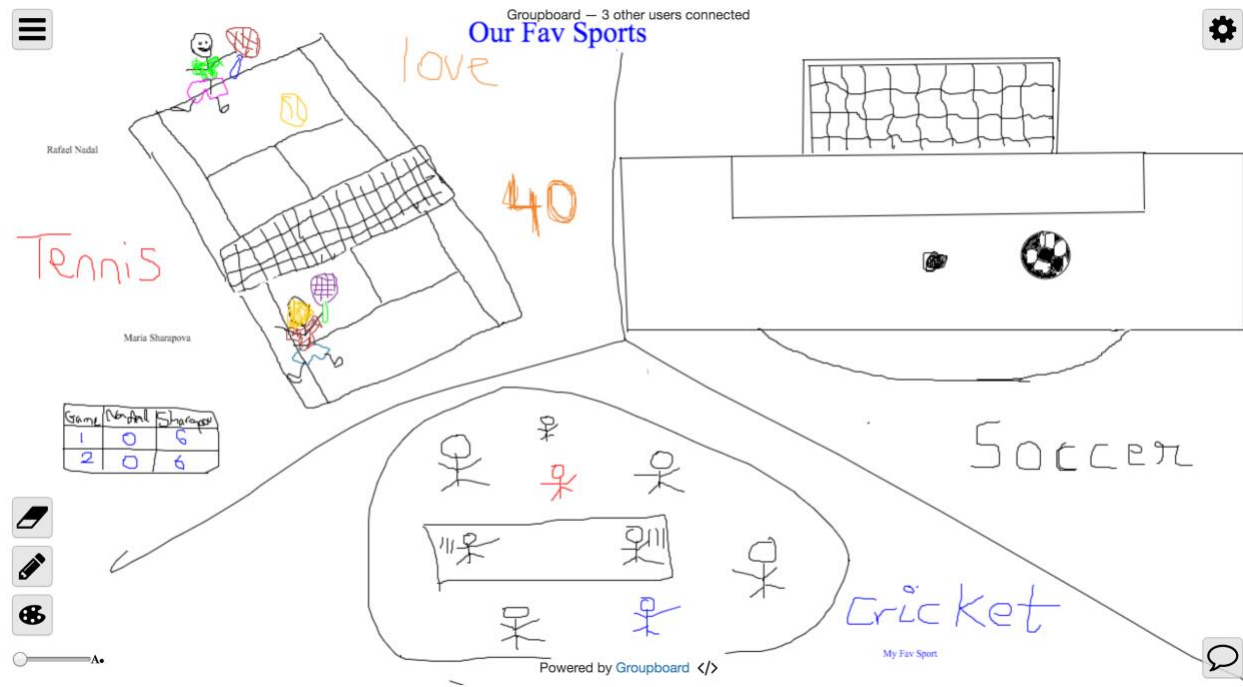
C1T3



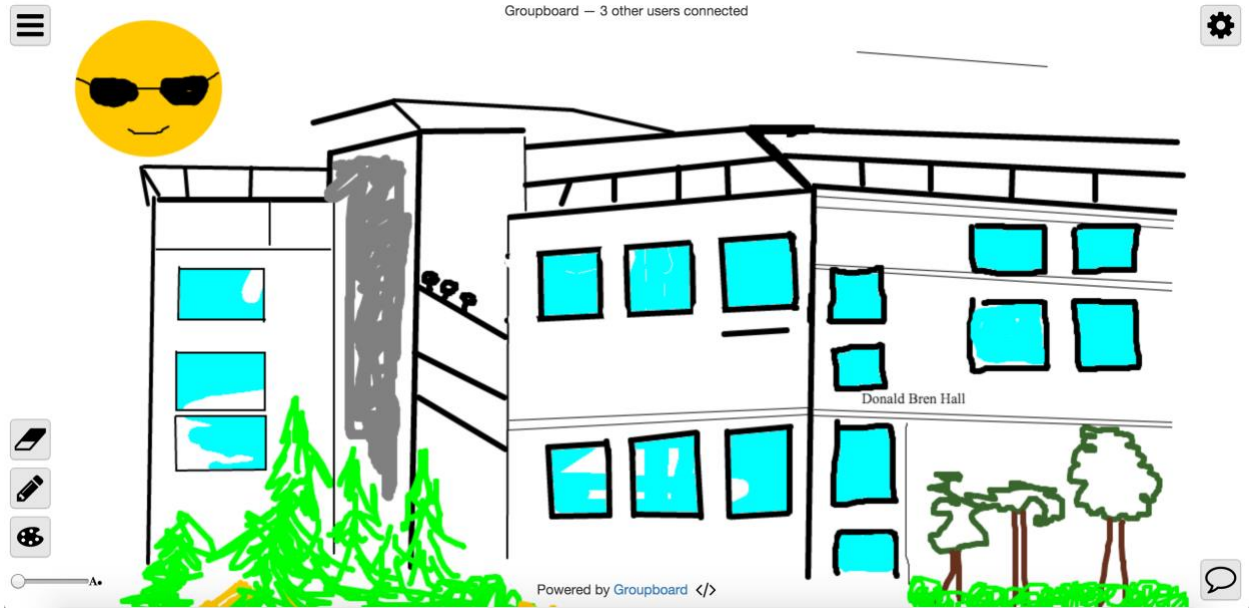
