Spring 2012

Improving Creativity in Temporary Virtual Teams

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IMPROVING CREATIVITY IN TEMPORARY VIRTUAL TEAMS

by

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A Thesis submitted to the Faculty of the Graduate School,
Marquette University,
in Partial Fulfillment of the Requirements for
the Degree of Master of Leadership Studies

Milwaukee, Wisconsin

May 2012

Abstract

We live in an interconnected world in which physical location has become less of a hindrance to communication, yet newer message transmission media alter not only the process but also the content of creative communication. While temporary virtual teams offer alternatives to solve issues which resist resolution using traditional approaches, virtual team characteristics can limit the ability to create novel and useful solutions. Since creativity is a necessary and significant requirement for success across a wide variety of domains, this poses a serious challenge for those intending to improve organizational creativity through the use of virtual teams and exposes the difficulty of studying creativity in a virtual environment.

The author creates a modular online research tool to more effectively study how eight characteristics of virtual teams interact to improve or restrict creativity: depersonalization, time pressure, noise, level of organization, degree of autonomy, range of potential solution categories, expectation, clarity of purpose, and potential personal gain. The design and implementation of the virtual creativity research environment are examined and used to research whether it is possible to improve the creativity of ad-hoc online teams.

Qualitative analysis of twenty quasi-experimental groups with total 136 participants determined a statistically significant difference between groups with two selected environments, with an effect size over 2.5. While the ability to control individual environmental elements is within the ability of the research tool created in this study, a multivariate analysis of individual elements was outside the scope of this initial study, but is suggested for further research.

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Temporary virtual team creativity is enigmatic: we commonly believe that we are more creative in groups than alone, yet research is not conclusive that this belief matches reality. At the same time, creativity remains a key component in success (Hall 2009). Organizations facing issues which resist solutions using traditional approaches need "the ability to transcend traditional ideas, rules, patterns, relationships, or the like, and to create meaningful new ideas, forms, methods, [and] interpretations." (Random House Webster's Dictionary, n.d.). Consistently generating creativity can be difficult, especially since even measuring creativity comes with its own peculiar issues: it is at best philosophically problematic to design a consistent, repeatable instrument to measure transcendent patterns, and quantify methods that do not yet exist.

Team creativity can be affected by a number of variables, so even if we believe that we can be more creative as a team, we may not achieve that goal for a wide variety of reasons. Reduce the likelihood of existing relationships between team members and dramatically limit the team's ability to communicate – the very environment created by a temporary virtual team – and the path to innovation becomes even more indistinct.

Yet, more and more, organizations use temporary virtual teams to address issues that have proven resistant to resolution by more traditional approaches. From hybrid-format college class assignments, to corporate teams planning for structural change, to non-profits seeking to identify future direction for the organization, temporary virtual teams – groups of individuals, who may not have had prior interaction, brought together to accomplish a single task for a short period of time, communicating primarily though electronic means – are increasingly viewed as an effective means to resolve problems which require creativity (Paulus and Van der Zee, 2002).

Frequently, these temporary virtual teams are created without an understanding of the content, structure, and environment that will guide the team to success, or any form of training to direct them toward their goal (Stout, Salas, & Fowlkes, 1997). In fact, these temporary virtual teams can be created with little more than a statement of the issue to be addressed and identification of a person who is nominally "in charge" of the group. The result can vary from innovative solutions to minimalist "least-likely-to-result-in-my-being-fired" answers. Given the complexity of the individual elements that combine in the temporary virtual team, research into the effectiveness of these teams can be difficult (Grawitch, Munz, Elliot, and Mathis, 2003; Klausen, 2010).

This study creates a controlled experimental online environment to research the factors that may affect creativity in temporary virtual teams. This web-based tool allows for the generation of experimental and control groups, including compliance with informed consent and basic demographic data collection; a modular pre-test/post-test creativity instrument; and a creativity exercise, with the ability to control individual components of the environment for control and experimental groups. A specific research question is then addressed using the research tool: is it possible to alter the environment of a virtual team to improve creativity, as measured by idea generation?

Literature Review

Evaluating the effectiveness of a proposed treatment on the creativity of a temporary virtual team requires an understanding of several underlying concepts: the human-computer interface, computer-mediated communication (CMC), creativity, teams, virtual teams, and temporary virtual teams. Given the complexity of each of the elements, each will be addressed individually in the sections that follow. Additionally, the characteristics of the pre-post test instrument selected for the study is analyzed.

