Crafting Closeness: Building Connection through Collaborative Creativity in Minecraft

by

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We acknowledge and respect the Lək^{w}əŋən (Songhees and X^{w}sepsəm/Esquimalt) Peoples on whose territory the university stands, and the Lək^{w}əŋən and W̱SÁNEĆ Peoples whose historical relationships with the land continue to this day.

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ABSTRACT

We investigate how designing to support collaborative creativity can foster social connection in interactive systems. Although creativity and social connection are conceptually linked, engaging in digital creative activity has not been examined as a mechanism for explicitly fostering social connection. We conducted a mixed-methods survey study of people who play Minecraft with others, combining measures of creativity, social connection, and features of digital collaboration with open-ended responses. Quantitative analysis revealed that both creative self-perception and the creativity support of the tool influenced the building of social capital through creative collaboration. Furthermore, creativity support was more influential in informing bonding ties than bridging ties. Qualitative thematic analysis identified three phases of the creative process (problem-finding, brainstorming, and implementation) and four experiential factors (unity, agency, playfulness, and achievement) that shaped experiences of social connection and disconnection. We contribute a set of general design implications for leveraging collaborative creativity to support social connection in digital systems.

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Chapter 1

Introduction

This chapter introduces the research presented in this thesis, first outlining the context and motivation, methodology and research questions, and then describing the contributions and overall structure of the document.

1.1 Introduction

Designing digital tools to support social connection remains a central challenge in human-computer interaction (HCI). Social connection—a sense of belonging and emotional closeness between two or more people—is a fundamental human need [6, 75] and its absence is associated with negative health outcomes [39, 40, 37, 38]. Accordingly, research into social technologies seeks to develop novel systems that harness the advantages of networked digital technology (e.g., ubiquity, the ability to bridge geographic distance, and flexibility for designing custom interactions). Many design strategies are used in this pursuit (e.g., simulating touch [85, 80, 89]; synchronizing physical experience [73, 80]; supporting ritual formation [9, 89]); however, we propose that one very promising and intuitively appealing strategy—*collaborative creativity*—is underexplored and worth investigating further. Creativity has many definitions [76], and in this paper we refer to creativity as a process by which an individual or group produces a perceptible artifact that is novel and useful within a social context [62]. Such social forms of collaboration provide individuals with a shared goal and a context for joint attention [55], and creative ideation is associated with play and exploration, which are linked with human bonding [10, 22]. Previous work in fields such as organizational psychology, art therapy, and education empirically sup-

ports the idea that creativity facilitates social connection through mechanisms such as self-disclosure and reduction of negative social behaviour [90, 5, 49]. This previous research provides evidence for the relationship between creativity and social connection in general, but the question remains whether it extends to digital spaces for use in relatedness technologies.

Two review papers that describe design strategies for developing social connectedness technologies suggest that creativity might be useful to pursue in this context, but neither highlights collaborative creativity specifically as a primary strategy [80, 89]. Individual studies in HCI that combine creativity, social connection, and digital technology tend to either involve custom lab-designed tools and show a link between engaging in digital creative activities and social connection but have limited ecological validity [47, 52, 88], or use existing real-world platforms/systems that involve creative activities in a social context but do not specifically investigate the efficacy of creativity as a medium for relationship building [24, 3, 56, 60]. Additionally, both of these categories of research are missing an explicit focus on creativity as a theoretical concept (i.e., using specific definitions, measures or types of creativity as opposed to particular creative activities), which is what designers would need in order to implement creativity as a general mechanism for fostering social connection within a variety of technology types (e.g., games, social media, VR, mobile apps). This need for theoretical clarity is in line with a similar gap in the general creativity support tool (CST) literature [27].

In this thesis, we propose that mutual engagement in the creative process can facilitate social connection between individuals, and therefore designing for collaborative creativity could be a useful strategy for designers of social connectedness technologies. However, guidance for *how* designers can support social connection through creativity in digital environments is limited by an existing gap in our understanding of how creativity (defined using theoretically-grounded measures) is related to social connection in ecologically valid digital contexts. To both justify and implement collaborative creativity as a strategy to facilitate connectedness through social technologies, designers first need empirical evidence that the relationship between creativity and social connection exists in a digital context, followed by specific guidance on how collaborative creativity could be used explicitly as a design strategy. To address these gaps, we take three specific approaches in our work.

First, for ecological validity, we chose to study an existing digital context that is both social and creative. Our study uses the context of the popular sandbox video

game Minecraft, whose game mechanics explicitly support emergent creativity [72, 1]. An extensive ethnographic study on Autcraft (a Minecraft server for children with autism and their allies) describes how the game and its surrounding communication ecology help support a thriving community through its variety of communication channels [69], an opportunity-rich environment allowing for a range of self-expression [70], and the DIY culture that emerges from its focus on enabling customization [68], making it an ideal platform to study the intersection of creativity and social connection.

Second, to empirically study the relationship between creativity and social connection, we chose three specific measures for each. We contextualize our work in the creativity research space by focusing on everyday creativity (i.e., "the originality of everyday life") [67], specifically mini-c creativity (i.e.,"novel and personally meaningful interpretations of experiences, actions and events") and little-c creativity (i.e., "creativity expressed through perceptible products or actions that are rated as novel and useful in a non-expert context") from the Four C Model of Creativity [44]. We are also interested in "process" as opposed to "product" from the 4Ps model (person, process, product, press) [66]. The 5 A's framework (Actor, Action, Artifact, Audience, Affordances) expands this model by applying a sociocultural lens and emphasizes the idea of creativity occurring through actions enabled by environmental affordances (whether social or material) [32]. Overall, we define creativity as "*engaging in the process of creating something (an idea or product) that is novel to the participant themselves and useful/appropriate within the context of Minecraft.*" In our study, creativity is operationalized by mapping Actor to a measure of creative self-perception, Action to a rating of personal creative activity, and Affordances to the creativity support of the tool (Artifact and Audience are less relevant to our specific framing). This idea that affordances (i.e., perceived uses of objects or potential actions that occur to an individual within a specific environment) influence creativity [31] is particularly interesting from a system design perspective, as designers of digital systems are responsible for choosing which interactions are possible, which features are included, and how available actions are made visible to users. Finally, social connection is operationalized using the concept of social capital [17, 91] and inclusion of other in the self [4].

And third, we employed a mixed-methods design, combining quantitative measures with qualitative data collection, to give us insights into both *how* and *why* collaborative creativity might lead to social connection through the lens of partici-

pants' experiences.

Through this research approach, we ask two main research questions:

1. What is the relationship between creativity and social connection in Minecraft (i.e., an existing digital system designed to support creativity)?

2. What are people who collaborate in Minecraft's perceptions of how collaborative creativity contributes to their experiences of social connection/disconnection?

Our findings show that there is a significant relationship between creativity and social connection in the digital context of Minecraft, revealing that both creative self-perception and the perceived support for creativity within Minecraft influenced the building of social capital through creative collaboration. Further, according to participants' experiences, engaging in the creative phases of problem-finding, brainstorming, and implementation leads to the potential for increased social connection. We found that this relationship is shaped through four experiential factors (*Unity*, *Agency*, *Playfulness*, and *Achievement*), whose presence or absence influences how the creative process affects participants' relationships. We use these insights to suggest general design implications that can be applied to many different types of digital systems that seek to facilitate social connection through collaborative creative activity. Overall, these results justify approaching the design of social connectedness technologies through a creativity-focused lens and provide inspiration for designers who aim to create better digital systems to support social connection by adding affordances to support emergent collaborative creativity to their design toolboxes.

1.2 Contribution

The contributions of this thesis project are multifold:

1. A *theoretical contribution* is made through synthesizing related literature to provide an argument for why designing to support collaborative creativity is a potentially useful strategy for designing relatedness technologies.

2. An *empirical contribution* is made through collecting quantitative evidence for the relationship between creativity and social connection within the context of Minecraft. Additionally, we contribute qualitative support for the nature of this relationship and the factors that may affect it by analyzing descriptions of

participants' experiences of social connection and disconnection during collaborative creativity in Minecraft.

3. Drawing from both of these, we ultimately provide a list of *design implications* for developing future systems that aim to foster social connection through digital platforms designed to encourage collaborative creativity.

1.3 Outline of Thesis

Chapter 1 introduces the research context, motivation, problem, proposed solution and its evaluation. Chapter 2 reviews the relevant literature, beginning with a brief overview of related fields and then moving on to how this project is situated within the related work. Chapter 3 outlines the research methodology, including in-depth descriptions of the measures and scales used. Chapter 4 presents the quantitative results, moving through descriptive statistics, correlations, multiple regression, mediation analysis and exploratory moderation analysis. Chapter 5 presents the qualitative results from an inductive thematic analysis, identifying four experiential factors and three phases of the creative process relevant to social connection and disconnection during collaborative creativity in Minecraft. Chapter 6 discusses our results in the context of our research questions, analyzes them to derive design implications for future systems that aim to increase social connection through designing for collaborative creativity, and then describes limitations and suggestions for future work. Chapter 7 provides a brief summary and conclusion for this project.

Chapter 2

Related Work

This chapter begins by outlining the fields that inform this thesis, followed by a review of the relevant literature and how this work is situated within it.

This thesis draws from research in several main areas. This includes research into social technologies within the field of human-computer interaction (HCI), encompassing both custom-designed tools and in-the-wild studies of existing social platforms such as games and social media. As well, this work integrates creativity research from the field of psychology to provide a theoretical foundation, and it overlaps with research on collaboration within games, especially the video game Minecraft, which is used as the context of this study. Finally, it takes inspiration from existing design recommendations from the creativity support tool literature, alongside work on designing to support collaborative creativity from other fields.

In the following sections, we will describe how our project is positioned within the literature, beginning with work on digital tools and social connection, moving on to the relationship between creativity and social connection, and concluding with a description of work that is closest in nature to our project—research situated at the intersection of digital systems/tools, creativity, and fostering social connection.

2.1 Digital Tools and Social Connection

Within the field of HCI, supporting social connection through digital systems has been studied via the design of custom systems with a range of features. These include synchronous media sharing [59], video game mechanics that promote interdependence [20], embodied synchronization [73], networked everyday objects (Internet

of Things) [9], and haptic systems that transmit the sensation of touch over long distance [85]. Studies also examine existing contexts, such as massively multiplayer online role-playing games (MMORPGs) [35], live streaming [78], fanfiction writing communities [24, 30], remote work [58] and social media [71]. Although several of these contexts involve creative activities (e.g., fanfiction writing), the research focus is on the particular system and interactions within it, rather than the concept of creativity itself.

A review of 241 relatedness technologies identified nine design strategies: *awareness*, *expressivity*, *physicalness*, *gift-giving*, *joint action*, *memories*, *genuine conversation*, *acts of care*, and *ritual formation* [89] and an analysis of 50 design artifacts for "mediated genuine connection" yielded a different set of nine design strategies: *affective self-disclosure*, *reflection on unity*, *shared embodied experience*, *transcendent emotions*, *embodied metaphors*, *interpersonal distance*, *touch*, *provocations*, and *play* [80]. Neither review, out of a total of 18 suggested strategies for increasing social connection through digital systems, includes creativity as a primary design strategy. The only explicit mention of creativity is within the strategy "play" from Stepanova et al. [80], where creative exploration is mentioned as an implementation mechanism and creativity is listed as an experiential quality. This provides evidence that collaborative creativity is a worthwhile strategy to explore in the space of relatedness technology design, but also suggests that it is presently underexplored. Additionally, while it is not listed as a main strategy, creative collaboration has the potential to naturally promote many of the included strategies. For example, the creation of artifacts lends itself to *gift-giving* (e.g., making your friend a playlist on a music platform) [29], creative idea generation may allow you to *express yourself* (e.g., sharing your emotions through an online creative writing app) [41, 34], engaging in the creative process may promote *playful exploration* (e.g., trying out different silly filters while editing photos) [10] and sharing a common goal allows for *joint action* (e.g., working together on a digital scrapbook of family memories) [52, 24]. Combined, these examples of previous research establish social technology design as an active and worthwhile field of study, suggest that collaborative creativity may be a potentially useful design strategy for crafting future systems, and indicate that this space has, at present, not been extensively investigated, and therefore provides an opportunity for further exploration.

2.2 Creativity and Social Connection

Creativity is commonly defined as the production of ideas that are novel and useful [2, 62]. More recently, the 5 A's Framework (Actor, Action, Artifact, Audience, Affordances) emphasizes the idea of creativity occurring through actions enabled by environmental affordances [32]; therefore, it could be encouraged through digital system design. In popular discourse, creativity is often described as contributing to social connection, though such claims are typically anecdotal. The inverse relationship, (i.e., the positive effect of social connection on creativity), has been more thoroughly studied [25, 82, 21]. However, this relationship is likely bi-directional; empirical evidence in many fields of study—including organizational psychology [90], art therapy [5], and education [49]—provides support for the positive effect of creativity on social connection. These studies primarily evaluate the social effects of creative activities such as team-building exercises [90], clay-based group therapy [5], and arts workshops [49]. However, they do not explicitly focus on the effect of creativity (as a general, theoretical concept rather than a specific creative activity) on social connection.

A different subset of previous research focuses more on creativity as a general construct and relates it to social connection. For example, a qualitative thematic analysis looking at the benefits of creativity in a mental health context found "increased social connection" as one of its themes [41]. Beyond establishing this relationship, these works also suggest several reasons why creativity might facilitate social connection. First, creativity could lead to closeness through mutual self-disclosure [34]. Previous work has found that people become more self-focused when they are expected to be creative and that sharing a creative idea is perceived to be revealing of the self [33, 46]. Second, creativity could lead to closeness through reducing negative social behaviour. Previous work has found that a creative mindset was associated with social closeness, a decreased tendency to both instigate and perceive rudeness, and a higher perceived value of others' contributions [26]. Rouse [74] suggests that two people can grow closer together through a series of "intimate creative interactions", which involve passing ideas back and forth throughout the creative process while engaging in unfiltered idea disclosure, supportive elaboration, and idea-focused evaluation. This leads to the development of mutual safety, trust, affection and cohesion, and ultimately to the creation of a shared interpersonal boundary, or a sense of "we". This boundary provides a sense of psychological safety and a reduced fear of judgement. Finally, Gauntlett [29] argues, from a sociological perspective, that

making is inherently linked to social connection in several ways: creative products carry the presence of their maker, people are often motivated to create in order to share their work with others (e.g., as gifts), and iterative cycles of making and sharing help bind communities together. Overall, this previous work strongly supports the idea that creativity and social connection are linked, while leaving an open gap for further research that explicitly investigates the relationship in a digital context with the aim of providing guidance for designers of social technologies.

2.3 Digital Systems/Tools, Creativity and Social Connection

Existing research that combines digital systems/tools, creativity, and social connection falls into three main categories. The first is the *design of custom tools* meant to increase closeness between people in specific contexts (e.g., young people who have experienced trauma [47]; multi-generational relationships [52, 88]) through the use of a creative activity (e.g., the creation of comics [47]; digital crafting [52]; tangible storytelling [88]). The second is the study of *collaborative work practices* within the context of remote creative projects (e.g., scientists in an astrophysics lab [3]; children collaborating on interactive media creation in the Scratch programming environment [3, 8]; multiple developers contributing to the code repository GitHub [53]; online DIY communities sharing resources and providing feedback [48]). Finally, the third is research on the benefits of engaging with *online social platforms that promote the sharing of creative projects*, which include social media (e.g., TikTok [60]; Tumblr [86]; Facebook [56]), fanfiction archives [24, 30], repositories for designs in specific domains (e.g., 3D-printing [12]; e-textiles [54]), and the video game Minecraft [68, 69, 70].

Workshops and field studies using custom HCI systems have found decreased feelings of loneliness and increased connection to the experiences of others [47], facilitation of collaborative interaction and discussion [52], and increased communication and connectedness through creative engagement [88]. However, these studies are constrained by their scope and sample size and lack a real-world context, which limits their ecological validity. Other studies using existing in-the-wild systems have shown the presence of socio-emotional communication in two diverse creative work contexts (e.g., astrophysics lab and Scratch collaborations [3]), emotional expression leading to closer relationships in online fanfiction communities [30], and the formation of social

ties through sharing project progress in an online knitting community [56], again suggesting that a creative digital environment can support social connection. However, while these studies examine types of communication during creative collaboration [3], how relationships form through leaving reviews on serially-published online stories [30], and the social benefits of sharing creative work on a digital platform [56], they do not specifically investigate mutual engagement in digital creative activities as a medium for relationship building. A digital system that *has* been studied using that perspective is Minecraft—a sandbox video game described as fostering a culture of making and sharing [70]—which has been shown to be uniquely well suited to supporting a community for children with autism by enabling diverse forms of social expression (such as building structures, text-based chat, and taking screenshots and videos of game play) [69].

However, while research in these varied areas (e.g., custom relatedness technologies; collaborative work practices; online platforms for sharing creative work; the video game Minecraft) all provide solid support for the idea that engaging in collaborative creativity in digital systems can foster social connection, none of these studies specifically measures or specifies the type of creativity. To our knowledge, no previous work explicitly investigates the link between creativity and social connection using specific theoretically grounded measures in an existing real-world digital context, which is what would help us generate more specific advice for designers of social technology; the present study addresses this gap. To achieve its goal, it uses the existing platform Minecraft.

Chapter 3

Methods

This chapter describes the research methodology used in this thesis, including the study design, the digital context chosen for the study (the video game Minecraft), participant criteria, survey structure, and procedure. This is followed by a detailed description of the measures, participant demographics, and exclusion criteria, as well as brief descriptions of the methods used for both quantitative and qualitative data analysis.

3.1 Study Design

This mixed-methods study consisted of one survey, which was used to collect both quantitative data (through validated scales, etc.) and qualitative data (through open-ended questions). Its purpose was to investigate the experiences of people who play the game Minecraft with other people, focusing on social connection and creativity. The study was approved by the University of Victoria Human Research Ethics Board (Title: "Social and Technical Features of Online Platforms for Collaborative Creativity"; Ethics Protocol Number: 24-0203) and each participant provided informed consent before starting the survey (see A.1 for the ethics approval).

3.2 Minecraft Description

Minecraft is a sandbox video game in which players can collect resources, combine them in various ways to produce other materials and objects, build 3D structures, and explore within a procedurally generated world [81]. Officially released by Mojang in

2011, it now boasts over 204 million active players [61] and has approximately 65,000 hits on Google Scholar [77]. It offers two basic play modes: 1) Survival mode (which includes a day-night cycle, monsters that spawn in the dark, and hunger and damage bars), and 2) Creative mode (which includes unlimited resources, infinite health, the ability to hover, and neither monsters nor a day-night cycle). Additionally, Minecraft supports the creation of multiplayer servers that allow multiple players to inhabit the same world. These can be local (i.e., on the same network; accessible only to players in the same geographic location) or online (i.e., hosted on the internet; available to anyone with the server access and permissions).