C1T4



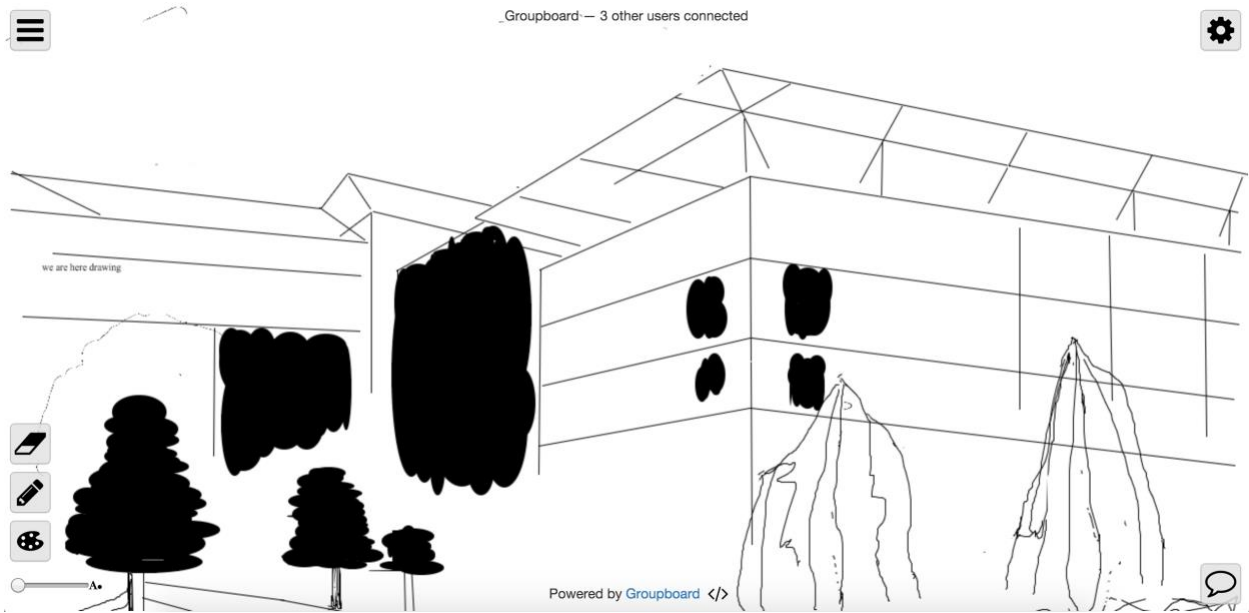
C1T5