Humans and Computers

Lying deep within the human character is the reality that we are tool-makers at heart. While our tools have varied over time, in recent decades we have taken to building devices which extend the ability that differentiates *Homo Sapiens* ("knowing man") from the other species around us: knowledge tools such as digital computing devices (Olson & Olson, 2003; Majchrzak, Rice, King, Malhotra, & Ba, 2000).

While we originally designed computing devices with the purpose of increasing an individual's ability to calculate, to store and retrieve information, and to become more productive on their own (Haines, 1999), we discovered a tool that allowed us to work together even more effectively (Thompson, L. F. & Coovert, 2003). At the same time, our model has often been to adjust the behavior of the user to the design of the tools, rather than adjust the tool to the needs of the user (Olson & Olson, 2003).

The interaction is not a simple one, as it is as multi-faceted as we are. The study of computer-supported cooperative work (CSCW) "is fundamentally interdisciplinary. The fields of cognitive, social, and organizational psychology are all important to research in the area, but other social sciences such as sociology and anthropology have played key roles, as have such

related fields as communication, management, operations research, and ergonomics" (Olson & Olson, 2003).

The study of the nature of the human-computer interface (HCI) reveals how complex even simple actions can be. Documenting the manner in which a user interacts with a computer to respond to an error by clicking a button on screen requires many underlying details: the use of both long-term and production memory, the ability to process auditory inputs, the ability to recognize and process visual using the ocular system, the ability create speech (for some applications), tactile sensing, gross and fine motor control, and the cognitive processing and rule-based processing to determine meaning, method, and an execution plan for the action (Olson & Olson, 2003). Each new input or new requirement can take additional cognitive processing time; operational complexity increases each time an additional element is factored into the model (Gray, 2008).

While this true of any human-computer interaction, this complexity is especially true when the computing device is used as a communication medium for task processes (Majchrzak et al., 2000). While humans have communicated for millennia using a variety of means of communication, each with their own characteristics, advantages and limitations, the development and spread of digital computing in the 1970's introduced a new medium: digitally transmitted text (Olson & Olson, 2003). Digital computing devices, including desktop computers, laptops, and smart phones, also include "border" devices such as dedicated voice-to-text and text-to-voice gateways, facsimile, and specialized applications (Mellander, 2001). While the study of the use of these computing devices reveals the underlying intricacy, the use of a digital computing devices for communication purposes overlays an additional level of complexity (Majchrzak et al., 2000).

Human communication involves a dance between competing interests and needs, including the desire to gain understanding (Clark, M.A., Anand, & Roberson, 2000); the desire to influence others (Olson & Olson, 2003); and even the desire to share time fairly between participants (Kuk, 2000). Communication messages that we receive include both verbal and non-verbal components. Since portions of communication occur at a nearly subliminal level, we often do not consciously evaluate each characteristic component of each of the messages we receive, responding at times to the non-verbal elements of communication before (or instead of) the verbal content (Driskell & Salas, 2005). In face-to-face communication settings, this dual nature of verbal and non-verbal is part of every conversation. Where verbally we may swing between rational persuasion and pressure tactics, we may also communicate the same message non-verbally using task cues and dominance cues (Driskell & Salas, 2005). When the communications medium blocks these messages, we can find it harder to communicate (Clark et al., 2000) and persuade (Guadagno & Cialdini, 2002) and accomplish the intended task that motivated us to communicate. The use of digital computer as a communications medium adds an additional level of complexity to our ability to convey and receive messages: even for those with substantial experience in decoding emotion in face-to-face or video environments, messages transmitted purely through text result in dramatic differences in the ability to detect emotion (Leiss et al., 2008).

Computer Mediated Communications

Computer Mediated Communications (CMC) are communications that take place via an indirect digital channel, rather than face-to-face interaction. CMC may consist of text messages, chat, email, or online postings in a variety of web-based interaction platforms. Synchronous

CMC is transmitted in real-time like spoken communication; asynchronous CMC allows for delay between the time of transmission and reception (Frehner, 2008).