Minecraft facilitates both self-expressive creativity (e.g., selecting colour, material, location, and shape of digital objects; modifying avatar appearance) and problem-solving creativity (e.g., optimizing resource collection pipelines; figuring out how to survive monster attacks). The game supports co-creation of game worlds, which allows players to become makers instead of simply experiencers [1]. As well, both built-in and supplemental features support social play. Players are able to construct lasting artifacts that other players can see and contribute to as they navigate the environment. They can also witness in-game actions of other players via avatars and communicate via text chat. Finally, while not a built-in feature of Minecraft, remote players often add voice chat facilitated by another technology/platform such as Discord. Based on its popularity, game mechanics that support creativity, and features that enable social interaction, Minecraft is an ideal context for this study; the platform provides excellent ecological validity for answering our research questions.

3.3 Survey

Our survey was created in SurveyMonkey and distributed on Prolific [63], an online crowd-sourcing platform that allows researchers to easily collect quality data. The survey took approximately 30 minutes to complete. Participants were compensated with $\$10.82/hr$ (CAD).

3.4 Participant Criteria

Participants for this study were required to be 18+ years of age, speak English as their primary language, and live in the United Kingdom, the United States, Australia, or Canada. We screened for these factors using the built-in Prolific filters (each user

provided this information in their profile when they signed up to the platform). As well, the participants needed to have played Minecraft with other people at least two times per month. This ensured that they would have regular creative and social experiences in a digital environment. This requirement was stated in the research study description; additionally, three pre-screening questions were included at the beginning of the survey to verify that participants met this requirement.

3.5 Procedure

In order to recruit participants, the study description was posted in Prolific. We opened slots gradually in sets to ensure there were no technical problems. Participants were linked to the SurveyMonkey survey. As it was filled out, we waited for responses to come in and answered any messages participants sent. Finally, we reviewed the data and paid participants. After we reached a desired amount of responses (around 150), the data were downloaded and analyzed.

3.6 Survey Description

The survey (see A.4 for full survey items) began with a request for the participant's Prolific ID, so that the survey data could be connected with the Prolific data. This was followed by three pre-screening questions to ensure that the participant had the correct experience to complete the study. These questions inquired if the participant had ever played Minecraft, played Minecraft with other people and played Minecraft with other people at least two times per month. Participants who answered no to any of these questions were routed to the end of the survey and informed they did not meet the eligibility criteria to participate in the survey. For those that answered correctly, they were directed to the study consent form.

After the consent form, participants answered demographic questions about their age, gender, profession and how often they played Minecraft with other people, followed by an attention check (i.e., please select "D"). The survey moved on to a series of questions about their Minecraft experience, beginning with an open-ended request for a description of the collaborative experience or activity in Minecraft they had decided to think about for this study (question 1). This question helped prime the participants and anchored their responses to a particular context; they were frequently asked to refer back to their response to this question. This question was

followed by: 2) *What kinds of things did you make with others?* (open-ended text box), 3) *How would you describe your relationship with the person or people you made things with?* (checkbox), 4) *Which phases of the creative process did you engage in?* (checkbox), 5) *What makes you feel socially connected during creative collaboration in Minecraft?* (open-ended text box) and 6) *What makes you feel socially disconnected during creative collaboration in Minecraft?* (open-ended text box). For each of these questions, the survey emphasized that the participant should refer back to the specific experience they had described in the first text box.

The next section of the survey included the various scales measuring creativity, social connection and features of creative collaboration (measures described fully below). This began with questions based on the Model of Coordinated Action (MoCA), which aimed to capture features of creative collaboration. Following this came the Internet Social Capital Scale (ISCS), including both the bonding and bridging subscales, and then the Inclusion of Other in the Self Scale (IOS), all measuring social connection. Finally came three measures of creativity: the Creativity Support Index (CSI), the Short Scale of Creative Self (SSCS), and a single question measuring self-rated creativity during their Minecraft experience (referred to from now on as "personal creativity rating").

3.7 Measures

3.7.1 Internet Social Capital Scale

Social capital is a popular, well-studied construct often used in sociological research. While it has been independently rediscovered and described in several ways over the years, in this study it is defined as a resource that an individual has access to, allowing them to pursue their goals more effectively, as described in Coleman (1988) [17]. It is created through the relationships between and among people. The Internet Social Capital Scale (ISCS) adapted the concept of social capital to an online context [91]. While the ISCS has four subscales, two for offline relationships and two for online relationships, this study used only the online subscales, as measuring social capital within the collaborative online context of Minecraft was our main objective. These consisted of a *bonding* subscale (which measures closeness of specific relationships, the availability of emotional support, access to scarce resources like money, and ability to generate solidarity for a cause), and a *bridging* subscale (which measures interactions

with a wide range of people, exposure to a variety of viewpoints, a sense of belonging to a larger group, and access to community resources). The bonding subscale and the bridging subscale each consisted of 10 items, each rated using a bipolar semantically anchored slider with 100 gradients (0 = Strongly Disagree to 100 = Strongly Agree). An example of a bonding subscale item is, "*There is someone I play Minecraft with who I can turn to for advice about making very important decisions,*" while an example of a bridging subscale item is, "*Interacting with people in Minecraft makes me feel like part of a larger community.*" In the present study, internal consistency was acceptable for both subscales (bonding: $\alpha = 0.864$; bridging: $\alpha = 0.908$). The ISCS allowed us to approximate social connection with a commonly-used and well-validated construct.

3.7.2 Inclusion of Other in the Self Scale

The Inclusion of Other in the Self Scale (IOS) was used to measure the closeness between the participants in this study and the people they played Minecraft with [4]. It is a visual scale with seven image options (see A.4) used to indicate level of closeness—beginning with two circles that are barely touching (1) and ending with two circles that are almost entirely overlapping (7). Participants were asked which image best described their relationship with the person or people they played Minecraft with.

3.7.3 Creativity Support Index

The Creativity Support Index (CSI) is a psychometric survey designed to quantify the degree to which a tool supports creativity in a particular context [13]. This index is necessary since creativity is difficult to define; the CSI uses six dimensions of creativity to calculate its score: **Collaboration** (e.g.,"*It was really easy to share ideas and designs with other people inside this system or tool.*"), **Enjoyment** (e.g.,"*I enjoyed using the system or tool.*"), **Exploration** (e.g., "*It was easy for me to explore many different ideas, options, designs, or outcomes using this system or tool.*"), **Expressiveness** (e.g., "*The system or tool allowed me to be very expressive.*"), **Immersion** (e.g., "*I became so absorbed in the activity that I forgot about the system or tool that I was using.*"), and **Results Worth Effort** (e.g., "*What I was able to produce was worth the effort I had to exert to produce it.*"). These dimensions were arrived at using research on flow, play, creativity and creativity support tools (CSTs). This measure is composed of two different sets of questions: 12 agreement statements and

a 15 question paired-factor comparison test. The agreement statements capture how well the tool supports each of the dimensions of creativity mentioned above, with two questions for each dimension, each rated using a bipolar semantically anchored slider with 100 gradients (0 = Highly Disagree to 100 = Highly Agree). The paired-factor comparison test ranks the importance of each factor within the particular creative context the tool is being used in (in this case, using the video game Minecraft to play and create with others). Each question was multiple choice with two options, each capturing one of the creativity dimensions—participants were asked to select which one was more important when doing their task. Finally, the results of the two question sets were used to calculate a final score out of 100, balancing the rating on each dimension with its importance to the task, then adding and averaging the scores to produce an overall measure of creativity support. The CSI was mapped to the Affordances component of the Five A's framework, providing a measure of Minecraft's creativity support as perceived by each individual participant.

3.7.4 Short Scale of Creative Self

The Short Scale of Creative Self (SSCS) was designed to measure trait-like creative self-efficacy (CSE) and creative personal identity (CPI), both important constructs used in psychology research about engagement in creative actions [43]. In contrast to the CSI, it provides a measure of how creative the participant rates themselves in general, rather than how well the tool they used supports creativity. The SSCS consisted of 11 items, each rated using a bipolar semantically anchored slider with 100 gradients (0 = Highly Disagree to 100 = Highly Agree). Some example items are "*Creativity is an important part of myself*" (CPI), and "*I am good at proposing original solutions to problems*" (CSE). In the present study, internal consistency was acceptable for both constructs (CSE: $\alpha = 0.883$; CPI: $\alpha = 0.876$). The SSCS was mapped to the Actor component of the Five A's framework, providing a measure of a participant's creative self-perception.

3.7.5 Personal Creativity Rating

The personal creativity rating was a single-item question adapted from the creativity measure used in previous work on creativity and happiness [18]. It was a single question: *"Overall, how creative do you feel you were during the Minecraft experience? Creativity includes coming up with novel or original ideas; expressing oneself*

or solving problems in an original and useful way; or spending time doing activities such as art, music, writing, programming, engineering, etc." It was scored using a bipolar semantically anchored slider with 100 gradients (0 = Not Very Creative to 100 = Very Creative). It was modified to fit the context of Minecraft and an additional section was added to the creativity definition—"solving problems" was added alongside "expressing oneself", and "programming, engineering" were added as examples, in order to capture the fact that creativity is used in procedural optimization as well as self-expression. The personal creativity rating was mapped to the Action component of the Five A's framework, providing a retrospective, self-reported proxy for a participant's creative engagement during their collaborative experience in Minecraft.

3.7.6 Model of Coordinated Action

The Model of Coordinated Action (MoCA) is a theoretical model developed to expand the definition of "collaboration" in the field of computer-supported cooperative work (CSCW) [51]. It is built off of existing CSCW work, such as Johansen's time-space matrix [42] (which characterizes digital collaborations as existing along two continuums—synchronous/asynchronous and face-to-face/electronic), and extends it to capture characteristics of a more diverse range of collaboration types. It includes seven dimensions: *synchronicity*, *physical distribution*, *scale*, *number of communities of practice*, *nascence*, *planned permanence*, and *turnover*. Its goal is to identify specific features relevant to digital collaboration that would enable researchers to study and compare collaborations across various contexts, with the hope of fostering greater integration between currently isolated research domains. This is relevant because these characteristics might influence the design decisions that would support specific types of collaborations.

The specific questions used to measure MoCA dimensions in this study were adapted from work by Choi and Tausczik [14], who studied MoCA in the context of open data analysis. Below is a description of the seven MoCA dimensions. Each response was collected using a bipolar semantically anchored slider with 100 gradients unless otherwise specified.

Synchronicity

Synchronicity is based on Johansen's time-space matrix and is an established feature of relevance in digital collaborations; it describes how users overlap in time. Partici-

pants were asked: "*How would you describe the synchronicity (i.e., at the same time (synchronous) vs. at different times (asynchronous)) of the collaboration style of the Minecraft experience?*" The response slider ranged from Entirely Synchronous (0) to Entirely Asynchronous (100).

Physical Distribution

Physical distribution is another dimension based on Johansen's time-space matrix, in this case describing how users overlap in space. Again, the extent to which users collaborate in the same physical space vs. purely in the digital realm influences how systems should be designed and how they are used. Participants were asked: "*How would you describe the physical distribution of the Minecraft experience? (i.e., do you play Minecraft in the same physical space or do you play remotely?)*". The response slider ranged from Entirely In-Person (0) to Entirely Remote Communication (100).

Scale

Scale is the size of the collaboration measured by the number of participants. It is another dimension based on existing CSCW research; previous studies have noted that requirements for social system design vary depending on group size. In this study, participants were asked: "*What was the group size of the Minecraft experience? (i.e., on average, how many people were involved at a given time point?)*" The response slider ranged from Very Small (2) to Very Large (100+).

Number of Communities of Practice

This dimension is based on Wenger's concept of communities of practice (CoP), which is an established concept with its own rich base of research [50]. For the purpose of this study, participants were given this basic description: *A "**community of practice**" is defined as a group of people engaged in a particular activity or activities. This group of people has a shared way of doing things that they teach to newcomers as they join the group, either through example or direct instruction.* The number of CoP captures how "interdisciplinary" the collaboration is (i.e., how many different communities have a hand in the project; how homogeneous is the group). A collaboration might include one CoP (i.e., between members of a single community), several CoP, or no CoP (e.g., a group of friends with no specific affiliation to a CoP as described above). A higher number of CoP may lead to conflict between differing priorities, vocabularies, and work processes that requires resolution. After a description

of CoP (see A.4 for the full text), participants were asked *which* CoP and *how many* CoP were involved in their Minecraft experience. The first question had a text box to collect responses and the second had a slider that went from None (0) to Many (10+).

Nascence

Nascence is a new dimension created by the authors of the MoCA scale [51]; it was proposed to capture how established the collaboration is. Collaborations may be new, or have been recently faced with a big change that challenged their work practices, suggesting that the process or goal of engaging in the collaboration is in flux (e.g., is being developed or re-organized). On the other hand, older and more stable collaborations may have habitual interaction patterns or workflow pipelines. This dimension was measured using two questions: 1) "*Did you feel uncertain about project outcomes during the Minecraft experience? (e.g., were you uncertain that you would be able to reach your goal or were you uncertain about what the goal was?)*" and 2) "*Did you have to make adjustments to your plans or process during the Minecraft experience? (e.g., did you change the goal you were working towards or did you change how you were working on it?)*" For both questions, the response slider ranged from Strongly Disagree (0) to Strongly Agree (100). During analysis, the responses were averaged to provide a score for nascence.

Planned Permanence

Planned permanence is another new dimension proposed by the authors of the MoCA scale [51]. It is similar to nascence, but is meant to capture whether the collaboration is intended to be short-term or long-term. This could influence the collaboration process—projects meant to last only a short while might involve more spontaneity, while projects meant to last long-term might involve more formal planning (e.g., the difference between writing a short program script meant to be used once vs. developing a large system that will be extended for years to come). In this study, as adapted from Choi and Tausczik [14], length of collaboration is used as a shorthand for this dimension. Participants were asked "*How long specifically did the Minecraft experience last (or has lasted so far?)*" and were given three text boxes to fill in, one for years, one for months and one for days. For the statistical analysis, these responses were converted to a total in the unit of days, and then divided by the longest project length in the study in order to provide a proportional measurement from 0 to 1.

Turnover

Turnover is a third and final new dimension proposed by the authors of the MoCA scale [51], meant to capture the difference between closed, private collaborations with a relatively stable participant makeup and massive online collaborations open to anyone, both of which involve different interaction styles. It describes how common it is for participants to enter or leave the collaboration. Again, this dimension was measured using two questions: 1) "*How frequently did new people join the Minecraft experience after it was started?*" and 2) "*How frequently did people leave the Minecraft experience before it was finished?*" For both questions, the response slider ranged from Never (0) to Constantly (100). During analysis, the response were once more averaged to provide a score, this time for turnover.

3.7.7 Stages of Creativity

There are many stage models of the creative process (see Wallas (1926) [87], IDEO (Kelley, 2001) [45], etc.), but the one used in this study was Sawyer's Eight Stages of the Creative Process [76]. It is based on a review and synthesis of many other previous models of the creative process. The stages are: 1) *problem-finding* (e.g., deciding the goal of the project; figuring out what is missing), 2) *acquiring knowledge* (e.g., skill-building; learning), 3) *gathering related information* (e.g., looking for inspiration; exploring), 4) *incubation* (e.g., taking time off and doing another activity; playing), 5) *generating ideas* (e.g., brainstorming; coming up with potential solutions), 6) *combining ideas* (e.g., synthesizing suggestions; making connections), 7) *selecting the best ideas* (e.g., reflection; evaluating and judging ideas), and 8) *externalizing ideas* (e.g., implementation; turning ideas into reality). Using a checkbox question, participants were asked to select which stages of the creative process they engaged in during their Minecraft experiences with others. This was because of an exploratory interest in whether several stages were more prominent than others in collaborative creative experiences; this would give designers of collaborative creativity systems meant to support social connection a direction to go in terms of their design decisions (i.e., which phase should they prioritize supporting).

3.8 Participants

We collected responses from 151 participants. After data cleaning, 111 participants remained (exclusion criteria described below). Among the remaining participants there were 61 men, 49 women, and one participant who preferred not to say. The average age of participants was 34.9 years (min = 18, max = 87, SD = 12.4). The distribution of ages is shown in Figure 3.1. The sample included a range of professions such as healthcare workers, engineers, managers, students, homemakers, food service workers, software developers, business owners, content creators, sales representatives, and consultants.

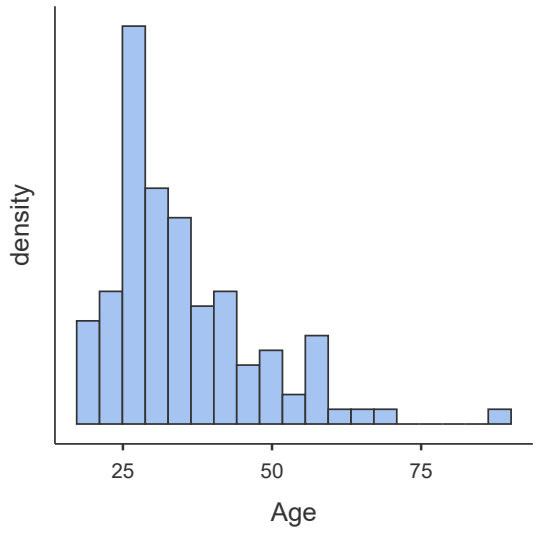


Figure 3.1. Distribution for Age

3.9 Exclusion Criteria

In total, 151 participants completed the survey. Four participants were removed because they responded incorrectly to an attention check question (i.e., select the answer "D"). Based on previous recommendations for detecting survey responses made without careful consideration, we settled on two exclusion criteria that involved variance [11, 57]. First, we analyzed the answers to four scales (i.e., bonding social capital, bridging social capital, SSCS, and CSI agreement scales) to detect if there was zero variance, showing that participants selected the same response to every question.

Since answers were collected on a 0–100 slider scale, it would be unlikely for participants to choose the exact same answer for each question on the scale by chance if they were carefully considering the response to each question. Five participants were removed because they had zero variance on the SSCS scale and two participants were removed because they had zero variance on the CSI agreement scales. After this, one participant was removed because they had a project length of zero days, a response that is nonsensical given the context of the study. Following that, the variance of several scales was analyzed to see if it was more than 2 SD above or below the mean scale variance, suggesting that participants were responding randomly to the questions. This included three scales where the answers to all questions were expected to be similar: the bonding social capital subscale, the bridging social capital subscale and the SSCS. Seven participants were removed because the variance of the bonding subscale was more than 2 SD above the mean, four participants were removed because the variance of the bridging subscale was more than 2 SD above the mean and four participants were removed because the variance of the SSCS was more than 2 SD above the mean.