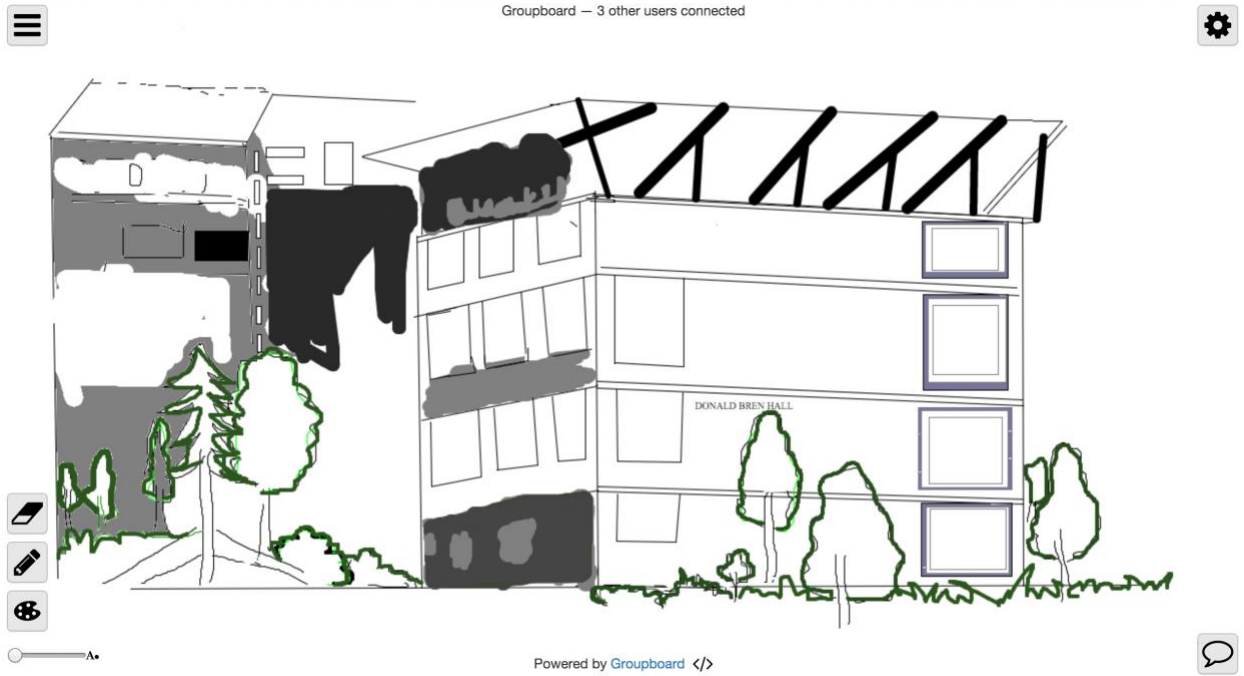
C1T6



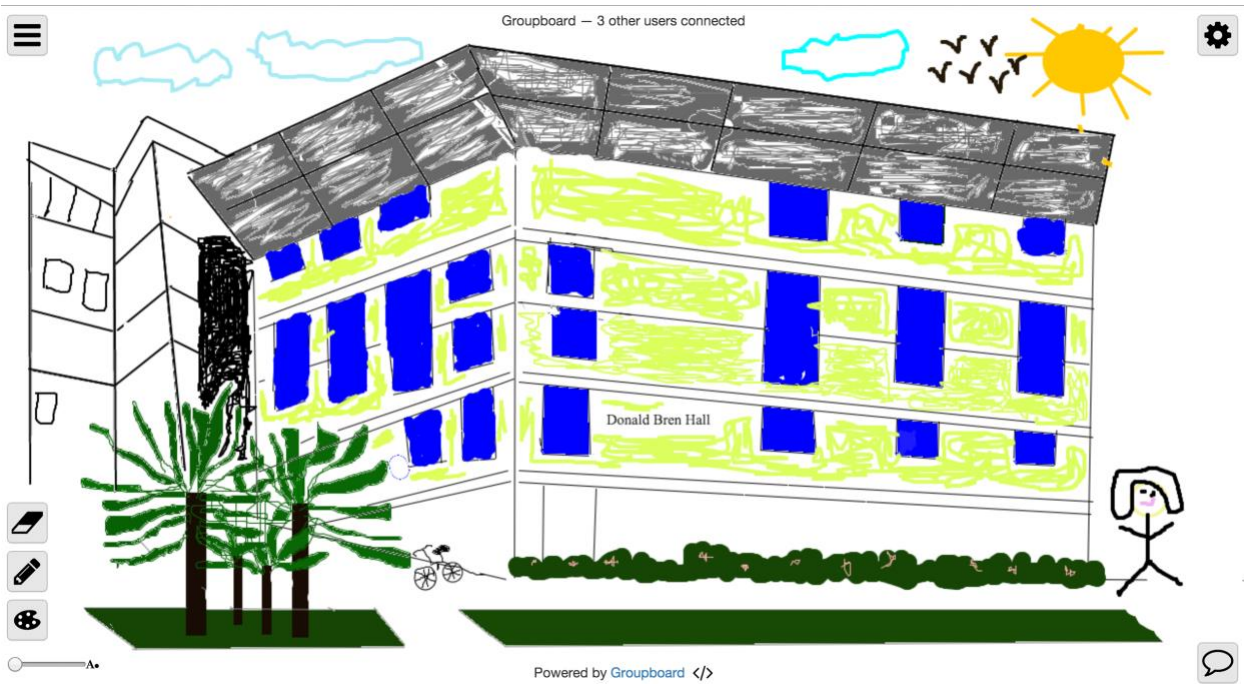
C2T1



C2T2