Another way to characterize CMC options is the grounding model presented by Clark and Brennan (1991) in which they identified five characteristics of communication: "copresence: group members occupy the same physical location; visibility: group members can see one another; audibility: group members can hear one another; cotemporality: communication is received at the approximate time it is sent; simultaneity: group members can send and receive messages simultaneously; sequentiality: group members' speaking turns stay in sequence" (as cited by Driskell, Salas, & Johnson, 1999, p. 298). All CMC media lack copresence and provide cotemporality, simultaneity, and sequentiality; audio conferencing and phone calls add audibility; and video teleconferencing further adds visibility (Driskell et al., 1999).

There are other shared characteristics to common CMC media. Messages that can be transmitted are short, ranging from only 160 characters for Short Message Service (SMS) text messages, to moderate length email messages. Messages are typically limited to only alphanumeric, special, and punctuation characters, although newer versions allow for the use of text decoration, such as italic or bold text or graphical special characters (Olson & Olson, 2003). This textual limit significantly limits the message sender's ability to encode non-verbal information (Leiss et al, 2008), except for the most limited expressions, such as so-called "smileys", formed by combining punctuation characters to simulate emotions; for example, the colon and the right parenthesis can be combined to form ":)" – a "smiley face." The removal of non-verbal elements in the communication dramatically reduces the effectiveness of the communication, especially as related to persuasiveness (Guadagno & Cialdini, 2002), the resolution of unclear messages (Frehner, 2008) and identifying emotional affect and expression

(Leiss et al, 2008). This lack of a framework for understanding personal content can be compensated for using changes in group design: a study by Morris, Nadler, Kurtzberg, and L. L. Thompson (2002) found that, in cases of members who needed to communicate using bandwidth-limited email CMC, providing direct interaction between members beforehand increased rapport between members. This can be especially helpful as CMC messages can have greater impact than verbal face-to-face messages; messages can carry a higher impact for disagreements when the tone of messages is contentious, as CMC are more frequently irrevocable and are typically available to others to review (Myers, 2007).

The nature of the CMC channel can also segment the communication by providing a communication channel from one person to a second while bypassing a third. This non-overlapping communication can create situations where a group of decision-makers can come into conflict, simply due to the fact that each possesses information which is not available to all (Thompson, L. L., 2008). Communication via email messages between members in a group can produce this situation when messages are sent to individual members, rather than to the entire group; SMS messages are all single-user to single-user and can lead to an even higher incident of information fragmentation.

Information segmentation is not the only potential side effect of CMC communication. L. F. Thompson and Coovert (2002) found participants using CMC felt less able to influence group decision-making and less satisfied with the process than face-to-face participants. In a follow up study in 2003, they documented that, as the use of CMC can be linked to difficulties in generating and maintaining common knowledge, this can make team discussions more confusing and less satisfying, and can reduce group satisfaction with both the process and the outcomes. At the same time, they found there was little performance difference between face-to-face and teams

using CMC. One key factor was the sense of time urgency, although this is not a factor for groups formed of anonymous members, as they tend to have a lesser sense of time pressure. One potential factor in the success of the team process is the software environment in which the team operates, as the characteristics of the software were predicted to have various positive or negative effects on the team process. One further conclusion of the L. F. Thompson and Coovert study was that the software environment was likely to have different results for different types of tasks, with generational tasks suggested as a potentially good fit for the CMC environment.

Majchrzak et al. (2000) reported a similar position on software effectiveness; while collaboration tools may "claim to support the exchange of ideas, opinions, and preferences within the group, the document database features that are currently available in most collaborative tools mainly serve as an information repository, not a gateway to the right information, or a process for developing shared cognition" (p. 51). In addition to alternative considerations at the software design level, their study suggested that adding a knowledge management role to the team could aid the group in collecting and organizing information, in building the shared knowledge of the group. As similar results were found in early computer conferencing studies, augmenting the automated tools with intelligent human interaction may make the group more effective at accomplishing its goals, in an way that reduces the costs of creating the shared knowledge pool and making the members more comfortable with the process.

When content of the communication is creative in nature, the lines between comfort with content and comfort with the channel can become blurred. While creativity is believed to remain a steady factor throughout our lives (Csikszentmihalyi & Nakamura, 2006), individual creativity can vary significantly due to differences in comfort levels in using CMC as compared to other communication environments. Degree of comfort with the CMC environment varies with age,

disability, language and culture (Olson & Olson, 2003). The message sender lack of comfort can become confused with the idea that they are simply not as creative as others.