In the next step, six participants were removed because they completed the survey in less than 7.15 minutes (i.e., less than one quarter of the mean completion time). These participants were judged to have had insufficient time to have given thoughtful answers to the survey questions. Finally, seven participants were removed for providing written responses that appeared inauthentic (e.g., similarity to other responses or atypical punctuation such as frequent em-dashes). These decisions were made after manually reviewing responses. After all data cleaning steps had been completed, 40 participants had been removed in total, resulting in 111 participants remaining.

3.10 Statistical Analysis of Quantitative Data

The data were exported as a spreadsheet from SurveyMonkey, then cleaned using a Python script and the pandas library. Following this, the spreadsheet was imported into Jamovi [84] and statistically analyzed. Analyses included descriptives, correlations, multiple regressions and exploratory mediations/moderations. These will be described in further detail in the results section directly prior to their use.

3.11 Qualitative Analysis

The qualitative data were analyzed using a reflexive thematic analysis, specifically an inductive approach, following the stages described by Braun and Clarke [7]. First, we familiarized ourselves with the data. Next, the open-ended survey questions were open-coded by the first author using NVIVO, while periodically meeting with members of the research team to reflect on and refine codes. Throughout the process, we remained attentive to the overarching research questions about the relationship between creativity and social connection and the factors that might influence it. In total, there were 123 codes. After codes were consolidated into higher-level themes, three creative phases were identified—problem-finding; brainstorming (encompassing idea generation, combination, and selection); and implementation. These phases were interpreted in relation to Sawyer [76]'s model of the creative process, which served as a useful lens for contextualizing the findings. In parallel, we identified four potentially relevant factors that appeared to influence the relationship between creativity and social connection: *Unity*, *Agency*, *Playfulness*, and *Achievement*.

Chapter 4

Quantitative Results

This chapter presents the quantitative results of our study, covering descriptive statistics, correlations, multiple regression analysis, mediation analysis, and exploratory moderation analysis.

4.1 Descriptive Characteristics of the Data

This study examined the relationship between measures of social connection—bonding social capital, bridging social capital, and the Inclusion of Other in the Self Scale (IOS)—and measures of creativity—the Creativity Support Index (CSI), Short Scale of Creative Self (SSCS), and personal creativity rating. Additionally, several other measures were collected due to exploratory interest, including the stages of creativity that players were engaged in (based on Sawyer's Eight Stages [76]), who Minecraft was played with, and the Model of Coordinated Action (MoCA), which breaks down digital collaborations into seven specific descriptive factors.

4.1.1 Social Connection Scores

The descriptive statistics for bonding social capital, bridging social capital, and IOS are shown in Table 4.1. Distributions for all three measures are presented in Figures 4.1–4.3.

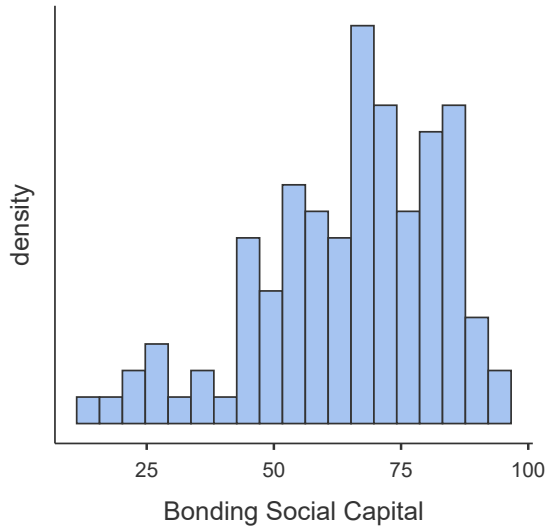


Figure 4.1. Distribution for Bonding Social Capital

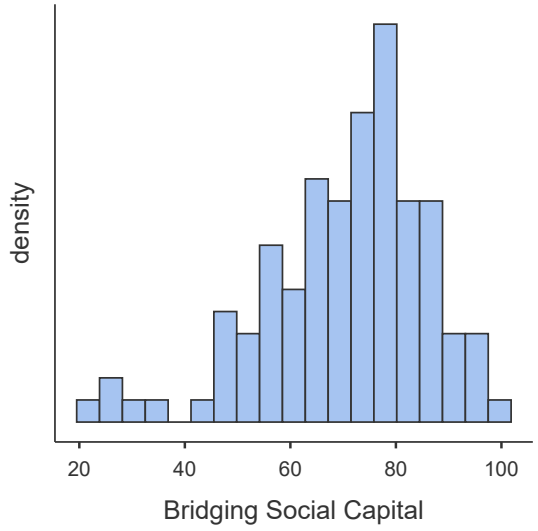


Figure 4.2. Distribution for Bridging Social Capital

4.1.2 Creativity Scores

The descriptive statistics for CSI, SSCS, and personal creativity rating are shown in Table 4.2. Distributions for all three measures are presented in Figures 4.4-4.6.

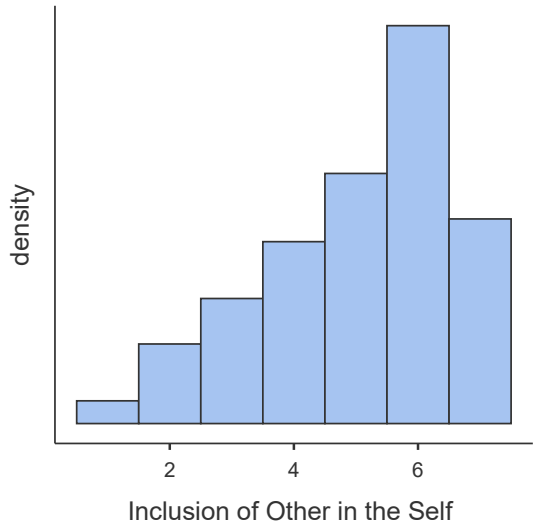


Figure 4.3. Distribution for Inclusion of Other in the Self

Table 4.1

Descriptive Statistics for Measures of Social Connection

Measure	*M*	*SD*	Range of Scale
Bonding Social Capital	64.9	17.7	0–100
Bridging Social Capital	70.5	15.6	0–100
Inclusion of Other in the Self	5.04	1.54	1–7

Table 4.2

Descriptive Statistics for Measures of Creativity

Measure	*M*	*SD*	Range of Scale
Creativity Support Index (CSI)	77.6	12.6	0–100
Short Scale of Creative Self (SSCS)	77.5	13.4	0–100
Personal Creativity Rating	82.7	12.2	0–100

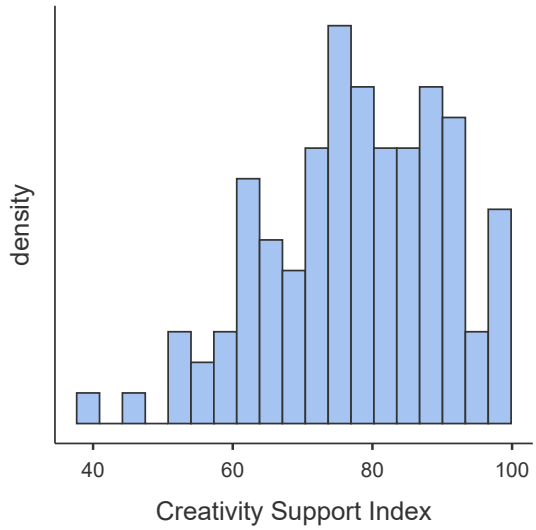


Figure 4.4. Distribution for Creativity Support Index

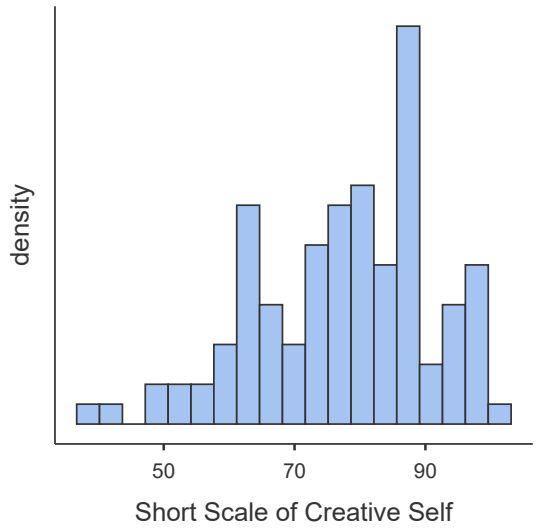


Figure 4.5. Distribution for Short Scale of Creative Self

4.1.3 Stages of Creativity

In our survey, we asked participants which stages of the creative process they engaged in to get a sense of which stages were more or less popular to engage in with others in Minecraft. The results can be seen in Figure 4.7.

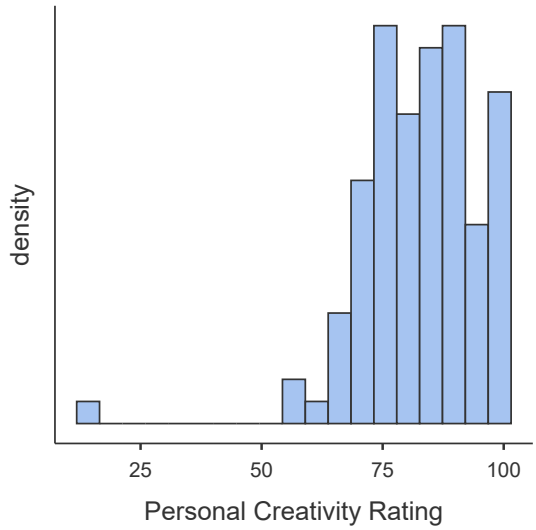


Figure 4.6. Distribution for Personal Creativity Rating

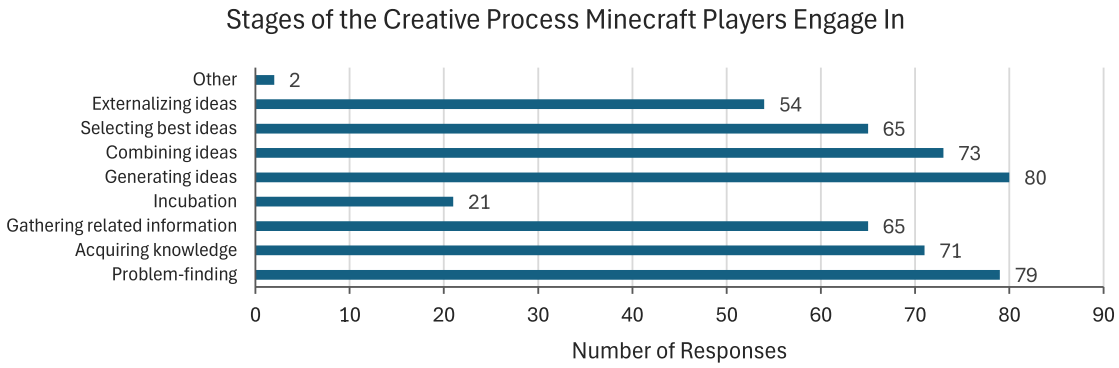


Figure 4.7. The number of participants who reported engaging in each of these stages of the creative process in Minecraft. Participants were allowed to select multiple options.

These data show that our sample engaged in all of the creative stages, as defined by Sawyer [76], while collaborating in Minecraft. The most popular stages of the creative process were generating ideas, problem-finding, and combining ideas, while the least popular were incubation and externalizing ideas (implementation). It is worth noting that by engaging in collection and construction in the Minecraft world, all players would have, by definition, engaged in the externalizing ideas phase; this

suggests that participants' internal mental model of this stage differed from that of the researchers.

4.1.4 Relationships between Minecraft Players

In our survey, we asked participants about the nature of their relationships with the people they played Minecraft with to get a sense of how close or distant they were. The results can be seen in Figure 4.8.

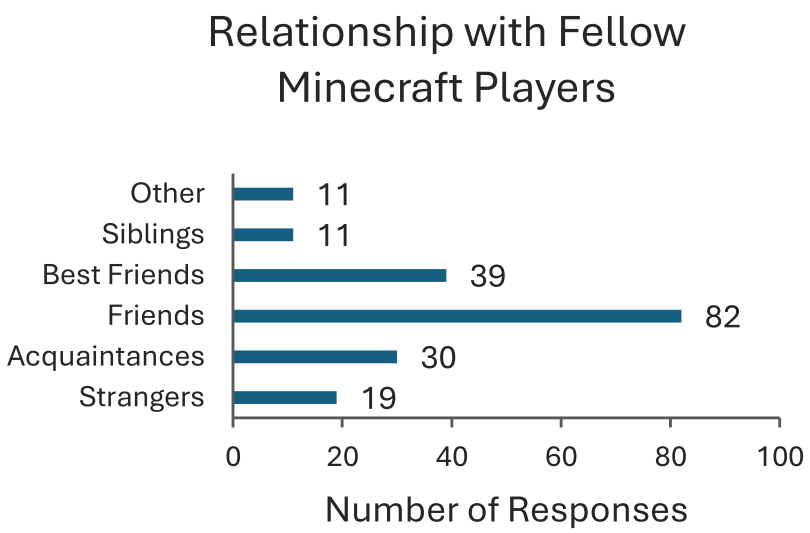


Figure 4.8. The number of participants who reported playing with each of these relationship types in Minecraft. Participants were allowed to select multiple options.

The Other category primarily included other variations on family relationships, including children, spouse, cousins, and nieces/nephews. Overall, these results suggest that this sample included people who played primarily with people they had closer relationships with (e.g., friends, best friends) as opposed to more distant relationships (e.g., strangers, acquaintances).

4.1.5 Frequency of Minecraft Play

For our survey, participants were required to have played Minecraft with others at least twice per month. A further question was included to collect more detailed fre-

quency information. The results can be seen in Figure 4.9.

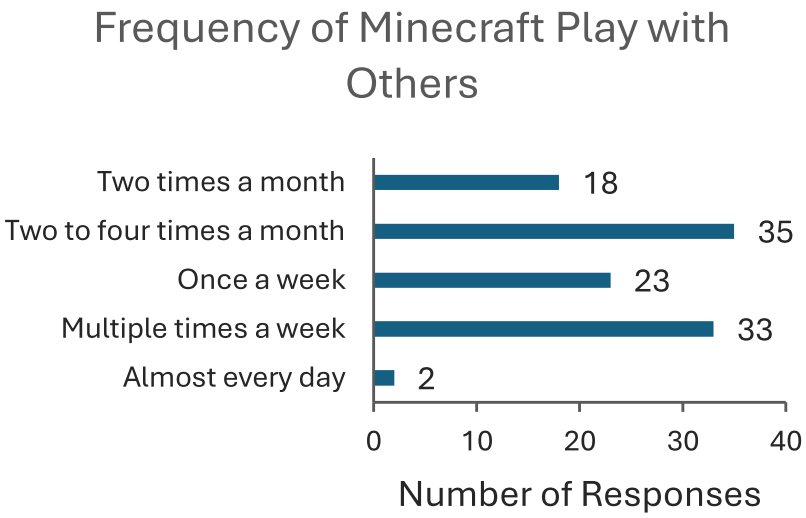


Figure 4.9. The frequency with which participants played Minecraft with others.

According to these results, "multiple times a week" and "between two to four times a month" are the most popular social play frequencies of the participants in this sample. The least popular frequency was "almost every day". Overall, the majority of participants played Minecraft with others more frequently than the baseline requirement for this study (2x a month).

4.1.6 Model of Coordinated Action Scores

The MoCA dimensions include: *synchronicity* (synchronous to asynchronous), *physical distribution* (completely in-person to completely online), *scale* (two participants to 100+ participants), *number of communities of practice* (zero CoP to 10+ CoP), *nascence* (not established to very established), *planned permanence* (short-term to long-term) and *turnover* (low turnover to high turnover). Project length (in days) is also included as a reference, since the scale variable was created using the max project length variable to calculate a proportion based on the overall longest project duration and therefore does not provide context for the specific length of time. The descriptive statistics for the MoCA dimensions can be seen in Table 4.3. Distributions for all

seven MoCA factors are presented in Figures 4.10–4.16.

Table 4.3

Descriptive Statistics for Model of Coordinated Action Scores

Measure	*M*	*SD*	Range of Scale
Synchronicity	45.9	25.8	0–100
Physical Distribution	74.5	29.1	0–100
Scale	23.5	25.0	2–100+
Number of Communities of Practice	2.74	2.91	0–10+
Nascence	55.3	20.2	0–100
Planned Permanence	0.0869	0.135	0–1
Turnover	32.4	25.6	0–100
Project Length (days)	431	669	

These results suggest that Minecraft collaborations tended to be over longer time spans (e.g., months) vs. shorter time spans (e.g., days).

4.2 Correlations

All core social connection measure (bonding social capital, bridging social capital, and IOS), creativity measures (CSI, SSCS, and personal creativity rating) and MoCA features (synchronicity, physical distribution, scale, number of communities of practice, nascence, planned permanence, and turnover) were analyzed for potential correlations. The results can be seen in Table 4.4.

Table 4.4

Correlations

		SC Bonding	SC Bridging	IOS Scale	Creativity Support Index	Short Scale of Creative Self	Personal Creativity Rating	Synchronicity	Physical Distribution	Scale	Number of CoP	Nascence	Planned Permanence	Turnover
SC Bonding	Pearson's r	—												
	df	—												
	p-value	—												
SC Bridging	Pearson's r	0.377***	—											
	df	109	—											
	p-value	< .001	—											
IOS Scale	Pearson's r	0.596***	0.295**	—										
	df	109	109	—										
	p-value	< .001	0.002	—										
Creativity Support Index	Pearson's r	0.372***	0.425***	0.246**	—									
	df	109	109	109	—									
	p-value	< .001	< .001	0.009	—									
Short Scale of Creative Self	Pearson's r	0.33***	0.646***	0.269**	0.531***	—								
	df	109	109	109	109	—								
	p-value	< .001	< .001	0.004	< .001	—								
Personal Creativity Rating	Pearson's r	0.11	0.436***	0.237*	0.332***	0.632***	—							
	df	109	109	109	109	109	—							
	p-value	0.252	< .001	0.012	< .001	< .001	—							
Synchronicity	Pearson's r	-0.119	0.103	-0.163	0.083	0.172	0.135	—						
	df	109	109	109	109	109	109	—						
	p-value	0.215	0.281	0.088	0.385	0.072	0.159	—						
Physical Distribution	Pearson's r	-0.08	-0.011	-0.066	0.187*	-0.063	-0.172	0.133	—					
	df	109	109	109	109	109	109	109	—					
	p-value	0.407	0.907	0.49	0.05	0.508	0.071	0.163	—					
Scale	Pearson's r	0.032	0.198*	0.05	-0.038	0.183	0.221*	0.289**	-0.014	—				
	df	109	109	109	109	109	109	109	109	—				
	p-value	0.739	0.038	0.605	0.692	0.055	0.02	0.002	0.882	—				
Number of CoP	Pearson's r	0.065	0.23*	0.095	-0.151	0.185	0.237*	0.179	-0.121	0.576***	—			
	df	109	109	109	109	109	109	109	109	109	—			
	p-value	0.499	0.015	0.32	0.114	0.052	0.012	0.06	0.206	< .001	—			
Nascence	Pearson's r	0.055	0.078	0.022	0.061	0.116	0.008	0.204*	-0.073	0.281**	0.114	—		
	df	109	109	109	109	109	109	109	109	109	109	—		
	p-value	0.565	0.414	0.819	0.528	0.227	0.931	0.032	0.444	0.003	0.232	—		
Planned Permanence	Pearson's r	-0.021	0.057	0.091	0.06	-0.005	0.108	0.02	-0.121	0.226*	0.217*	0.02	—	
	df	109	109	109	109	109	109	109	109	109	109	109	—	
	p-value	0.829	0.55	0.342	0.531	0.957	0.258	0.835	0.206	0.017	0.022	0.831	—	
Turnover	Pearson's r	-0.112	0.15	-0.084	-0.133	0.129	0.095	0.192*	-0.029	0.575***	0.494***	0.333***	0.302**	—
	df	109	109	109	109	109	109	109	109	109	109	109	109	—
	p-value	0.242	0.115	0.379	0.165	0.176	0.32	0.043	0.762	< .001	< .001	< .001	0.001	—

Note. The degrees of freedom were 109 for all correlations.