C2T3



C2T4



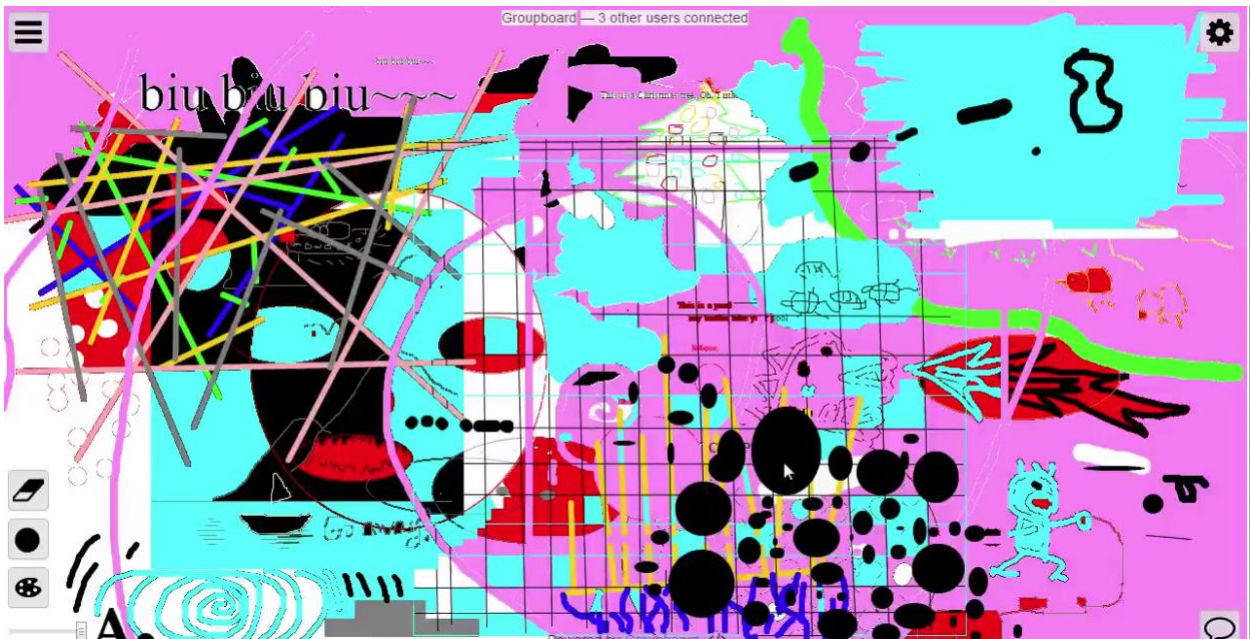
C2T5



C2T6



C3T1