This link between comfort with a CMC environment and productive output is seen in many domains, including education. Lynch (2001) found strong differences between educational settings using online courses versus face-to-face formats: student dropout rates were as high as 35% to 50%, compared to 14% for traditional classes, with students reporting feelings of social isolation in response to electronically delivered homework. A related study by O'Brien and Renner (2002) found that factors that positively influence retention included: enhancing the comfort level of students with the technology, creating a sensitive online faculty persona generating trust in the environment, and addressing safety and security needs to support highly interactive experiences.

Since team identification is linked to creativity, the link between group retention and team identification suggests that these factors could also affect team creativity. While social identity has been shown to have an effect team communication, both as related to morale building and to task communication, some studies (Michinov, Michinov, Toczek-Capelle, 2004) have indicated that it may have a limited impact on productivity and called for a reconsideration of the effect of social identity on team productivity. This may be an effect compounded by multiple factors as Postmes, Spears, and Lea (2002) found that the effect of depersonalization on the team can alter the impact of social identity. Douglas & McGarty (2002) found that anonymity in CMC directly affected the tone of the communication, including increased deindividuation and the use of stereotypes and language abstraction related to group identity.

Gender-based differences can be another factor, as seen in differences in perceptions of persuasiveness in a study by Guadagno and Cialdini (2002). The study found a significant

decrease in the effectiveness of persuasion in computer-mediated communications, as compared to face-to-face conversation, for women in the study, while men reported no differences. While various reasons could exist for the responses, they postulated the cause as differing expectations related to relationship formation and cooperation. This is similar to the relationship between team identification and lower levels of task and relationship conflicts found by Han and Harms (2010). Majchrzak et al. (2000) indicated that success in CMC may be predicated on the establishment of a common language and tools created first in face-to-face communications; however, this may also be related to relational issues over purely linguistic considerations.

Defining Creativity

Creativity is defined by the Random House Webster's Dictionary (n.d.) as "the ability to transcend traditional ideas, rules, patterns, relationships, or the like, and to create meaningful new ideas, forms, methods, interpretations," although the simpler definition of "the production of something that is both novel and appropriate" (Klausen, 2010, p. 347) or "work that is novel (i.e., original, unexpected), high in quality, and appropriate" (Beghetto & Kaufmann, 2007, p. 73) are used for most creativity research. Some have questioned the usefulness of this definition (Hennessey & Amabile, 2010; Klausen, 2010; Sternberg & Lubart, 1991; Plucker, Beghetto, & Dow, 2004), even suggesting that "the standard definition of creativity is problematic and maybe in an even worse state than is generally acknowledged by creativity researchers themselves" (Klausen, 2010, p. 347). While the topic is primarily of interest to creativity researchers, the traditional definition unfortunately makes the measurement of creativity even more difficult to achieve, or may result in measuring elements that are, in fact, not directly related to creativity at all (Klausen, 2010).

Traditional definitions of creativity break creative activity into two main categories: divergent and convergent (Albert & Runco, 1999). Divergent thinking "is a kind of thinking that aims not at producing correct answers, but rather at coming up with a variety of unusual, original, or even off-the-wall ideas" (Prieto et al., 2006, p. 278) forms the primary area of research for this area of study. Divergent thinking can be influenced by environmental issues, including such varied factors such as sleep loss, where a the lost of a single night's sleep show marked decreases in divergent thinking, where convergent thinking remained less responsive to sleep loss. (Horne, 1988)

Even using the intrinsic models of creativity, it can be affected by a number of environmental factors. Kasof (1997) demonstrated a correlation between environmental noise and creativity, positing that breadth of attention was positively linked to creativity; Grawitch, Munz, and Kramer (2003) demonstrated a link between positive mood and increased creativity. These correlations indicate that, even for models that define the creative act as an outward expression of the creative person, there is a degree to which creativity must be examined in light of the environment in which creative work is performed.

Even the subject of creative thought can affect creative output. The manner in which problems are defined have been shown to have an impact on creativity, specifically related to the ability to break a complex task down into smaller, more achievable tasks. This "task decomposition" ability has been shown to be directly affected a number of constructs, even including the number of solution categories presented. A study by Coskun, Paulus, Brown, and Sherwood (2000) demonstrated that changing the manner in which categories of potential solutions were submitted changed the number of ideas generated; additionally, presenting a

relatively large or relatively small number of categories also increased the number of ideas generated.