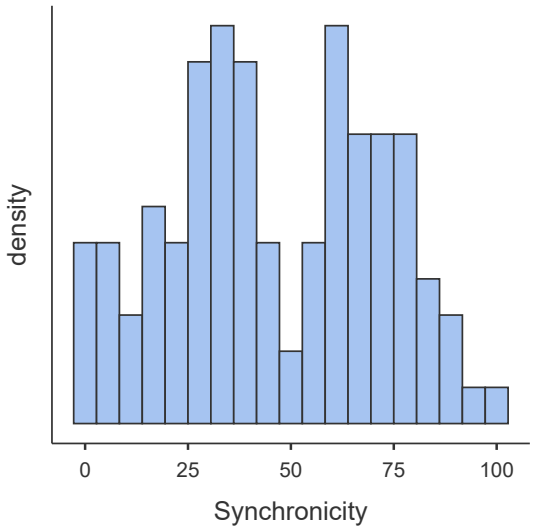


Figure 4.10. Distribution for Synchronicity

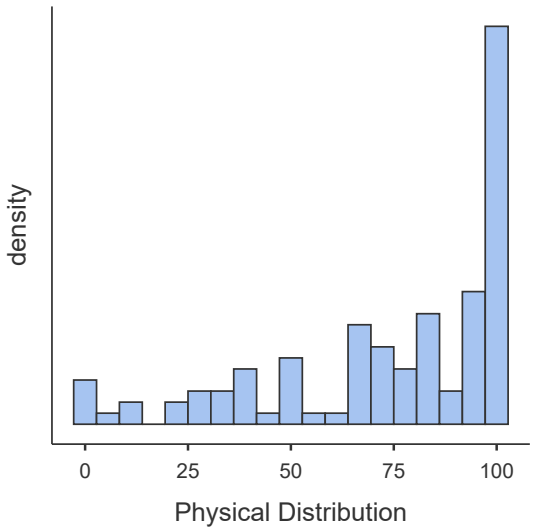


Figure 4.11. Distribution for Physical Distribution

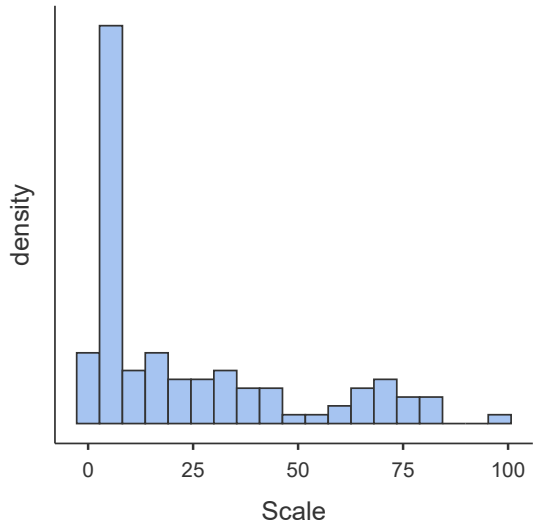


Figure 4.12. Distribution for Scale

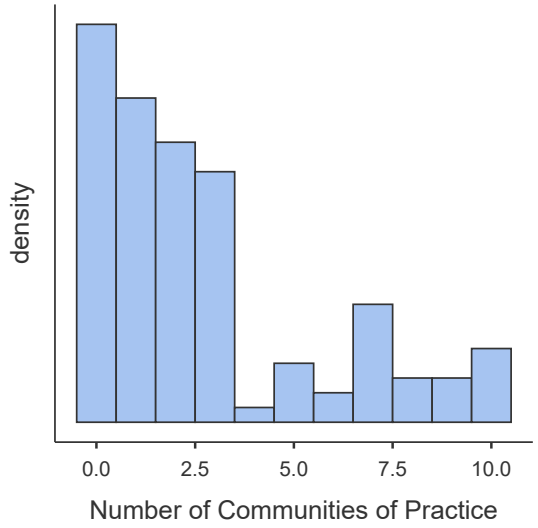


Figure 4.13. Distribution for Number of CoP

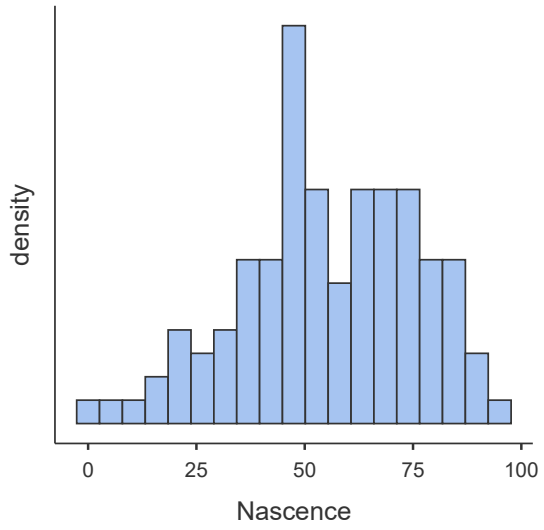


Figure 4.14. Distribution for Nascence

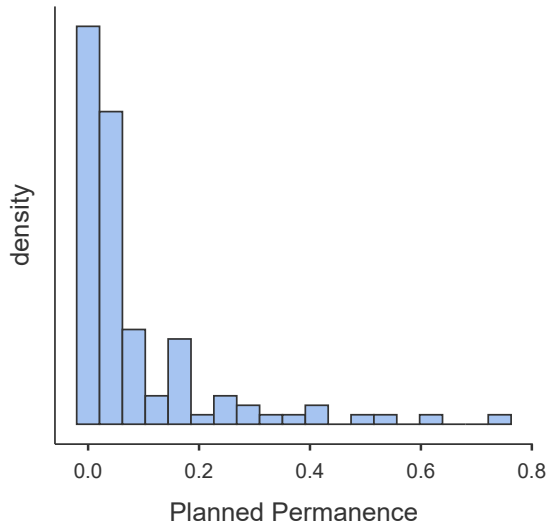


Figure 4.15. Distribution for Planned Permanence

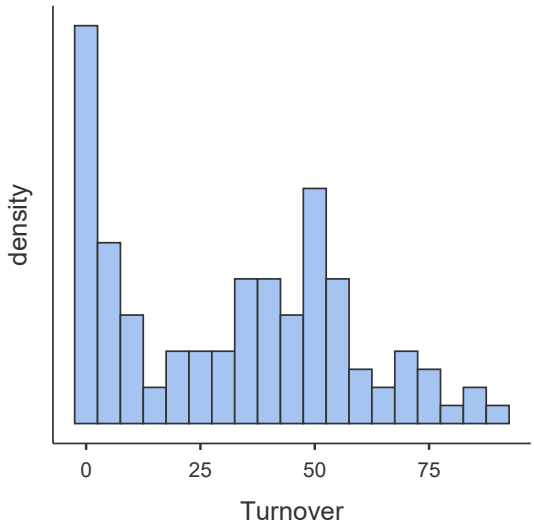


Figure 4.16. Distribution for Turnover

As expected, each of the social connection measures was positively correlated with each other, including bonding social capital and bridging social capital ($r = 0.377$, $p < .001$), bonding social capital and IOS ($r = 0.596$, $p < .001$), and bridging social capital and IOS ($r = 0.295$, $p = 0.002$). A similar pattern was observed within the creativity measures, with CSI and SSCS ($r = 0.531$, $p < .001$), CSI and the personal creativity rating ($r = 0.332$, $p < .001$), and SSCS and personal creativity rating ($r = 0.632$, $p < .001$) each being positively correlated with each other.

When it comes to the relationship between social connection measures and creativity measures, there was a positive correlation between all measures of social connection (bonding social capital, bridging social capital, and IOS) and all measures of creativity (CSI, SSCS, and personal creativity rating), except for between bonding social capital and personal creativity rating.

The significant positive relationships between social connection measures and creativity measures were as follows: bonding social capital and CSI ($r = 0.372$, $p < .001$), bonding social capital and SSCS ($r = 0.330$, $p < .001$), bridging social capital and CSI ($r = 0.425$, $p < .001$), bridging social capital and SSCS ($r = 0.646$, $p < .001$), bridging social capital and personal creativity rating ($r = 0.436$, $p < .001$), IOS and CSI ($r = 0.246$, $p = 0.009$), IOS and SSCS ($r = 0.269$, $p = 0.004$), and IOS and personal creativity rating ($r = 0.332$, $p < .001$).

Bonding social capital and personal creativity rating were the only social con-

nection and creativity measures that were not significantly related. The reason for this is unclear—perhaps it is because a higher perception of personal creative action was associated with a less prosocial and more individualistic interaction style as the participant focused on their own goals over group goals. Future research is needed to properly clarify this result. In general, the hypothesis that there is a significant relationship between social connectedness and creativity is supported.

Within the features of MoCA, *synchronicity* was positively related to scale ($r = 0.372$, $p < .001$), suggesting that increased group size was related to increased asynchronous activity. Synchronicity was also positively related to nascence ($r = 0.204$, $p = 0.032$) and turnover ($r = 0.192$, $p = 0.043$), which suggests that more asynchronous play was related to less-established collaboration practices (i.e., developing instead of routine) as well as more members joining/leaving the group.

Physical distribution was not correlated with any of the other MoCA features.

Scale was positively correlated with synchronicity (i.e., increased asynchronous play) as previously mentioned ($r = 0.372$, $p < .001$), as well as number of communities of practice ($r = 0.576$, $p < .001$), nascence ($r = 0.281$, $p = 0.003$), planned permanence ($r = 0.226$, $p = 0.017$), and turnover ($r = 0.575$, $p = < .001$). This suggests that collaborations with a larger number of people involved more asynchronous play, a larger variety of communities, developing procedures/goals, were more long-term, and involved more people joining/leaving.

Number of communities of practice was positively correlated with scale ($r = 0.576$, $p < .001$), planned permanence ($r = 0.217$, $p = 0.022$), and turnover ($r = 0.494$, $p < .001$). This suggests that collaborations that involved a larger number of communities tended to involve a larger number of people, were more long-term, and involved more people joining/leaving.

Nascence was positively correlated with synchronicity ($r = 0.204$, $p = 0.032$), scale ($r = 0.281$, $p = 0.003$), and turnover ($r = 0.333$, $p < .001$), suggesting that developing collaborations in Minecraft tended to use more asynchronous collaboration styles, be larger, and involve more members joining/leaving.

Planned permanence was positively correlated with scale ($r = 0.226$, $p = 0.017$), number of communities of practice ($r = 0.217$, $p = 0.022$), and turnover ($r = 0.302$, $p < .001$). This suggests that more long-term, stable collaborations tended to involve a larger number of people, a more diverse variety of people, and involve more members joining/leaving.

Finally, *turnover* was positively correlated with synchronicity ($r = 0.192$, $p = 0.043$), scale ($r = 0.575$, $p = < .001$), number of communities of practice ($r = 0.494$, $p < .001$), nascence ($r = 0.333$, $p < .001$), and planned permanence ($r = 0.302$, $p < .001$). This suggests that collaborations with more members joining/leaving involve more asynchronous play styles, a larger number and variety of people, a collaboration style/process that is still developing rather than established, and tend to be more long-term.

Next, we review the relationship between measures of social connection and MoCA features. There were no correlations between bonding social capital and any of the MoCA variables. However, there was a positive correlation between bridging social capital and scale ($r = 0.198$, $p = 0.038$), suggesting that bridging social capital increased as the group size of the creative Minecraft collaboration increased. As well, there was a positive correlation between bridging social capital and the the number of communities of practice ($r = 0.230$, $p = 0.015$). Both of these results are reasonable given that a larger group size and a larger number of communities of practice would increase opportunities to meet new people and expand player worldviews. There were no correlations between IOS and any of the MoCA variables.

Finally, we review the relationship between measures of creativity and MoCA features. There was a positive correlation between CSI and physical distribution ($r = 0.187$, $p = 0.050$), suggesting that a higher creativity support rating was related with more online play. There were no correlations between SSCS and any of the MoCA variables. Finally, there was a positive correlation between personal creativity rating and scale ($r = 0.221$, $p = 0.020$), as well as personal creativity rating and number of communities of practice ($r = 0.237$, $p < .012$), which suggests that people who rated themselves as being more creative in their Minecraft experiences tended to be associated with larger collaborations that involved more diverse members. Overall, the relationship between social connection, creativity, and MoCA variables appears complex and requires further study.

4.3 Multiple Regression

Multiple regression analysis was performed using the data with the specific aim of exploring the relationship between all three creativity measures (CSI, SSCS, and personal creativity rating) and each of the social connection measures (bonding social capital, bridging social capital, and IOS). This resulted in three different equations,

one for each of the social connection measures.

Table 4.5

Multiple Regression

		B	t	*p*	R^2
SC Bonding				<.001	0.179
	Creativity Support Index (CSI)	0.384	2.04	0.009	
	Short Scale of Creative Self (SSCS)	0.381	2.30	0.023	
	Personal Creativity Rating	-0.239	-1.45	0.149	
SC Bridging				<.001	0.428
	Creativity Support Index (CSI)	0.1415	1.324	0.188	
	Short Scale of Creative Self (SSCS)	0.6447	5.283	<.001	
	Personal Creativity Rating	0.0609	0.503	0.616	
IOS Scale				.013	0.0948
	Creativity Support Index (CSI)	0.0176	1.323	0.189	
	Short Scale of Creative Self (SSCS)	0.0139	0.919	0.360	
	Personal Creativity Rating	0.0143	0.952	0.343	

The results of this analysis indicate that when all three creativity measures are used to predict bonding social capital, CSI significantly and most strongly predicts bonding social capital ($B = 0.384$, $p = 0.009$), followed by SSCS ($B = 0.381$, $p = 0.023$), which also significantly predicts bonding social capital. Personal creativity rating does not predict bonding social capital ($B = -0.239$, $p = 0.149$) when the other creativity measures are included.

When all three creativity measures are used to predict bridging social capital, SSCS ($B = 0.645$, $p = <.001$) significantly and most strongly predicts bridging social capital. Neither CSI ($B = 0.142$, $p = 0.188$) nor the personal creativity rating ($B = 0.0609$, $p = 0.616$) predict bridging social capital when the other creativity measures are included in the model.

Neither CSI ($B = 0.0176$, $p = 0.189$), SSCS ($B = 0.0139$, $p = 0.360$) nor personal creativity rating ($B = 0.0143$, $p = 0.343$) predict IOS scores when all three creativity measures are included in the model.

4.4 Mediations of CSI on Prediction of Social Capital by SSCS

4.4.1 Mediation 1: Bonding Social Capital

Exploratory investigation using mediation analysis was conducted to determine whether the observed relationship between SSCS and social capital was mediated by the CSI rating for Minecraft.

We conducted a mediation analysis with bonding social capital as an outcome, SSCS as a predictor, and CSI as a mediator.

Table 4.6

Mediation Analysis of the Effect of SSCS on Bonding Social Capital through CSI

				95% *CI*			
Effect	Path	*B*	*SE*	Lower	Upper	*Z*	*p*
Total	SSCS → SC Bonding	0.436	0.118	0.204	0.667	3.69	<.001
Indirect	SSCS → CSI → SC Bonding	0.192	0.077	0.040	0.343	2.48	0.013
Direct	SSCS → SC Bonding	0.244	0.135	-0.021	0.509	1.81	0.071

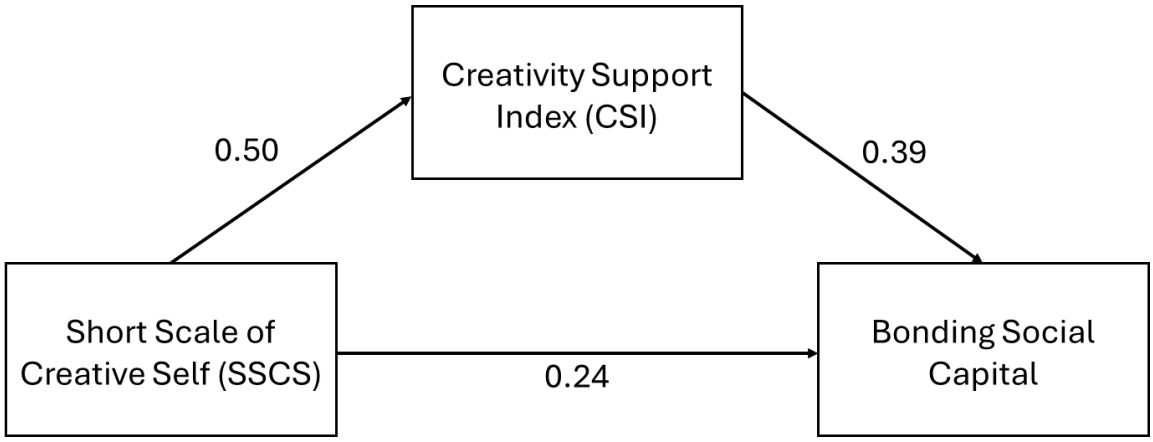


Figure 4.17. Mediation model with SSCS, CSI, and bonding social capital.