C3T2



C3T3

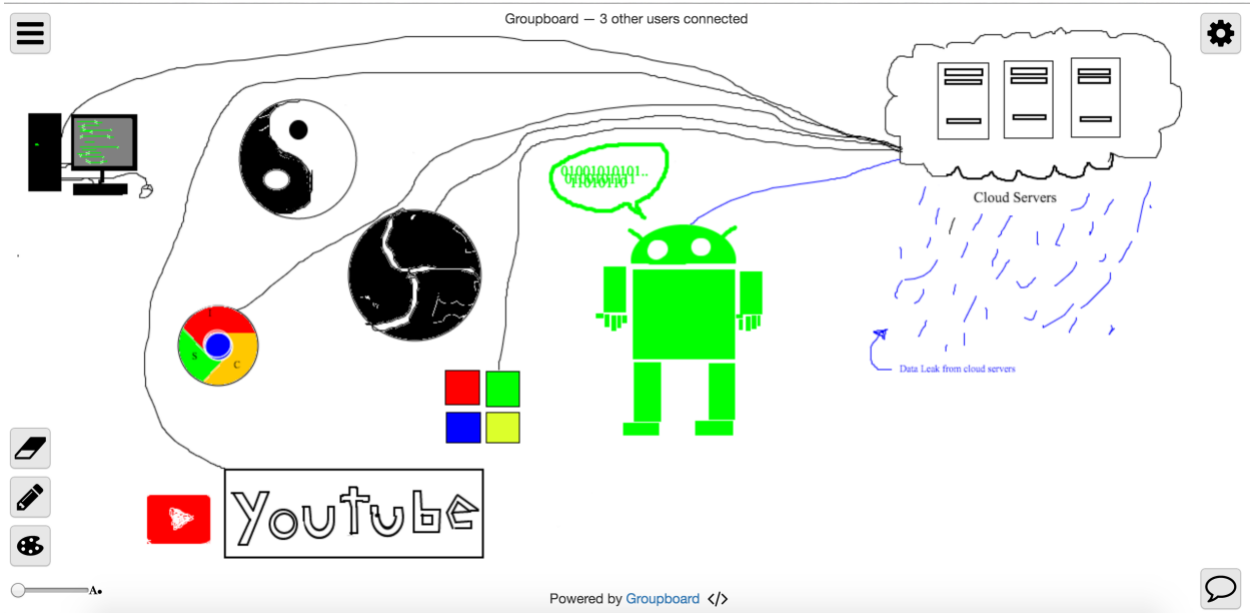


C3T4