Some research tends to indicate that the problem is related to an overly simplistic view of the nature of creativity. One weakness of the current definition is that it could be interpreted as an audience- or judgment-relative property, in other words, creativity is defined in the eye of the beholder: in Klausen's (2010) view, "work may count as the result of a creative process even if it is not accepted by a contemporary audience; but it must be accepted by some group at some time" (p. 349). Sternberg and Lubart's (2006) two theories of creativity take an alternate direction, namely that creativity happens in spite of – or as a result of – the degree to which the creative idea is novel:

> Our investment theory of creativity (Sternberg & Lubart, 1991, 1995) is a confluence theory according to which creative people are those who are willing and able to "buy low and sell high" in the realm of ideas (see also Rubenson & Runco, 1992, for the use of concepts from economic theory). Buying low means pursuing ideas that are unknown or out of favor but that have growth potential. Often, when these ideas are first presented, they encounter resistance. The creative individual persists in the face of this resistance and eventually sells high, moving on to the next new or unpopular idea (Sternberg, 2006, p. 87).

Their view is that the nature of creativity is not solely based in creative individual, but also in the creative idea itself, and the novelty of the idea as evidenced by the common lack of acceptance of the concept. As the idea gains acceptance, it becomes less novel; hence, it becomes less creative, if creativity is defined using the "novel and useful" definition. As a

result, the individual cannot be creative if the ideas they espouse are common and accepted; stating this in a different way, the individual may only be as creative as their ideas are unpopular.

This "investment theory" identifies a model by which this balance between the acceptance of an idea and the potential creativity of the individual holding the idea can be linked. This connection between the need to evaluate both the characteristics of the individual and the elements of the environment in which they exist is a key element of both the investment theory and a related model they added several years later.

The second theory, the propulsion theory, expands the investment theory by explaining how the creative investment is made to expand the investment theory:

> …[the] propulsion theory of creative contributions (Sternberg, 1999b; Sternberg, Kaufman, & Pretz, 2001, 2002) . . . addresses this issue of how people decide to invest their creative resources. The basic idea is that creativity can be of different kinds, depending on how it propels existing ideas forward. When developing creativity, we can develop different kinds of creativity, ranging from minor replications to major redirections in thinking. . . . Most theories of creativity concentrate on the attributes of the individual (see Sternberg, 1999a; Ward, Smith, & Vaid, 1997). However, to the extent that creativity is in the interaction of person with context, we need to concentrate as well on the attributes of the individual and the individual's work relative to the environmental context. (Sternberg, 2006, p. 88)

These theories identify a multi-dimensional model of creativity that enhances our ability to study creativity; at the same time, they highlight the difficulty of attempting to create a simple linear instrument to measure such a complex factor (Cropley, 2000). At the core of the issue are theories that describe creativity as being constructed of multiple modalities: common to most of

the models is the thought that both divergent and convergent creativity is required in real-world situations (Sternberg, 1997; Cropley, 2000; Mathisen & Einarsen, 2004).

More detailed models vary in how they identify the key elements, domains, and defining characteristics of creativity. Several models argue for a bifurcated view, based on the nature of the creative ideas generated: "Big C" or eminent creativity which are the grand creative works of genius, researched by studying the lives of artistic, scientific, or leaders of renown (Csikszentmihalyi, 1999; Kaufmann, 2003); and "little c" or everyday creativity, such as finding creative solutions to a complex work dilemmas or performing simple creative artistic activities (Sternberg, 1999; Kaufmann, 2003). Beghetto and Kaufmann (2007) have expanded this view to include "mini c" creativity, "the novel and personally meaningful interpretation of experiences, actions, and events" (p. 73), creativity required to develop personal knowledge and understanding; and, later, "Pro-C", the creative mid-ground between the "little-c" that includes the

> "…everyday creativity of the home cook who can creatively combine ingredients to develop unique and tasty meals and the Big-C category is appropriate for chefs who have revolutionized the profession . . . the professional chef who makes a living developing creative entrées (clearly surpassing the creativity of the innovative home cook) but has not yet attained (or may never attain) Big-C status" (Kaufmann & Beghetto, 2009, p. 4).