This study found that CSI mediates the relationship between SSCS and bonding social capital. There were positive and significant relationships between each of these

measures in the correlation analysis (see Table 4.4). When mediation analysis was applied (see Table 4.6), there was a significant total effect ($B = 0.436$, $p = <.001$) of SSCS on bonding social capital. There was also a significant indirect effect ($B = 0.192$, $p = 0.013$) of SSCS on bonding, mediated by CSI. Because the direct effect ($B = 0.244$, $p = 0.071$) was no longer significant when CSI was included as a mediating variable, this indicated a fully mediated relationship between SSCS and bonding social capital through CSI. Figure 4.17 shows the path estimates. Overall, these results suggest that CSI is more relevant when it comes to predicting bonding social capital than SSCS on its own.

4.4.2 Mediation 2: Bridging Social Capital

We conducted a mediation analysis with bridging social capital as an outcome, SSCS as a predictor, and CSI as a mediator.

Table 4.7

Mediation Analysis of the Effect of SSCS on Bridging Social Capital through CSI

				95% *CI*			
Effect	Path	*B*	*SE*	Lower	Upper	*Z*	*p*
Total	SSCS → SC Bridging	0.750	0.0842	0.585	0.915	8.91	< .001
Indirect	SSCS → CSI → SC Bridging	0.0703	0.0534	-0.0343	0.175	1.32	0.188
Direct	SSCS → SC Bridging	0.680	0.0985	0.487	0.873	8.91	< .001

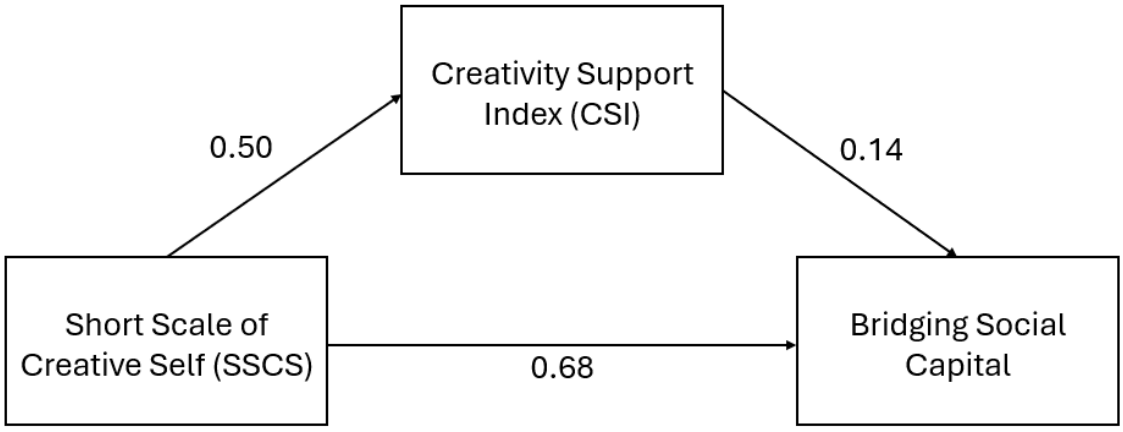


Figure 4.18. Mediation model with SSCS, CSI, and bridging social capital.

This study found that CSI does not mediate the relationship between SSCS and bridging social capital. There were positive and significant relationships between each of these measures in the correlation analysis (see Table 4.4). When mediation analysis was applied (see Table 4.7), there was a significant total effect ($B = 0.750$, $p = < .001$) of SSCS on bridging social capital. The direct effect remained significant ($B = 0.680$, $p = < .001$) when SSCS was included as a mediating variable. However, the indirect effect was not significant ($B = 0.0703$, $p = 0.188$), suggesting that CSI does not mediate the relationship between SSCS and bridging social capital. Figure 4.18 shows the path estimates. Overall, these results reinforce the finding that SSCS is more relevant when it comes to predicting bridging social capital than CSI.

4.5 Exploratory Moderations

We additionally conducted exploratory moderation analyses to determine whether the observed relationship between the support for creativity within Minecraft (i.e., CSI) was moderated by the MoCA dimensions. If significant, it would suggest that the type of collaboration influenced whether the creativity support of the tool translated into social capital.

4.5.1 Moderation 1: Bonding Social Capital

We conducted a moderation analysis with bonding social capital as an outcome, CSI as a predictor, and planned permanence as a moderator.

Table 4.8

Moderated Regression Predicting Bonding Social Capital from CSI, Planned Permanence, and Their Interaction

Predictor	*B (Estimate)*	*SE*	*Z*	*p*
Creativity Support Index (CSI)	0.506	0.122	4.161	$< .001$
Planned Permanence	-10.221	11.340	-0.901	0.367
CSI x Planned Permanence	1.656	0.770	2.150	0.032

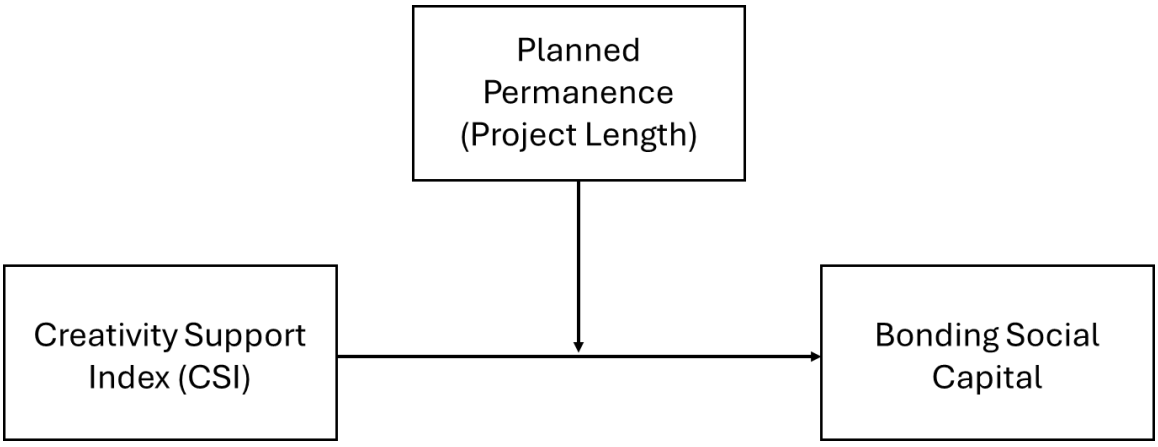


Figure 4.19. Moderation model with CSI, planned permanence, and bonding social capital.

Table 4.9

Simple Slopes of CSI Predicting Bonding Social Capital at Levels of Moderator Planned Permanence

Level of Planned Permanence	*B*	*SE*	*Z*	*p*
Low (-1 SD)	0.284	0.168	1.69	0.091
Mean (0 SD)	0.506	0.124	4.10	$< .001$
High (+1 SD)	0.729	0.155	4.71	$< .001$

As shown in Table 4.8, we found that planned permanence significantly moderated the relationship between CSI and bonding social capital. Simple slopes analyses revealed that the relationship between CSI and bonding social capital was stronger at higher levels of planned permanence (+1 SD: $B = 0.729$, $p =< .001$; mean: $B = .506$, $p < .001$; -1 SD: $B = 0.284$, $p = 0.091$). Participants whose collaborations had higher planned permanence, measured here by project length, experienced greater gains in bonding social capital with increasing CSI. The moderation model is shown in Figure 4.19 and the simple slopes analysis is shown in Table 4.9.

4.5.2 Moderation 2: Bridging Social Capital

We conducted a moderation analysis with bridging social capital as an outcome, SSCS as a predictor, and scale as a moderator.

Table 4.10

Moderated Regression Predicting Bridging Social Capital from SSCS, Scale, and Their Interaction

Predictor	*B (Estimate)*	*SE*	*Z*	*p*
Short Scale of Creative Self (SSCS)	0.71078	0.08174	8.70	$< .001$
Scale	0.07617	0.04379	1.74	0.082
SSCS x Scale	-0.00818	0.00327	-2.50	0.012

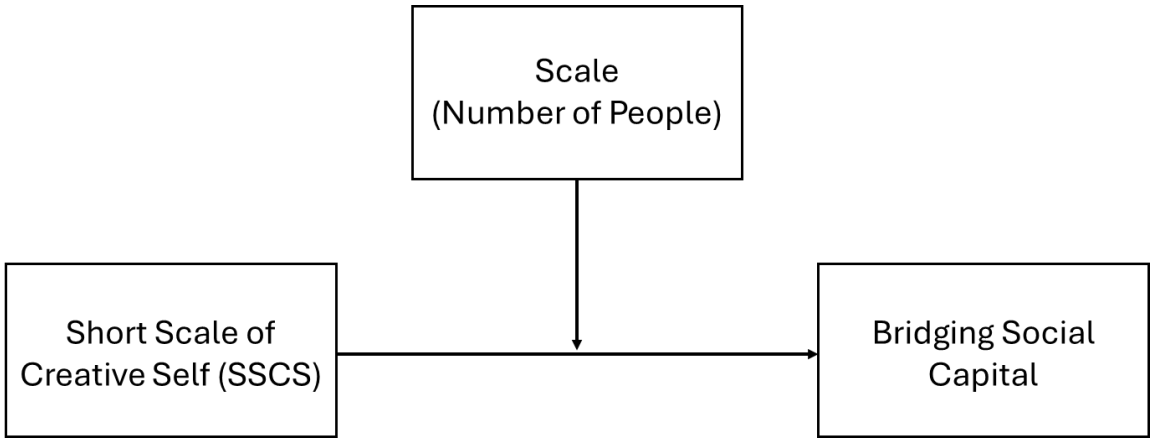


Figure 4.20. Moderation model with SSCS, scale, and bridging social capital.

Table 4.11

Simple Slopes of SSCS Predicting Bridging Social Capital at Levels of Moderator Scale

Level of Scale	*B*	*SE*	*Z*	*p*
Low (-1 SD)	0.915	0.1141	8.01	$< .001$
Mean (0 SD)	0.711	0.0840	8.46	$< .001$
High (+1 SD)	0.507	0.1215	4.17	$< .001$

As shown in Table 4.10, we found that scale moderates the relationship between SSCS and bridging social capital. Simple slopes analyses revealed that the relationship between SSCS and bridging social capital was stronger at lower levels of scale (-1 SD: $B = .915$, $p < .001$; mean: $B = .711$, $p < .001$; +1 SD: $B = .507$, $p < .001$). Participants whose collaborations had lower scale, measured here by number of people they collaborated with, experienced greater gains in bridging social capital with increasing SSCS. The moderation model is shown in Figure 4.20 and the simple slopes analysis is shown in Table 4.11.

Overall, the results support the existence of a relationship between creativity (as measured by CSI, SSCS, and personal creativity rating) and social connection (as measured by bonding social capital, bridging social capital, and IOS). As well, CSI appears to play a more important role in the relationship between creativity and bonding social capital, while SSCS appears to play a more important role in the

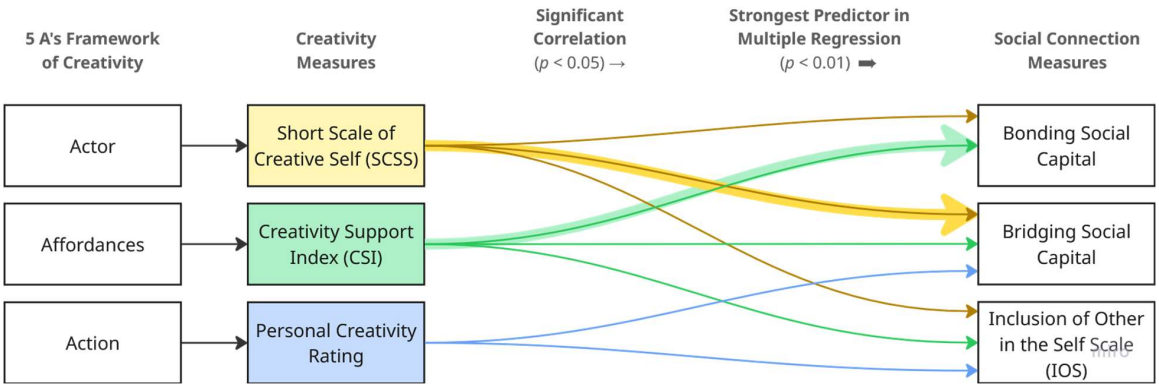


Figure 4.21. Overview of relationships among the dimensions of the 5 A's framework of creativity, creativity measures, and social connection measures. Thin arrows denote significant correlations ($p < 0.05$), while thick arrows indicate the strongest significant predictor of each social connection measure in multiple regression analyses ($p < 0.01$).

relationship between creativity and bridging social capital. Figure 4.21 provides a visual overview of the quantitative results.

Chapter 5

Qualitative Results

This chapter presents the qualitative results of our study. Our quantitative results indicated an association between creativity and social connection. In this section, we present results that provide insights into how this relationship is experienced and shaped in practice, highlighting factors that participants perceived as contributing to or undermining social connection within a collaborative creative digital environment. Our analysis identified several phases of the creative process relevant to social connection—problem-finding, brainstorming, and implementation—as well as factors that influenced connection and disconnection within each phase. Although these phases have overlaps in practice, they are presented separately in our findings to clarify how different factors operated across phases. The factors we identified are: *Unity*, *Agency*, *Playfulness*, and *Achievement*. Figure 5.1 provides a visual overview of the qualitative results.

5.1 Phases of the Creative Process and Factors that Facilitate Social Connection/Disconnection

This section will first describe the phases of the creative process we identified, and then how they are relevant to each factor. As will be discussed further in the individual factor sections, each creative phase contributed to increased social connection, as expected, but each phase *also* contained potential conflict points—failure to resolve these issues led to increased social *disconnection*, pushing participants further apart

rather than closer together.

5.1.1 Creative Phase Descriptions

Problem-finding is the phase in which participants establish the project's guiding goal. This goal can be more procedural (e.g., building an optimally defensive castle) or it can be more self-expressive (e.g., designing a dream house).

The *brainstorming* phase consists of three main stages: idea generation, idea combination, and idea selection [76]. In this phase, participants discuss, explore, refine, and combine ideas before selecting those they will implement. Although brainstorming frequently involves material experimentation in practice, we focus here on its conceptual and verbal dimensions to clarify how factors operated within this phase.

The *implementation* phase is the phase in which conceptual/verbal ideas are applied to the actual physical (or digital) world. Participants explore, experiment, and transform using their tools and materials, turning ideas into reality. During this stage, participants collaborate on actual artifacts; in Minecraft, this usually involves creating 3D structures and modifying the shared world.

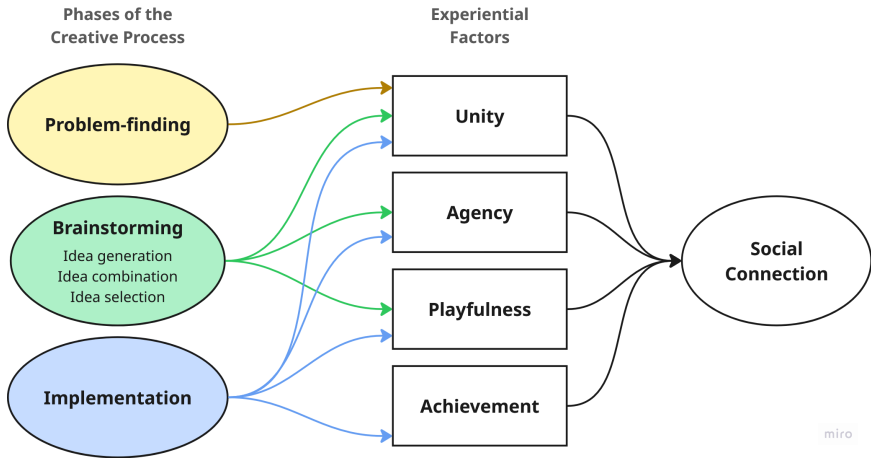


Figure 5.1. Overview of the relationships between creative phases and experiential factors.

5.1.2 *Unity*

Based on our data analysis, we define the factor *Unity* as a sense of "we-ness" that is created through the formation of shared interpersonal boundaries. This definition is similar to that described by Rouse [74]. Through the transition from "mine" to "ours", individuals develop the feeling of being a team (i.e., one entity rather than separate parts). Increased *Unity* was largely associated with increased social connection (except in cases where a commitment to overall group cohesiveness led to a specific individual feeling like they no longer belonged), while decreased *Unity* was associated with greater social disconnection. In our analysis, we found *Unity* is relevant within the creative phases problem-finding, brainstorming, and implementation.

Phase: Problem-finding

In the problem-finding phase, *Unity* was primarily operationalized as the groups' ability to decide on a common goal. Twenty-eight of 111 participants emphasized the importance of a shared goal or common ground in bringing them together and making them feel like a group rather than a collection of individuals. They explained that *"we all worked towards a common goal so we relied on each other and this made me feel like a part of the team"* (P5), and *"working with other people to complete a goal (whether it's fighting, gathering or building) makes me feel really connected to the guys I play with"* (P99). The shared goal also provided mutual rules of engagement (i.e., the meta-game); this is especially important since Minecraft's open-ended structure offers many options for play (e.g., deciding to build bases and attack each other; recreating famous real-world structures; mutually collaborating on a castle and defending it from built-in enemies). Collaborations (i.e., group cohesiveness) fell apart or faced serious difficulties if the initial goal could not be decided on. Several participants (n = 14) linked project goal disagreement to social disconnection and others (n = 15) described a lack of shared vision as leading to disconnection. For example, when asked what made them feel socially disconnected, P71 reported: *"It would definitely be when we [don't] agree on anything. When we all have different ideas and [don't] want to accept just one plan."* Remaining stuck in this state of creative limbo impeded project progress, leading to further dissatisfaction and disconnection—*"At worst, I would say that we sometimes disagree on what to work on and end up spending more time planning something than actually doing something"* (P15). However, if the shared or common goal is established, the group can typically move on to the next phase of the

creative process.

Phase: Brainstorming

Participants indicated that the brainstorming phase generated feelings of *Unity* through sharing ideas and then combining them, an iterative process made possible by the presence of the joint goal. Thirty-eight of 111 participants linked sharing ideas to social connection; others highlighted idea combination (n = 8) and idea selection (n = 5). For example, P98 expressed that: *"Sharing ideas with each other and finding ways to connect them in the game is what makes me feel the most connected"* and noted the significance of *"being able to incorporate our different styles into a cohesive design"*. This process was conducted primarily through communication channels such as text chat (n = 7), which is built into Minecraft, or voice chat (n = 13), with several participants explicitly mentioning Discord as a platform for voice communication (n = 6). Overall, 22 of 111 participants highlighted the importance of being able to talk (in some fashion) as an important aspect of their experience. Conversely, roadblocks or interruptions to the brainstorming process led to disconnection. One player reported feeling more distanced from fellow players *"if our ideas aren't working well together or don't combine well to work towards our end goal"* (P53). Disconnection could also result through *"disagreeing on what way we should create a structure"* (P46) and *"differences in opinion on choice of color, design and make of the town"* (P82), suggesting that rigid adherence to personal ideas during design disagreements can result in a failure to reach a sense of synchrony (n=12). Conversely, P10 reported: *"Most importantly, if we did not say what we thought or how we felt, it made us feel like we shared a world but were not really connected"*, indicating that despite the potential for conflicts, it was important for group cohesion that every team member shared their ideas. Whereas problem-finding builds *Unity* by establishing a shared goal, brainstorming supports more in-depth discussion of project details, fostering cohesion as group members resolve conflicts and synthesize ideas into a unified plan.