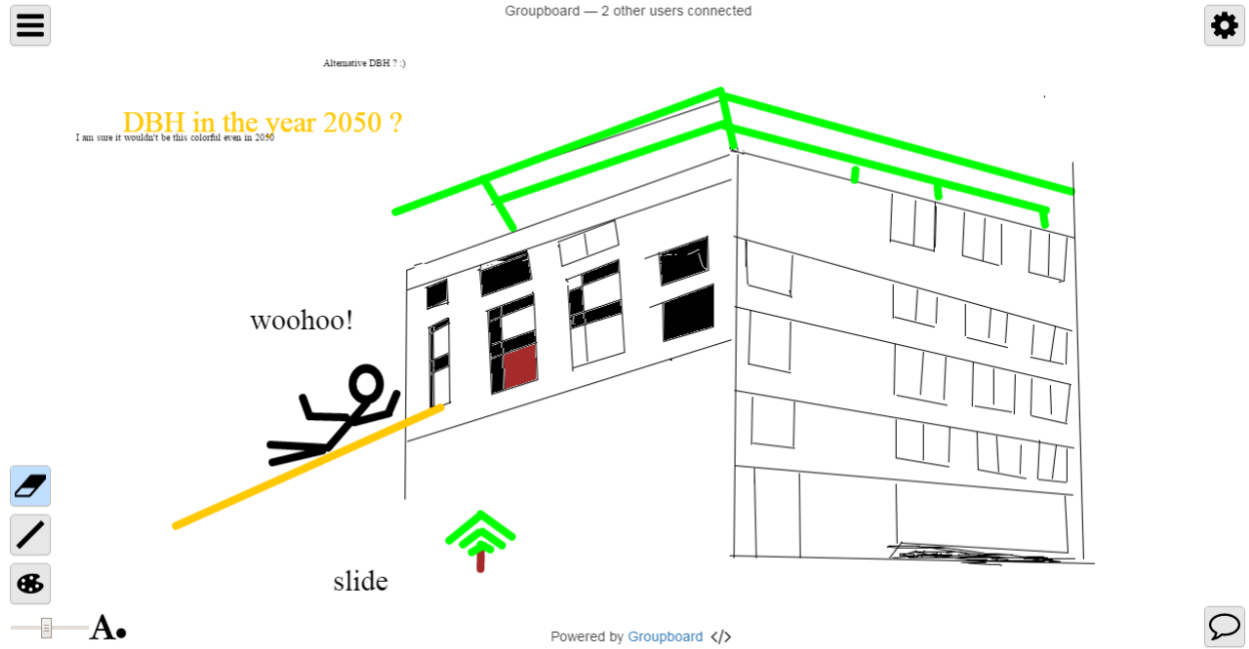




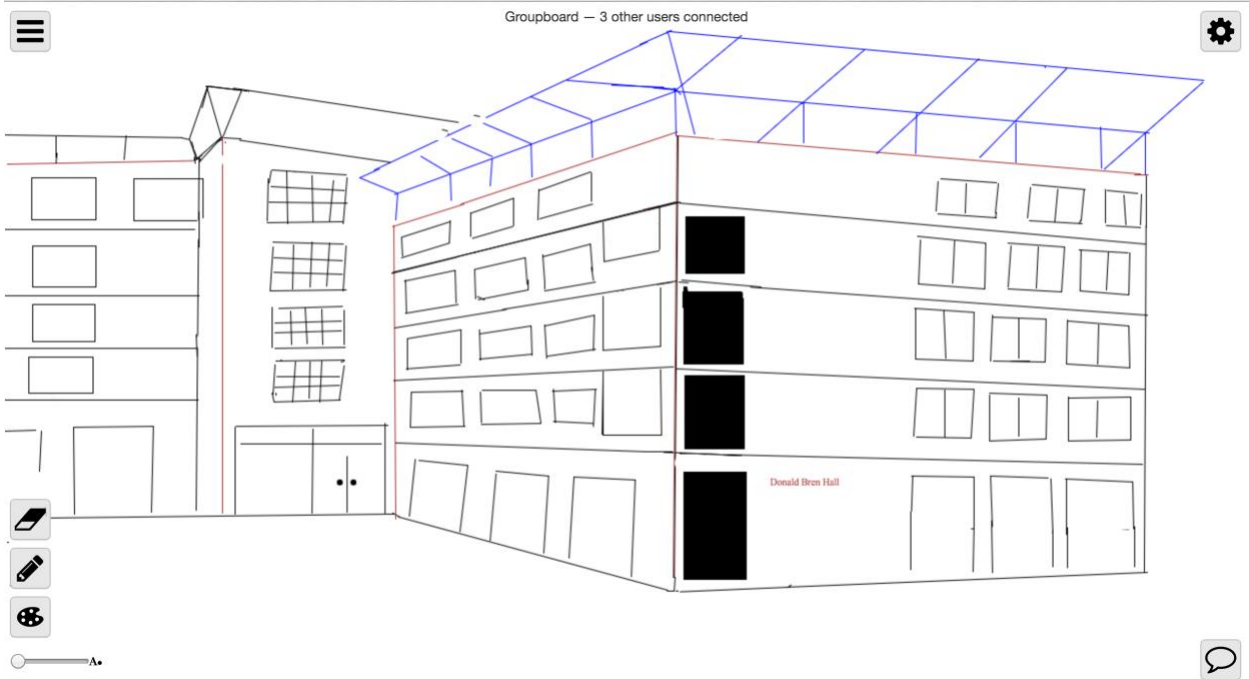
C3T5