The discussion centers on the thought that attempting to lump every creative act into purely Big-C and little-C categories tends to understate the nature of creativity: "current conceptions of little-c creativity are not inclusive enough to accommodate the personal creative processes involved in students' development of new understanding and personal knowledge construction" (Beghetto & Kaufmann, 2007, p. 75).

Identifying the level of creativity of both the act and the actor that generated it, in strictly interpreted confluence models, requires determining the nature of the creative act, the context, the actor, and the connections between; this could imply our creativity could be limited by the least imaginative people around us, a charge leveled by Klausen (2010) and others. Among the confluence model proponents, there is an unwillingness to hold completely to the line that requires external recognition for the existence of creativity: "One could have all of the internal resources needed to think creatively, but without some environmental support (such as a forum for proposing those ideas), the creativity that a person has within him or her might never be displayed" (Sternberg, 2006, p. 89).

These views are not as distinct and disconnected as they first appear. The intrinsic, psychometric models allow for some interaction between the actor and the environment, where intrinsic elements of creativity can be affected by the environment. The confluence models allow for creativity, occurring as an amalgamation between the reagents in both actor and environment, to remain unexpressed as an internal event. Both suggest some elements of actor and environment may be quantifiable as predictive of creativity. Both, at least in the long-term, would tend to accept the same items as "creative", even if grouped into different creative domains. Both require a multi-faceted definition of creativity, a problem for research such as this study, as such complex definitions do not lend themselves to simple linear tests of ability. Correspondingly, measuring creativity may be as elusive a goal as defining it.

Measuring Creativity

The study of creativity and attempts to measure it date back well into the last 19th Century, although many view J. P. Guilford's Presidential Address to the American Psychological Association in 1950 as the starting date for scientific creativity research (Plucker

& Renzulli, 1999). Over the first twenty five years of this period, sometimes called "the first golden age of creativity research" (Plucker & Renzulli, 1999, p. 36), research fell into two main camps. The first group tended to view creativity as a cognitive skill and included tests such as the Torrance Tests of Creative Thinking, developed by E. Paul Torrance in 1974, still the most widely used assessment of creative talent (Sternberg, 2006). The second group tended to view creativity as a personality syndrome, related to a variety of personal traits such as openness to new experiences. Research on both lines tended to view creativity as an intrinsic property, inherent to the actor. In 1999, Plucker & Renzulli grouped the types of research by stating that "[n]early all creativity studies can be classified in five categories: psychometric, experimental, biographical, historiometric, and biometric" (p. 37). The biographical and historiometric approaches use historical and biographical data to attempt to use the eminent minds in a field as a model to understand creativity. Biometric approaches focus on the physiological operations of the human mind. The psychometric and experimental approaches look to correlation, causal-comparative, quasi-experimental, and experimental methods to quantify the creative process. Research in each of these categories were attempting to define the key characteristic that made one person "creative" and another not. This model fit well with the idea of being able to create a measurement tool that could be used to analytically measure the components that comprise creativity, once those items could be identified (Plucker & Renzulli, 1999). Divergent thinking forms the primary target of research for this area of model of creativity study.

These intrinsic models of creativity have inspired a large number of measurement instruments, most focused on divergent thinking: "Kaltsounis and Honeywell (e.g., 1980) published a substantial list of creativity tests, and Torrance and Goff (1989) identified no fewer than 255 such instruments" (Cropley, 2000, p. 72). Instruments based on these models have

demonstrated reliable predictive ability; for example, the "composite verbal (but not figural) creativity scores on the TTCT . . . accounted for about 50% of the variance of scores on the criterion of publicly recognized creative achievements and participation in creative activities obtained several years later, and predicted about three times as much of the criterion variance as IQs" (p. 73).

Creativity testing based on divergent thinking provided a good foundation; however, "[a]n important advance in creativity testing in recent years derives from increasing recognition of the fact that actual creative production does not depend on divergent thinking alone, but also requires convergent thinking" (Cropley, 2000, p. 73). This was driven by the fact that combining additional actors into the divergent scores increased the predictive validity coefficients of the models, especially when combined with other, non-creative factors: "We also found that adding our creative measures to analytical as well as practical measures roughly doubled the predictive value of the SAT for our sample in predicting grades for first-year college students" (Sternberg, 2006, p. 93).