Phase: Implementation

In the implementation phase, it was the actual process of building, of co-creation on the same artifact through laying blocks or collecting resources, that led to a sense of togetherness. Twelve of 111 participants linked implementation to increased social connection; others mentioned working together or collaboration (n = 17), and shared time, experiences, and memories (n = 15). This was unlike the brainstorming phase,

where *Unity* was created through the merging of conceptual/abstract ideas. In this phase, P1 reported, *"I feel closer to my friends when we have major ideas that we decide to put into reality, which makes us feel connected"* and P70 explained they *"felt socially connected as we collaborated on what to do and actually building the structures"*. As well, several participants linked social connection with the sense of being a team (n = 6), while others said the same for shared effort and engagement (n = 5) and shared ownership (n = 3). On the other hand, disconnection resulted from a lack of cohesion during the building process, caused by factors such as isolation (n = 8), communication problems (n = 27), and an individual making changes without consulting the rest of the group (n = 17). For example: *"A player began altering the town design independently without consulting the group members. The situation resulted in frustration since teammates had already dedicated work on areas that needed rebuilding or modifying"* (P34) and *"I felt socially disconnected when communication broke down, especially when people started working on separate projects without coordinating with the group"* (P23). Other factors included imbalanced commitment—*"Sometimes some of our friends don't want to come online and spend time with us, which makes us unhappy. We work as a team and I feel that if we're all not playing, we are not edging toward to ultimate goal of finishing what we've started, together"* (P50)—and *"uneven participation, when some players dominate the project while others are left out or ignored"* (P5). Overall, these examples show that, although the creative process can lead to social disconnection, it offers rich opportunities to strengthen bonds when group members are mutually engaged and able to communicate and resolve conflicts.

5.1.3 *Agency*

Based on our data analysis, we define the factor *Agency* as being recognized as an autonomous individual within the group by both oneself and others. This involves a perception of being able to make meaningful changes to the project and believing personal ideas are being represented in the whole. It is reinforced by a sense of inclusion and the feeling that personal contributions are appreciated by the team. Increased *Agency* was largely associated with increased social connection (except in cases where individual agency led to a decrease in overall group cohesiveness), while decreased *Agency* was associated with greater social disconnection. In our analysis, we found *Agency* is relevant within the creative phases brainstorming and implementation.

Phase: Brainstorming

In the brainstorming phase, people felt closer to others by expressing their individual agency through sharing ideas (n = 38) and then feeling heard, seen, and supported when their individual agency was recognized by fellow group members (n = 11). In contrast to the implementation phase, this occurred through conceptual/verbal ideation as opposed to the construction of digital artifacts. However, as mentioned previously, the boundaries between these two phases are blurred in practice, since conceptual ideas manifest themselves as actions within the shared world (e.g., the conceptual idea of building a medieval village with a castle, a marketplace, and a defensive wall is translated into actual structures through resource collection and building activities). Feeling closer through brainstorming could be achieved through positive reinforcement or even critique in response to the expression of ideas: *"One moment that made me feel connected was when a teammate complimented my building design and suggested an improvement that made it even better. We laughed, shared ideas, and hyped each other up"* (P68). Another participant noted, *"I feel socially connected when I feel like my ideas are heard and valued. It doesn't necessarily mean my idea is accepted, but just that my idea was taken into consideration by others"* (P70). Conversely, disconnection occurred if a team member felt left out or disregarded during the ideation process (n = 5). One person noted that they felt disconnected *"when you give an idea and it was a bit shunned out"* (P2), while another responded, *"when people don't want to consider my ideas and only want to do what they think of—then it's one sided and not collaborative and that is pretty frustrating as it should be a group effort with equal contributions"* (P76). These are threats to a specific individual group member's agency (e.g., "*I* feel left out of the group") as opposed to challenges to the general group sense of unity (e.g., "*We* don't feel like a team").

A note on Unity vs. Agency: Threats to *Unity* occurred in the brainstorming phase when there was a failure to reach consensus on next steps or there was a sense that not everyone was participating in idea sharing, and they occurred in the implementation phase when a group member went rogue and implemented something the team did not agree on. It is important for increased social connection that the group reaches agreement on the ideas they wish to implement (*Unity*), but it is equally important that each group member feels represented and heard during the brainstorming process (*Agency*)—this may lead to conflict if players have differing opinions, but it is through resolving these disagreements that group members feel closer to each other. Group members need to both take into account ideas of others (i.e., to foster *Unity*

through idea combination) and share their own ideas (i.e., to foster *Agency* through self-expression) in order to create optimal conditions for connections to form.

Phase: Implementation

In the implementation phase, social connection was facilitated through individuals feeling like they could make meaningful contributions during the actual building of the structures. This is in contrast to the brainstorming phase, where individual agency is expressed through sharing conceptual/abstract ideas, usually through words; in the implementation phase, agency is expressed through action. Seven of 111 participants linked acknowledgement of their contributions to social connection. P41 described the experience as *"feeling appreciated when my friends praised my building designs and incorporated them into the city. It created a sense of camaraderie and shared ownership."* In this case, a player's agency is reinforced through group members recognizing their contribution and changing their own actions in response. *Agency* was also supported by other people contributing progress towards a player's own ideas, such as, *"what made me feel socially connected during the collaboration was knowing that these random people on the internet who I called my friends and acquaintances wanted to help bring my vision to life, and help create my dream home"* (P63). Practically, this was supported through task division, which allowed each individual to contribute something meaningful to the whole—many participants (n = 47) mentioned divided or specialized tasks as part of their creative process. On the other hand, several participants (n = 20) described disconnection as resulting from feeling excluded, undervalued as an individual, or like individual contributions had been made irrelevant. This included *"if somebody, even accidentally, demolished something you were working on or uses a space you were planning to use that is very frustrating and you feel you've not been considered"* (P66), and *"I felt disconnected when there were miscommunications about the build. One frustrating moment was when a friend unexpectedly changed part of a structure I had been working on without discussing it first"* (P25). As well, perceived disrespect, such as *"when someone takes my resources or [intrudes] into my space while working"* (P101) and feeling left out, such as *"when you log on and see how some things have been built without you"* (P96) contribute to disconnection. Once more, just as in the brainstorming phase, the tension between *Unity* and *Agency* is highlighted—group actions should be directed towards the common goal (supporting *Unity*), but can lead to disconnection if any individual does not feel included in the implementation process (failing to support

Agency); ultimately, balance is the key.

5.1.4 *Playfulness*

Based on our data analysis, we define the factor *Playfulness* as the experience of having fun and being whimsical. It can be generated through exploring options, trying things out, laughing, bantering, and being curious while having less concern for optimal outcomes. Increased *Playfulness* was largely associated with increased social connection (except in cases where one individual's sense of fun—such as deliberate destruction of artifacts—resulted in other group members experiencing negative emotions), while decreased *Playfulness* was associated with greater social disconnection. In our analysis, we found *Playfulness* is relevant within the creative phases brainstorming and implementation.

Phase: Brainstorming

Many participants (n = 23) indicated that another important factor for social connection was having fun, including throughout the brainstorming process. *"It wasn't just about building stuff; it was the fun moments we shared while planning things out,"* said P4. Several participants (n = 16) described this as emerging in forms such as banter, humour, and laughter. As well, participants used strategies for adding playfulness and whimsy to their idea generation process—for example: *"We made a series of building[s] purely using our imagination and the randomizer. We ended up with such a [hodgepodge] of buildings with weird attributes that we decided to call the kingdom of heisenberg (inside joke)"* (P91). On the other hand, several participants (n = 11) mentioned that disengagement or disagreement during the idea generation phase decreased enjoyment and fun. P86 indicated they felt socially disconnected when *"I was unable to contact people when I wanted advice or to suggest new ideas"* or "*if someone disagreed with one of my proposals"*. Playfulness could also be negatively affected if "*the other person swore a lot, [was] rude or [didn't] follow instruction*" (P65) or if *"someone is trolling"* (P100). This emphasizes the importance of lightheartedness, exploration, and acceptance while generating, combining, and selecting ideas.

Phase: Implementation

Playfulness also tied people together during the implementation phase. P15 described how *"playing the game with my friends [lets] me forget about the real world for a while, and gives me time to goof off"*, highlighting the importance of the lowered stakes of the game compared to the real world (n = 6). The sense of fun created through shared jokes and whimsy, as well as other shared positive emotions like joy, led to a bonding experience (n = 23). Creating together could also lead to a feeling of flow and of being in the moment: *"Enjoying the time together whether [it's] strangers or closer people that [I] know [it's] all about the experience and being in the moment whether [it's] fishing hunting playing a modded world each of the tasks are really enjoyable and fun with the people you know you can be in the moment with and have a good time!"* (P30). P111 noted that the goal of their Minecraft experience was *"just going on an adventure together :)"*. However, this only worked as long as all team members perceived the playfulness as positive—participants (n = 11) indicated that disconnection could result from disagreeable behaviour, such as *"taking the game too seriously. Sometimes we can take the jokes too far which make you feel frustrated and angry especially if your team is [losing]"* (P27) and *"when someone takes a [joke] too far and almost kills you bahah"* (P105). Sometimes this included deliberate destruction, which entertained only the player engaging in it, rather than the entire team—*"Sometimes it's frustrating when my friends destroy important parts of our base, just for a laugh. Especially something we worked on for a while and they act like they don't care"* (P57). Playfulness tended to overlap in brainstorming and implementation since players used voice chat to discuss ideas and comment on events while interacting with the shared world and building structures. This might present as making a joke or laughing in response to an action that has just occurred, or making a silly suggestion about what to try next.

5.1.5 *Achievement*

Based on our data analysis, we define the factor *Achievement* as the experience of accomplishing goals. It can arise through bringing a personal vision into reality, improving skills, solving problems, or generally continuing on in the face of adversity. Increased *Achievement* was largely associated with increased social connection (except in cases where the achievement of one group member came at the cost of another team member not meeting their goals), while decreased *Achievement* was associated with greater social disconnection. In our analysis, we found *Achievement* is relevant within

the creative phase implementation.

Phase: Implementation

A mutual sense of accomplishment led to bonding during the implementation phase. This theme expressed itself in two main ways: through the achievement of goals the group had set for themselves (n = 43) and through the process of learning/teaching (n = 11). P48 described their experience of group goal achievement, noting the benefit of shared positive emotions: *"When we finished the castle, we all gathered to admire it, take screenshots, and plan the next project, feeling proud and excited together."* As well, both learning—*"The closeness I experience would be learning from my friend during this time. He'd played the mod before and I hadn't, so he took the time to teach me how to play. It was a great experience [as] we laughed and learned the new mod"* (P18), and supporting the skill development of others—*"My children are quite happy when I play the game with them. It's quite fun to see them engage with a game that isn't just about combat and I enjoy fostering their creative side and sometimes just sitting back and watching what they come up with"* (P17) resulted in increased closeness. However, *failing* to achieve goals could lead to disconnection. This could be because the game was too difficult for player ability, leading to frustration while learning skills and the player feeling unable to contribute (n = 17). P91 elaborated, *"my current world spawned me on top of a tree, and I had to be careful trying to jump down otherwise I take fall damage. I generally have a lot of trouble with survival series, and I asked my friend for help with this. They started to get really frustrated when I wasn't able to get it right away, and that really ruined the fun. I didn't do a lot of survival series after that."* The lack of skill of *other* players could also lead to disconnection, such as *"if there's anyone who doesn't play the game obviously it would slow down the process and gamers would generally feel disconnected when playing or creatively collaborating"* (P9) or if something otherwise got in the way of goal progression (n = 6), such as *"[I] would feel disconnected when something [didn't] go right, if someone [didn't] put something where it needs to be, or if they [didn't] help follow instructions or listen. And things go wrong"* (P22). Finally, the negative comparison of self to others could also impair social connection (n = 6), as indicated by P54, who said, *"I feel I don't contribute as much as the others at times. I feel like compared to them my building and imagination skills aren't as good"* and P95, who said that both *"having the others progress quicker than me, or have better ideas than what I was having"* made them *"not want to carry on playing*

at times". In the implementation phase, *Achievement* needs to be balanced with *Playfulness*—it is important that the game provides enough challenge so that players feel accomplished when goals are reached, but the stakes need to be low enough and the controls simple enough that the consequences of failure do not inhibit players from engaging in lighthearted exploration.

Chapter 6

Discussion

This chapter provides a summary of our key results, followed by a description of three main design implications (based on the design of Minecraft, existing research, and our qualitative results), and a list of seven general design recommendations. It closes with a discussion of the study's limitations and suggestions for future work.

6.1 Summary of Results

Overall, our findings support a relationship between creativity and social connection within Minecraft, using both quantitative and qualitative research methodologies. The following sections describe the answers to our research questions.

6.1.1 Research Question 1

What is the relationship between creativity and social connection in Minecraft (i.e., an existing digital system designed to support creativity)?

Our results show significant correlations between each of the creativity measures and each of the social connection measures (except for bonding social capital and personal creativity rating), providing general support for an overall relationship between the two constructs in the context of Minecraft. Additionally, we found that creativity support of the tool (as measured by CSI) was the strongest predictor of *bonding* social capital while creative self-perception (as measured by SSCS) was the strongest predictor of *bridging* social capital. This difference is further supported by the results of our mediation analysis—the creativity support of the tool (CSI) medi-

ates the relationship between creative self-perception (SSCS) and social connection for *bonding* social capital but not for *bridging* social capital, further emphasizing that the creativity support of the tool is associated more with the development of close ties rather than weaker and more distant ones.

6.1.2 Research Question 2

What are people who collaborate in Minecraft's perceptions of how collaborative creativity contributes to their experiences of social connection/disconnection?

Through our qualitative analysis, we found that there were three phases of the creative process (problem-finding, brainstorming, and implementation) that contributed to participants' experiences of social connection, as well as four factors (*Unity*, *Agency*, *Playfulness*, and *Achievement*) that shaped the relationship between collaborative creativity and social connectedness, bringing people either closer together if they were present or further apart if they were absent. Each phase of the creative process appeared to provide opportunities for increased social connection if specific challenges were successfully met (e.g., problem-finding—deciding on a mutually satisfying joint goal; brainstorming—successfully integrating ideas from each of the group members; implementation—navigating construction conflicts and producing a unified project). Problems often resulted from a threat to one of the four factors. These findings, in combination with our quantitative results, support our view that designing to support collaborative creativity (especially the phases problem-finding, brainstorming, and implementation) is a potentially useful strategy for building systems to support social connection, and provide insights into how systems could be implemented in practice (by taking into account the factors *Unity*, *Agency*, *Playfulness*, and *Achievement*).

6.2 Design Implications

In this section, we will discuss *how* to support social connection in future relatedness technologies through features that foster collaborative creativity by exploring how our qualitative results, prior work on creativity support tools, and the affordances of Minecraft can be synthesized to provide general design implications. Overall,

we provide three high-level suggestions: 1) Provide explicit support for the creative phases of problem-finding, brainstorming, and implementation, 2) Balance the tension between *Unity* and *Agency*, and 3) Balance the tension between *Playfulness* and *Achievement*.

6.2.1 Explicitly Support the Creative Phases of Problem-finding, Brainstorming, and Implementation

Participants mentioned aspects of problem-finding, brainstorming, and implementation while describing their experiences of social connection and disconnection during collaborative creativity in Minecraft, suggesting that designing to explicitly support each these phases is a useful potential strategy for fostering social connection through digital systems. For example, participants mentioned the crucial importance of having a shared goal (which is formed through the process of problem-finding), the benefits of engaging in the brainstorming process together (from sharing ideas and being validated by their fellow group members), and the bonds created through implementing a project from start to finish as a team (through shared time, mutual effort, and a sense of group accomplishment). It is worth noting that engaging in the creative process did not universally support connection; instead, it appears that it offers opportunities to become closer, with actual outcomes dependent on how conflicts and tensions within each phase are resolved. These conflicts often arise due to tensions related to the factors *Unity*, *Agency*, *Playfulness*, and *Achievement*. The following sections offer general suggestions for explicitly facilitating problem-finding, brainstorming, and implementation based on the design of Minecraft, existing research on supporting creativity in digital systems, and our qualitative results.

Problem-finding

Problem-finding is crucial for settling on a shared group goal (or common ground), which participants frequently described as a factor that positively contributed to social connection. This relationship (between common ground and social connection) is also frequently mentioned in the existing literature [52, 3, 24]. Minecraft supports the problem-finding phase through its open-ended sandbox nature, allowing players to select their own personally meaningful goals while providing scaffolding to prevent paralyzing indecisiveness (e.g., through the obvious goals of mine, craft, build, and survive) [23]. Prior Autcraft research similarly finds that Minecraft's environment

provides many avenues for self-expression while providing constraints that enhance creativity [70]. This aligns with the creativity support tool principle "wide walls", which advocates for offering diverse options so users with different play styles or interests can find a project direction that engages them [65]. In our study, we find that such design elements enable groups to select a shared goal that satisfies all members, which is important for *Unity* (as mentioned in Section 5.1.2) and provides the context for the subsequent stages of the creative process.

Brainstorming

Participants highlighted the importance of brainstorming (generating, combining, and selecting ideas) before and during creative implementation for building social connection. It helps merge the ideas of individual players into a unified whole (*Unity*), enables self-expression (*Agency*), and encourages light-hearted "what-if" exploration (*Playfulness*) (Sections 5.1.2–5.1.4). Brainstorming is a process used for exploring potential solutions before committing to implementation (which often takes more time and resources); it is often conducted through verbal discussion or visual mediums such as sketching [83]. Minecraft supports in-depth idea generation by having a large design space (e.g., many types of blocks, crafted materials, entities like farm animals and monsters, and procedurally generated environments) that gives users many options to explore [23]. However, it provides limited formal support for engaging in the process of brainstorming (e.g., text chat only). While participants most commonly used voice chat for ideation, this relies on external platforms such as Discord. Integrating voice chat directly into Minecraft could better support brainstorming without requiring peripheral applications. Additionally, previously explored features for ideation, such as displaying all previous ideas visually or allowing participants to share ideas in parallel [79], could be worth integrating to mitigate some of the brainstorming problems mentioned by players (e.g., not being heard). Digital applications that contain similar features include virtual whiteboard tools such as Miro and collaborative document editing tools such as Google Docs and Google Slides.