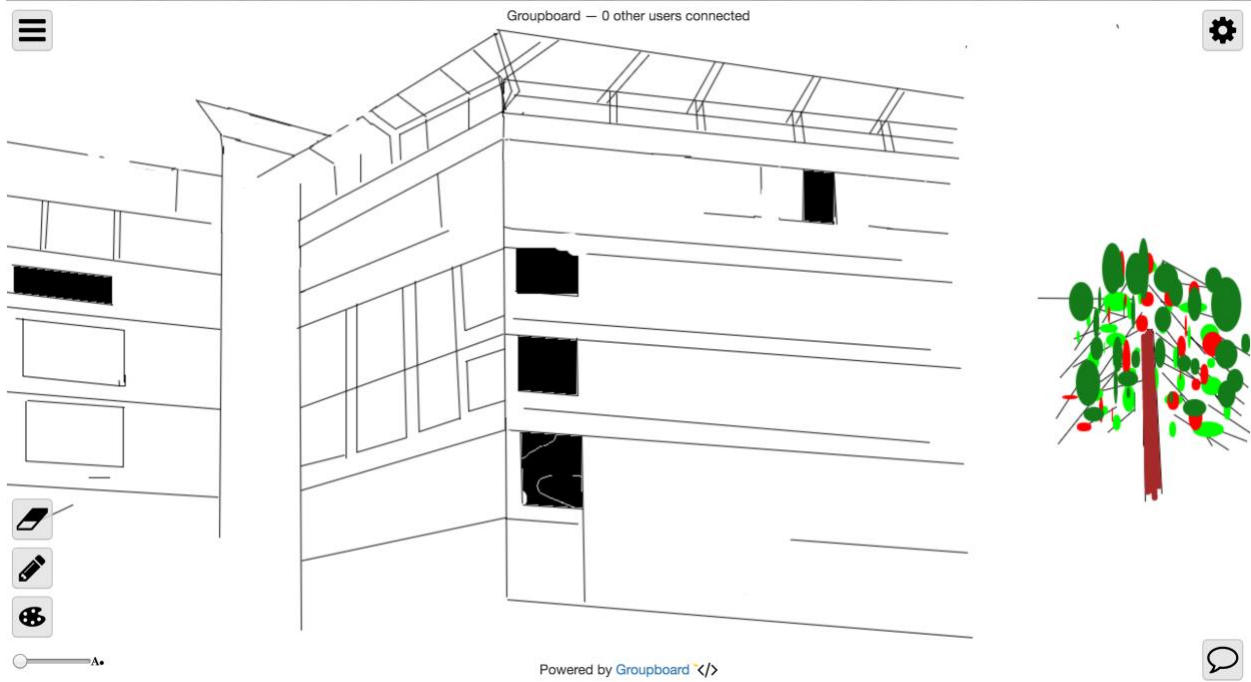
C3T6



C4T1



C4T2



C4T3



C4T4



C4T5



C4T6