Implementation

Finally, the implementation phase provided an opportunity for participants to spend time co-creating, which was frequently mentioned as leading to social connection. Minecraft supports the implementation phase by providing tools and materials that

enable users to create artifacts and transform the environment within the system itself [68], encouraging active engagement in creative collaboration. This phase showed evidence of all four factors, supporting social connection by motivating players to spend time and mutual effort on a shared project (*Unity*), allowing each user to make meaningful contributions (*Agency*), encouraging humour through playful actions and unexpected outcomes (*Playfulness*), and providing an arena for accomplishing group goals together (*Achievement*) (Sections 5.1.2–5.1.5). Other research also highlights how engaging in the joint production of creative artifacts supports social connection; a digital crafting activity provided a "ticket-to-talk" for children and grandparents by establishing a context for conversation [52], and the process of building a custom platform for archiving written fanworks led to the development of a community of practice [24]. Overall, we argue that Minecraft's strongest feature that contributes to social connection through creative collaboration is its integration of the implementation phase directly into the system. This distinguishes it from many other social and creative platforms, such as those that support community formation through sharing and commenting on creative artifacts (e.g., fanfiction archives [30], Facebook groups [56], Thingiverse [12]). Allowing users to modify a system to better suit their needs is a core tenet of Fischer's meta-design theory, which emphasizes enabling systems to evolve through user creativity after their deployment [25]. This aligns with the creativity support tool principle "design for designers" which encourages developers to include options that allow their users to design, create, and invent themselves as they use the tool [65].

Design Recommendations

Based on our findings, we suggest that systems aiming to foster social connection through creativity could 1) support the creative phase problem-finding through allowing for open-ended goal formation, providing clear entry-points, and providing a range of goal types, 2) support the phase brainstorming through including a way to communicate symbolically (e.g., through words or images) and providing a large combinatorial design space, and 3) support the phase implementation through affording meaningful action through tools and materials, and supporting co-creation of shared artifacts or environments.

6.2.2 Balance the Tension Between *Unity* and *Agency*

Unity and *Agency* are both related to previously existing strategies for designing technologies to support social connection; previous work suggests "reflection on unity" as a design strategy which fosters closeness through creating a self-other overlap [80], similarly to the mechanism proposed by Rouse [74], which suggests that co-creation helps form shared interpersonal boundaries, while "expressivity" [89] and "affective self-disclosure" [80] are proposed strategies that reflect the importance of sharing aspects of your inner experience for relationship development, which is a component of *Agency*'s focus on acting and being perceived as a unique individual. Creativity, with its emphasis on expression and novelty, invites personal contribution, thereby encouraging self-expression and promoting *Agency* [33, 46], while its focus on the integration of diverse perspectives and providing a joint goal (a unifying project) supports the development of *Unity* [25, 74].

Unity

Minecraft supports *Unity* through shared ideas and artifacts (Section 5.1.2). This is facilitated by large, unifying structures—such as Minecraft's persistent shared world or the system itself (as well as the shared fandom universes) in Archive of Our Own (AO3) [24]. Unity can also be fostered through smaller-scale interactions, including mechanisms for practical and emotional support, such as sharing food in Minecraft or providing encouraging feedback on project updates [30]. These practices align with Gauntlett [29]'s principle of "some gifts" (from "some gifts, some theatre, some recognition") for designing platforms to support creativity. In general, acts of giving—whether material, practical, or emotional—reinforce a sense of group belonging while supporting *Agency* for the giver.

Agency

Minecraft supports *Agency* through individual contributions and task division (Section 5.1.3). This is enabled by features that allow each individual to contribute to the same artifact, such as the ability of every player to add blocks to or collect resources for the same structure concurrently within Minecraft, and the forking and pull request features in Github [53]. Minecraft also supports a wide range of roles (e.g., designer, builder, resource collector), allowing users to select tasks that match their skills and preferences while still contributing to the group [23].

Balancing Tension

Minecraft balances the tension between *Unity* and *Agency* (Sections 5.1.2 and 5.1.3). While supporting individual achievement can sometimes decrease the sense of collective cohesion, and emphasizing group goals can sometimes diminish individual agency, Minecraft addresses this by including interdependent play mechanisms which make individual actions essential to the group process. For example, resource collection in Survival mode requires players to gather various materials from different parts of the environment, enabling even less technically skilled players to contribute to shared structures and thereby supporting asymmetric cooperation [36]. The open 3D environment further supports task division by allowing players to divide the space into sections for each person to work on. These dynamics enable players to adopt distinct but meaningful roles while contributing to a shared goal, which has been shown to increase social connection [20].

However, participant responses also suggest challenges related to control and ownership of artifacts in Minecraft (Sections 5.1.2 and 5.1.3). *Unity* is supported when group members contribute to a shared artifact, while *Agency* is supported when each individual feels control over their section of the project. Tension arises when individual actions conflict with group goals, undermining *Unity*, or when a player perceives that others are interfering with their contributions, undermining *Agency*. Addressing this balance requires careful design. For example, enforcing strict consensus or locking editing controls could negatively impact *Agency*, while granting full control over specific pieces of the project to individuals could negatively impact *Unity*. A more balanced approach may lie between these extremes. One potential solution is implementing version control, such as used in GitHub [53], which makes it possible to revert back to a previous version of the project if desired and requires explicit consent for merging new changes into the current version. Another is supporting remixing, as in TikTok, Tumblr, or Scratch [64, 60], which lets users build on each others' work while preserving the original artifact. Overall, balancing *Agency* and *Unity* requires supporting meaningful tasks for individuals while providing ways for the entire group to contribute to the same joint goal.

Design Recommendations

Based on our findings, we suggest that systems aiming to foster social connection through creativity could balance the tension between *Unity* and *Agency* by 1) sup-

porting the factor *Unity* through enabling joint contribution toward shared goals and providing mechanisms for mutual support, and 2) supporting the factor *Agency* through offering diverse roles, granting users control over contributions, and ensuring each participant is essential to the collective process.

6.2.3 Balance the Tension Between *Playfulness* and *Achievement*

On their own, both *Playfulness* and *Achievement* have been associated with social connection. Playfulness, in the form of laughter, has long been associated with human bonding [22] and play is suggested as a primary design strategy in previous work on digital systems that support social connection [80]. Achievement, on the other hand, may lead to social connection through emotional synchrony [15]—players frequently mentioned experiencing shared emotions such as pride and joy after accomplishing a joint goal together. This is additionally supported by the inclusion of "shared embodied experience" as a strategy for supporting connection within digital systems [80], which manifests, for example, in systems that seek to synchronize physiological signals [73]. Overall, it appears that engaging in the creative process provides optimal conditions to experience both a playful sense of exploration [83] and sense of achievement from reaching meaningful goals [56], which may contribute to an increased social connection during collaborative creativity.

Playfulness

Minecraft supports *Playfulness* by encouraging experimentation and exploration, and by reducing the costs of failure (Section 5.1.4). Similar principles appear in other systems: for example, in Scratch, users can iteratively assemble and modify code through manipulable visual blocks [64], while Minecraft's primary interaction mechanic is using cubes to build structures that can be deconstructed into reusable components [23]. Creativity support tool principles note the importance of facilitating exploration and recommend enabling users to try out many combinations and recover easily from errors [65]. Lowering the cost of failure encourages continued experimentation and reduces hesitation to explore. Playfulness is also shaped by the social environment. Psychological safety—characterized by tolerance for mistakes—supports creative exploration and playfulness by promoting risk-taking, ultimately resulting in the development of trust [74].

Achievement

Minecraft supports *Achievement* by enabling goal setting and skill development (Section 5.1.5). This can be further supported by platforms and communities that emphasize learning, such as through legitimate peripheral participation—where novices begin with simple tasks and progressively develop expertise through experience and observation—as has been found within the developers of AO3 [24], or through transparency, where users can view and learn from examples of expert work, as in GitHub [53]. Achievement may also be supported by systems that offer a significant degree of creative complexity, such as Minecraft and Scratch, which allow users to pursue increasingly ambitious goals as their skills develop.

Balancing Tension

Minecraft balances the tension between *Playfulness* and *Achievement* (Sections 5.1.4 and 5.1.5). While high stakes (i.e., failure as a consequence for errors) can hinder playful exploration, they can also increase the meaning and satisfaction of achievement [28]; more broadly, playfulness is associated with lower stakes while achievement is heightened by greater challenge. Minecraft addresses this through multiple game modes (e.g., Creative and Survival mode) and adjustable difficulty levels, allowing players to choose the play style and amount of challenge they prefer. Creative mode emphasizes open-ended building with minimal constraints, while Survival mode introduces challenges such resource scarcity, enemies, and potential death. In general, Minecraft also supports recovery from mistakes by allowing players to take apart their structures and reuse the blocks, while the game can be made more difficult by increasing the frequency of hostile enemies (i.e., monsters). Through these features and others, Minecraft reflects the creativity support tool principle "low threshold, high ceiling" [65] by making the game accessible to beginners (e.g., through simple controls and incremental progression with advanced features initially hidden) and providing complexity for experts (e.g., very sophisticated structures can be built using a large variety of collected resources and crafted materials). This aligns with the concept of flow [19], in which optimal engagement emerges from an ideal balance between skill and challenge. This balance also promotes joint success, which is associated with social bonding [16]. Overall, balancing *Playfulness* and *Achievement* involves supporting exploration and fun while maintaining meaningful challenge and opportunities for skill development.

Design Recommendations

Based on our findings, we suggest that systems aiming to foster social connection through creativity could balance the tension between *Playfulness* and *Achievement* by 1) supporting the factor *Playfulness* through making it easy to try again after failure and fostering a psychologically safe environment, and 2) supporting the factor *Achievement* through creating an easy starting point, providing complexity to give experts a challenge, and supporting tools for learning/teaching.

A summary of the design recommendations can be found in Table 6.1.

Table 6.1

Overview of Design Recommendations for Supporting Social Connection through Collaborative Creativity in Digital Technologies.

Phase/Factor	Design Recommendation	Individual Components
1. Problem-finding	Allow for open-ended goal formation while providing clear entry-points and a range of goal types.	• Allow for open-ended goal formation • Provide clear entry-points • Provide a range of goal types
2. Brainstorming	Provide a way to communicate symbolically (e.g., through words or images) alongside a large combinatorial design space to explore.	• Include a way to communicate symbolically • Provide a large combinatorial design space
3. Implementation	Afford meaningful action through tools and materials, and support co-creation of shared artifacts or environments.	• Afford meaningful action through tools and materials • Support co-creation of shared artifacts or environments
4. *Unity*	Encourage cooperation by enabling joint contribution toward shared goals and providing mechanisms for mutual support.	• Enable joint contribution toward shared goals • Provide mechanisms for mutual support
5. *Agency*	Support interdependence by offering diverse roles, granting users control over their contributions, and ensuring each participant is essential to the collective process.	• Offer diverse goals • Grant users control over contributions • Ensure each participant is essential to the collective process
6. *Playfulness*	Facilitate low-stakes experimentation by making it easy to try again after failure and by fostering a psychologically safe environment.	• Make it easy to try again after failure • Foster a psychologically safe environment
7. *Achievement*	Design for a range of skill levels by creating an easy starting point for novices, providing complexity to give experts a challenge, and supporting tools for learning/teaching.	• Create an easy starting point • Provide complexity to give experts a challenge • Support tools for learning/teaching

6.3 Limitations/Future Work

Our results are limited to the specific context of Minecraft; to extend results (and make them more general), we would need to study different contexts. Future work could apply similar methods to another creative and social online context (such as fan-fiction writing, game modification, open-source programming, indie video game dev, etc.). As well, this study is cross-sectional; therefore, we cannot establish causality. The relationship between social connection and creativity in digital systems could be further studied through a variety of different research methods. Longitudinal studies could explore how relationships within social and creative online contexts (e.g., Minecraft) develop over time, measuring both creative interaction and social connection, thus prioritizing ecological validity. Experimental methodology could also be applied—for example, by developing multiple interface versions and studying how system use changes relationships over time, thus prioritizing internal validity. Finally, the design implications could be used to develop a custom system that uses collaborative creativity strategies to support social connection, which is then evaluated with users. With regards to qualitative data, open-ended survey responses offer less depth than an interview study would have and did not offer the opportunity to add follow-up questions—interview studies could be used as well to collect more in-depth qualitative data about the experience of socializing and being creative in a digital system.

Chapter 7

Conclusion

Creativity and social connection have long been intertwined, yet the question remained whether this relationship could be demonstrated empirically in digital environments or how designers of social technologies might harness collaborative creativity. Our findings—within the context of Minecraft—reveal that creative self-perception best predicts *bridging* social capital, while the perceived creativity support of the tool best predicts *bonding* social capital. Beyond establishing this relationship, our qualitative findings highlight how social connection emerges through active engagement in the creative phases of problem-finding, brainstorming, and implementation. Participants' perspectives also reveal two key design tensions—between *Unity* and *Agency*, and between *Playfulness* and *Achievement*—that shape experiences of connection and disconnection. Together, these findings culminate in seven design recommendations that extend the empirical results into practical guidance for designers of social technologies. By demonstrating how creativity can meaningfully support social connection, this work identifies a promising direction for future systems that seek to bring people together through collaborative creativity.

Appendix A

Additional Information

A.1 Research Ethics Approval Letter

University of Victoria
Office of Research Services | Human Research Ethics Board
Michael Williams Building Rm B202 PO Box 1700 STN CSC Victoria BC V8W 2Y2 Canada
T 250-472-4545 | F 250-721-8960 | uvic.ca/research | ethics@uvic.ca

Certificate of Approval - Annual Renewal with Amendments

PRINCIPAL INVESTIGATOR:	**Regan Mandryk** (Supervisor)	**ETHICS PROTOCOL NUMBER:** Expedited review - delegated	**24-0203**
PRINCIPAL APPLICANT:	**Phaedra Berger** **Master's student**	ORIGINAL APPROVAL DATE:	31-Jul-2024
UVIC DEPARTMENT:	**Computer Science COSI**	APPROVED ON:	15-Sep-2025
		APPROVAL EXPIRY DATE:	30-Jul-2026

PROJECT TITLE: **Social and Technical Features of Online Platforms for Collaborative Creativity**

RESEARCH TEAM MEMBERS:
Elizabeth Reid - PA, UVic
Sowmya Somanath - Co-investigator/Co-supervisor, UVic
Maria Aufheimer - PA, UVic

DECLARED PROJECT FUNDING:
Natural Sciences and Engineering Research Council (NSERC), FN-11012
Natural Sciences and Engineering Research Council (NSERC), FN-6563

DOCUMENTS INCLUDED IN THIS APPROVAL:
Phaedra_tcps2_core_certificate.pdf - 24-May-2024
Collaborative Creativity Interview Protocol Sample.docx - 05-Jul-2024
interview-consent-form.docx - 05-Jul-2024
Recruitment Text Interview Collaborative Creativity.docx - 05-Jul-2024
Additional Question on Asynchronous Interactions.docx - 14-May-2025
hre-notification_of_change_of_principal_investigator (1).pdf - 29-Jul-2025
Amended Survey Consent Form.pdf - 08-Sep-2025
Amended Survey Questions.pdf - 08-Sep-2025
Amended Survey Recruitment Text.pdf - 08-Sep-2025

Conditions of approval

This Certificate of Approval is valid for the above term provided there is no change in the protocol.

Amendments
To make changes to the approved research procedure in your study, please submit "Amendments" or "Annual renewal with amendments" form. You must receive research ethics approval before proceeding with your amended protocol.

Renewals
Your ethics approval must be current for the period during which you are recruiting participants or collecting data. To renew your protocol, please submit a “Request for Renewal” form before the expiry date on your certificate. You will be sent an emailed reminder prompting you to renew your protocol about six weeks before your expiry date.

Project Closures
When you have completed all data collection activities and will have no further contact with participants, please notify the Human Research Ethics Board by submitting a “Notice of Project Completion” form.

Certification

This certifies that the UVic Human Research Ethics Board has examined this research protocol and concluded that, in all respects, the proposed research meets the appropriate standards of ethics as outlined by the University of Victoria's policies for research involving human participants.

Dr. Sandra Gibbons
Chair, Human Research Ethics Board

Dr. Cindy Holder
Vice-chair, Human Research Ethics Board

Certificate Issued On: 15-Sep-2025

A.2 Prolific Recruitment Text

Edited Text (for study description on Prolific):

About this study:

We are researchers in the Department of Computer Science at the University of Victoria, and are **conducting research to understand how technical features and social factors impact creative collaboration on digital platforms**. This study is specifically about **Minecraft.**

Here **creative collaboration** refers to engaging in the creative process with at least one other person and having a shared goal. The process can result in a product (e.g, a piece of visual art or writing), a customized shared environment (e.g., building a city in Minecraft) or an experience (e.g., collaborative storytelling in a roleplaying game or an event people can attend). **Digital platforms** refer to a variety of applications such as games, social media platforms and websites where many people can share and interact online. In this study, we are specifically interested in exploring the experiences of people who engage in the creative process for hobby purposes (i.e., not for financial gain). The platform we are interested in exploring in this particular study is **Minecraft.**

Requirements for participation:

To participate in this study, you must **play Minecraft with other people at least twice a month.**

You will be asked a variety of questions about your Minecraft experiences, social relationships, and creative collaborations. Our **study will take place online**, and will involve **a survey that will take about 30 min**.

A.3 Survey Consent Form

University of Victoria

Department of Computer Science

Participant Consent Form

Social and Technical Features of Online Platforms for Collaborative Creativity

You are invited to participate in this study "Social and Technical Features of Online Platforms for Collaborative Creativity" that is being conducted by Phaedra Berger, Regan Mandryk, and Sowmya Somanath.

This study will be conducted by Phaedra Berger, a graduate student in the Department of Computer Science at the University of Victoria.

Phaedra Berger can be contacted by e-mail at phaedraberger@uvic.ca.

As a graduate student, I am conducting research as part of the requirements for a Master's degree in Computer Science. This research is being conducted under the supervision of Regan Mandryk and Sowmya Somanath, who can be contacted by e-mail at reganmandryk@uvic.ca and sowmyasomanath@uvic.ca.

This study is being funded by the Natural Sciences and Engineering Research Council (NSERC).

In this form we provide details about the study, and seek your consent for participation. Please reach out to us if you have any questions about this form or need clarifications about the study. Our contacts are listed at the end of this form.

Purpose of this study:

Presently, online platforms for socialization are an everyday part of people's lives, and their use has been growing, becoming more (not less) embedded in how people interact with each other. This study investigates existing online platforms that have a high level of creative and social behaviour in order to discover more about which social features and technical affordances lead to social connection and creativity through online interaction— both of which are linked to increased well-being. From our interview and survey data, we expect that design recommendations can be synthesized, which will support developers of future platforms to encourage more making and sharing behaviour that benefits the users and their wellbeing.

You have been invited to participate in this study because you regularly engage in creating and connecting on a platform for collaborative creativity. We think such regular engagement will help us learn from you about your experiences on these platforms, the social value you have gained from these platforms, and the mechanisms or processes you use to create and connect with others.

If I choose to take part in this study, what will I do?

If you take part in this study, you will:

- Fill in a questionnaire that includes demographic questions and some questions about your experience on the collaborative creativity platform. This questionnaire will take about 30 minutes of your time.

Data Gathering

In this study, data will be gathered using an online questionnaire. This will include questions about basic demographics, as well as your experiences with creating and sharing on online platforms. The survey will be administered through a link to Survey Monkey. Please be advised that information about you that is gathered for this research study uses an online program that can be accessed from the US (Survey Monkey). As such, there is a possibility that information about you may be accessed without your knowledge or consent by the US government in compliance with the US Freedom Act.

The gathered data will be used for analysis (i.e., using the data we will explore how and why people use online platforms for making and connecting, as well as what social value they derive from it). The questionnaire responses will be shared in research articles, student thesis, and research presentations. However, such sharing will be done anonymously and in an aggregate form. In other words, we will not associate the data with any of your personal identifiers.

You do not have to answer any questions or complete any tests that make you feel uncomfortable.

How long will this take?

The questionnaire will take about 30 minutes of your time and will take place online

What are the possible harms and discomforts?

There are no known risks associated with taking part in this study.

What are the possible benefits of taking part in this study?

You may benefit from this study through becoming more reflective about how you use collaborative online platforms to make and connect with others, and may perhaps be inspired to create and connect online with others in new ways. This is beneficial as both being creative and connecting socially with other people have been shown to improve well-being.

As well, you will be contributing to the state of knowledge on how to design online platforms to encourage both creativity (making) and sharing (social connection). In the modern day, online platforms are frequently used for various purposes and the study of how to design them to encourage well-being would be beneficial to many people. Our study has the potential to contribute novel insights into which social factors and technical affordances in digital platforms are potentially useful for fostering creating and connecting.

Will I receive any compensation for taking part in the study?

You will receive a CAD $10 Prolific payment as a small thank-you gift.
If you start the survey and then decide you want to withdraw, you will still receive the gift card.

Who will see my information?

The data that we gather will be confidential. As well, for analysis and reporting of the results all data will be confidential. Each participant will be assigned a unique ID and all of their data will be associated with this unique ID. This unique ID will not contain any identifiable information.

Please be advised that information about you that is gathered for this research study uses a third-party online server provided by the Digital Research Alliance of Canada. As such, there is a possibility that information about you may be accessible by this group during the online research collection process.

Data collected from participants will be downloaded and stored in an encrypted drive that is only accessible by the researchers on this ethics application.

Information collected during this study will be stored for 5 years. At the end of this time, all paper records will be shredded, and all audiotapes/videotapes/computer files will be deleted.

How will the study results be shared?

Findings from this study will be reported in journal or conference articles, or books and in the student's thesis. The findings may be presented at workshops/conferences. Your name will not be used in these publications or presentations.

Please note:

- You may change your mind and withdraw from this study at any time. There is no need to explain why you have changed your mind. If you withdraw from the study your contribution will not be used in the analysis or final report.
- You do not have to answer any questions or complete any tests that make you feel uncomfortable.
- It's your choice whether or not you want to take part in this study. Your participation is voluntary.

If you have any questions or if you would like to discuss this study further, please contact the researcher Phaedra Berger at phaedraberger@uvic.ca.

You can also contact the Human Research Ethics Office at the University of Victoria at 250-472-4545 or ethics@uvic.ca, to check the ethical approval of this study, or to raise any concerns you might have.

Please remember that participation in this study is voluntary.

Consent:

I have read this consent letter…….....yes…….no

I have had the opportunity to ask questions…..……..…….....yes…….no

I understand that my participation in this study is voluntary ……..yes……no

I understand that I can withdraw my consent at any time…….....yes…….no

I agree to take part in the study……..…….....yes…….no

_____	_____	_____
Name of Participant	*Signature*	*Date*

A copy of this consent letter will be left with you and the researcher will take a copy.

A.4 Finalized Survey Questions

1. What is your Prolific ID? (textbox)

Pre-Screening

1. Have you ever played the video game **Minecraft**? (multiple choice: yes/no)
2. Do you ever play **Minecraft** with other people? (multiple choice: yes/no)
3. Do you play **Minecraft** with other people at least twice a month? (multiple choice: yes/no)

Consent Form

- copied from the consent form document included in the ethics submission

Demographics

1. What's your age? (textbox)
2. What's your gender?
   multiple choice:
   - Man
   - Woman
   - Gender-fluid
   - non-binary
   - Prefer not to say
   - Other (please specify)
3. What's your profession? (textbox)
4. How often do you play **Minecraft** with other people?
   multiple choice:
   - Two times a month
   - Between two to four times a month
   - Once a week

- Multiple times a week
- Almost every day

5. Select D as your answer choice. (multiple choice: A/B/C/D/E)

Open-ended Text Questions

I'm interested in looking at why and how people engage in **creative online collaborations**, as well as what **social value** they gain from them. In particular, I'm interested in 'casual' or 'hobby' creative collaborations (i.e., not collaborations done for commercial or formal educational purposes), and have therefore chosen the context of Minecraft. A collaboration, broadly defined, is **at least two people** working toward a **shared goal**. The shared goal might be a shared project or might entail working in the same area on separate but related projects.

A **collaboration** can:

- be short-term or long-term
- take place in the same physical location, or take place exclusively online, or some combination of the two
- be asynchronous (i.e., members working at different times) or synchronous (i.e., members working at the same time), or some combination of the two
- involve a pair of people or a large group
- be new or established
- always involve the same members, or have constantly changing members
- be between members of different communities, within the same community, or involve no particular community

Think of a **specific example** of a collaborative project or activity you've experienced in the **context of Minecraft**. This might involve playing on a server with your friends, contributing to a specific structure on a public server, participating in a role-playing server, or filming a story set in a Minecraft world.

Please **refer back** to this example when answering the following questions.

Please do not use ChatGPT or other large language models (LLMs) to answer the written questions in this survey.

1. Briefly describe the collaborative experience or activity in Minecraft that you've decided to think about for this study: (textbox)

2. During the **specific** Minecraft experience you described, **what kinds of things did you make with others**? This can be a specific object (e.g., a structure or a collection of structures; a video; code for a custom mod), or it could be something intangible (e.g., acting out a story). (textbox)

3. During the **specific** Minecraft experience you described, how would you **describe your relationship with the person or people you made things with**? Check multiple options if more than one applies to your situation.
   checkboxes:

   - Strangers
   - Acquaintances
   - Friends
   - Best friends
   - Siblings
   - Other (please specify)

4. During the **specific** Minecraft experience you described, which **phases of the creative process** did you engage in when you **worked with others**? Select all answers that apply.
   checkboxes:

   - Problem-finding (e.g., deciding the goal of the project; figuring out what's missing)
   - Acquiring knowledge (e.g., skill-building; learning)
   - Gathering related information (e.g., looking for inspiration; exploring)
   - Incubation (e.g., taking time off and doing another activity; playing)

- Generating ideas (e.g., brainstorming; coming up with potential solutions)
- Combining ideas (e.g., synthesizing suggestions; making connections)
- Selecting the best ideas (e.g., reflection; evaluating and judging ideas)
- Externalizing ideas (e.g., implementation; turning ideas into reality)
- Other (please specify)

5. In the context of the **specific** experience you described, **what makes you feel socially connected** during creative collaboration in Minecraft? (i.e., what makes you feel closer to other people?) This might look like feeling understood, happy, excited, or looking forward to continuing the collaboration. Briefly describe an example. (textbox)

6. In the context of the **specific** experience you described, **what makes you you feel socially disconnected** during creative collaboration in Minecraft? (i.e., what makes you feel further apart from other people?) This might look like feeling angry, frustrated, sad, or not wanting to continue with the collaboration anymore. Briefly describe an example. (textbox)

Model of Coordinated Action (MoCA) Questions

For the following questions, please refer back to the **specific** collaborative Minecraft experience or activity you used in the previous section.

1. How would you describe the synchronicity (i.e., at the same time (synchronous) vs. at different times (asynchronous)) of the collaboration style of the Minecraft experience?
   slider: Entirely Synchronous (0) $\longleftrightarrow$ Entirely Asynchronous (100)

2. How would you describe the physical distribution of the Minecraft experience? (i.e., do you play Minecraft in the same physical space or do you play remotely?)
   slider: Entirely In-Person (0) $\longleftrightarrow$ Entirely Remote Communication (100)

3. What was the group size of the Minecraft experience? (i.e., on average, how many people were involved at a given time point?)
   slider: Very Small (2) $\longleftrightarrow$ Very Large (100+)

4. Did you feel uncertain about project outcomes during the Minecraft experience? (e.g., were you uncertain that you would be able to reach your goal or were you uncertain about what the goal was?)
   slider: Strongly Disagree (0) $\longleftrightarrow$ Strongly Agree (100)

5. Did you have to make adjustments to your plans or process during the Minecraft experience? (e.g., did you change the goal you were working towards or did you change how you were working on it?)
   slider: Strongly Disagree (0) $\longleftrightarrow$ Strongly Agree (100)

6. Is the Minecraft experience still on-going? (multiple choice: Yes/No)

7. How long specifically did the Minecraft experience last (or has lasted so far?) If you don't know for sure, give your best estimate. If the box does not apply to your situation, fill it in with 0. (e.g., if you estimate your collaboration lasted 3 months, put a 0 in the years box, a 3 in the months box, and a 0 in the days box.)
   textbox: Years:
   textbox: Months:
   textbox: Days:

8. How frequently did new people join the Minecraft experience after it was started?
   slider: Never (0) $\longleftrightarrow$ Constantly (100)

9. How frequently did people leave the Minecraft experience before it was finished?
   slider: Never (0) $\longleftrightarrow$ Constantly (100)

10. A **"community of practice"** is defined as a group of people engaged in a particular activity or activities. This group of people has a shared way of doing things that they teach to newcomers as they join the group, either through example or direct instruction.

    For example, a Minecraft YouTube channel, a Minecraft wiki, or a Minecraft Discord server could all be considered **communities of practice**, where newcomers learn from existing videos, tutorials or other players. Communities of practice related to your collaboration would involve communities (e.g., **groups of people**) whose **"shared way of doing things"** are related to what you are making. For example, this might include a community who makes Minecraft

YouTube videos, or a community of people playing on a particular role-playing server. Different members of your collaboration might belong to different communities of practice.

A collaboration might include **one** community of practice (e.g., a public Minecraft server), **several** communities of practice (e.g., a group of Minecraft players creating YouTube videos for public viewing), or **no** communities of practice (e.g., playing Minecraft casually with your friends without any ties to a larger community or communities).

Which communities of practice are involved in the Minecraft experience? (textbox)

11. How many communities of practice are involved in the Minecraft experience? slider: None(0) $\longleftrightarrow$ Many(10+)

Internet Social Capital Scale (Bonding Subscale)

For the following questions, please refer back to the **specific** collaborative Minecraft experience or activity you used for the written questions at the beginning of the survey.

The format for every question in this section is:
slider: Strongly Disagree (0) $\longleftrightarrow$ Strongly Agree (100)

1. There are several people I play Minecraft with who I trust to help solve my problems.
2. There is someone I play Minecraft with who I can turn to for advice about making very important decisions.
3. There is no one I play Minecraft with that I feel comfortable talking to about intimate personal problems.
4. When I feel lonely, there are several people I play Minecraft with who I can talk to.
5. If I needed an emergency loan of $500, I know someone I play Minecraft with who I can turn to.
6. The people I play Minecraft with would put their reputation on the line for me

7. The people I play Minecraft with would be good job references for me.
8. The people I play Minecraft with would share their last dollar with me.
9. I do not know the people I play Minecraft with well enough to get them to do anything important.
10. The people I play Minecraft with would help me fight an injustice.

Internet Social Capital Scale (Bridging Subscale)

For the following questions, please refer back to the **specific** collaborative Minecraft experience or activity you used for the written questions at the beginning of the survey.

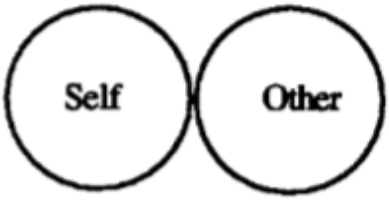
The format for every question in this section is:
slider: Strongly Disagree (0) $\longleftrightarrow$ Strongly Agree (100)

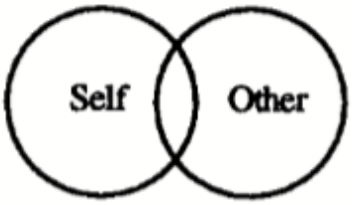
1. Interacting with people in Minecraft makes me interested in things that happen outside of my town.
2. Interacting with people in Minecraft makes me want to try new things.
3. Interacting with people in Minecraft makes me interested in what people unlike me are thinking.
4. Talking with people in Minecraft makes me curious about other places in the world.
5. Interacting with people in Minecraft makes me feel like part of a larger community.
6. Interacting with people in Minecraft makes me feel connected to the bigger picture.
7. Interacting with people in Minecraft reminds me that everyone in the world is connected.
8. I am willing to spend time to support general Minecraft community activities.
9. Interacting with people in Minecraft gives me new people to talk to. In Minecraft, I come in contact with new people all the time.

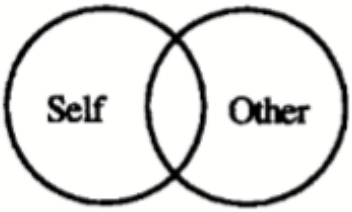
Inclusion of Other in the Self Scale

For the following question, please refer back to the **specific** collaborative Minecraft experience or activity you used for the written questions at the beginning of the survey.

Please select the picture below which best describes your relationship with the person or people you play Minecraft with.
multiple choice:

- 

- 

- 

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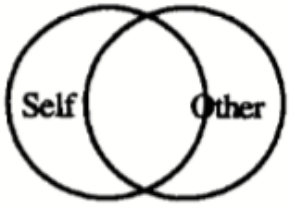
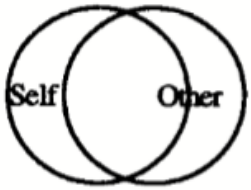
- 

- 

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Creativity Support Index (CSI) Agreement Statements

For the following questions, please refer back to the **specific** collaborative Minecraft experience or activity you used for the written questions at the beginning of the survey. The system or tool in this case is the game Minecraft.

The format for every question in this section is:
slider: Highly Disagree (0) $\longleftrightarrow$ Highly Agree (100)

1. The system or tool allowed other people to work with me easily.
2. It was really easy to share ideas and designs with other people inside this system or tool.
3. I would be happy to use this system or tool on a regular basis.
4. I enjoyed using the system or tool.
5. It was easy for me to explore many different ideas, options, designs, or outcomes, using this system or tool.
6. The system or tool was helpful in allowing me to track different ideas, outcomes, or possibilities.
7. I was able to be very creative while doing the activity inside this system or tool.
8. The system or tool allowed me to be very expressive.

9. My attention was fully tuned to the activity, and I forgot about the system or tool that I was using.

10. I became so absorbed in the activity that I forgot about the system or tool that I was using.

11. My attention was fully tuned to the activity, and I forgot about the system or tool that I was using.

12. I became so absorbed in the activity that I forgot about the system or tool that I was using.

CSI Paired-Factor Comparison Test

For the following questions, please refer back to the **specific** collaborative Minecraft experience or activity you used for the written questions at the beginning of the survey.

1. When doing this task, it's most important that I'm able to ...
   multiple choice:
   - Be creative and expressive
   - Become immersed in the activity

2. When doing this task, it's most important that I'm able to ...
   multiple choice:
   - Be creative and expressive
   - Enjoy using the system or tool

3. When doing this task, it's most important that I'm able to ...
   multiple choice:
   - Be creative and expressive
   - Explore many different ideas, outcomes, or possibilities

4. When doing this task, it's most important that I'm able to ...
   multiple choice:
   - Be creative and expressive

- Produce results that are worth the effort I put in

5. When doing this task, it's most important that I'm able to ... multiple choice:
   - Be creative and expressive
   - Work with other people
6. When doing this task, it's most important that I'm able to ... multiple choice:
   - Become immersed in the activity
   - Enjoy using the system or tool
7. When doing this task, it's most important that I'm able to ... multiple choice:
   - Become immersed in the activity
   - Explore many different ideas, outcomes, or possibilities
8. When doing this task, it's most important that I'm able to ... multiple choice:
   - Become immersed in the activity
   - Produce results that are worth the effort I put in
9. When doing this task, it's most important that I'm able to ... multiple choice:
   - Become immersed in the activity
   - Work with other people
10. When doing this task, it's most important that I'm able to ... multiple choice:
    - Enjoy using the system or tool
    - Explore many different ideas, outcomes, or possibilities
11. When doing this task, it's most important that I'm able to ... multiple choice:

- Enjoy using the system or tool
- Produce results that are worth the effort I put in

12. When doing this task, it's most important that I'm able to ...
    multiple choice:
    - Enjoy using the system or tool
    - Work with other people
13. When doing this task, it's most important that I'm able to ...
    multiple choice:
    - Explore many different ideas, outcomes, or possibilities
    - Produce results that are worth the effort I put in
14. When doing this task, it's most important that I'm able to ...
    multiple choice:
    - Explore many different ideas, outcomes, or possibilities
    - Work with other people
15. When doing this task, it's most important that I'm able to ...
    multiple choice:
    - Produce results that are worth the effort I put in
    - Work with other people

Short Scale of Creative Self

For the following questions, answer using your **general** day-to-day experience.

The format for every question in this section is:
slider: Highly Disagree (0) $\longleftrightarrow$ Highly Agree (100)

1. I think I am a creative person.
2. My creativity is important for who I am.
3. I know I can efficiently solve even complicated problems.

4. I trust my creative abilities.
5. My imagination and ingenuity distinguish me from my friends.
6. Many times, I have proved that I can cope with difficult situations.
7. Being a creative person is important to me.
8. I am sure I can deal with problems requiring creative thinking.
9. I am good at proposing original solutions to problems.
10. Creativity is an important part of myself.
11. Ingenuity is a characteristic which is important to me.

Personal Creativity Measure

For the following question, please refer back to the **specific** collaborative Minecraft experience or activity you've used throughout the survey.

1. Overall, how creative do you feel you were during the Minecraft experience? Creativity includes coming up with novel or original ideas; expressing oneself or solving problems in an original and useful way; or spending time doing activities such as art, music, writing, programming, engineering, etc.

slider: Not Very Creative (0) $\longleftrightarrow$ Very Creative (100)

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