This dichotomous connection of convergent and divergent thinking formed a midpoint on the path to newer, more holistic models. While the prior shift was due more to the desire to improve the statistical validity of the model, the newer shifts have been tied to philosophical shifts in our understanding of human reasoning and knowledge, adopting a more postmodern view of human creativity. The issue is that creativity is "not like height or acidity, but more like, say, humor or beauty, a quality that people—although they may concur in many of their actual judgments—are prone to disagree about" (Klausen, 2010). These changes draw the issue away from the divergent/ convergent debate, and place creativity in a larger, more systems-based perspective (Csikszentmihalyi, 1999).

The shift in perspective is similar to the transition that has occurred in our understanding and measurement of human intelligence: the original models envisioned a single value that could be used to represent innate intelligence; newer models follow models such as Gardner's multiple intelligences (1983), requiring corresponding changes in the measurement methods and techniques. Similar to the concept of multiple intelligences in IQ testing, a number of multi-modality models have arisen, starting with the Four-C model (Csikszentmihalyi, 1999; Sternberg, 1999; Kaufmann & Beghetto, 2009). The shift is a philosophical one at heart, moving from a modernistic, "test-tube" approach to a more postmodern observational approach: "In another study, we looked at predictions for everyday kinds of situations, such as when milk will spoil (Sternberg & Kalmar, 1997). In this study, we looked at both predictions and postdictions (hypotheses about the past where information about the past is unknown) and found that postdictions took longer to make than did predictions" (Sternberg, 2006, p. 88). Creative output is no longer the only topic of interest: the process by which creative thought is generated, the interaction between all of the elements, including the creative actor and environment but expanding beyond, is considered as significant elements of creativity.

The conceptual shift has moved the measurement model from an attempt to isolate discrete elements of the actor and environment which intrinsically contribute to creativity, to an integrated model in which no single components can be "creative" in and of itself. The complexity of the models varies, but they hold in common the view that the whole is not just the sum of the parts. While the changes in our definition do not inhibit research on creativity, the mix of complexity and ambiguity in the definition of the nature of creativity does make meaningful measurement correspondingly more difficult. Some have gone so far as to claim that the defect in definition can result in a complete failure in the ability to measure creativity itself;

instead "[c]reativity tests have thus been criticized for actually testing other abilities that are either merely components of creativity or factors typically accompanying it" (Klausen, 2010, p. 348).

Where the Four-C model attempts to define the operation of creativity based on the nature, scope, and long-term recognition of creative acts, other approaches take a more systems view. One such model is the confluence model proposed by Sternberg and Lubart (1991), Beghetto and Kaufman (2007), and others. Rather than viewing creativity as dichotomous in nature, confluence models extend that categorization to describe the interplay between a much wider range of components. Sternberg (2006) proposes that "creativity requires a confluence of six distinct but interrelated resources: intellectual abilities, knowledge, styles of thinking, personality, motivation, and environment" (p. 88).

While the Four-C and confluence models have expanded our perspective, their focus still is more heavily on the actor in identifying creative acts and creative potential. Another group of models places a focus on the environment, but establishing mechanisms to perform creativity testing on the environment. Mathisen and Einarson (2004) provided a summary and critique of five commonly used creativity tools that analyze the environment for creativity: Ekvall's Creative Climate Questionnaire (CCQ); the Siegel Scale of Support for Innovation (SSSI); Amabile's KEYS; Anderson and West's Team Climate Inventory (TCI); and the Situational Outlook Questionnaire (SOQ) from Isaksen, Lauer, and Ekvall.

In the case of a study with limited research funds available like this project, attempting to measure this multi-faceted nature of creativity poses a significant problem. This is compounded by the goal of performing a pre-test / post-test combination to determine a creative baseline for study participants to determine if the simple fact of thinking about creativity makes us more

creative. Also, given the objective of allowing study participants to complete the study completely within an hour, any tests selected must provide a high predictive validity, high inter-rater reliability, and low cost. Two tests were selected for possible inclusion in the project, and will be examined in greater detail next.

Creativity Tests: The Torrance Tests of Creative Thinking

The most widely used and most referenced test in this group is the Torrance Tests of Creative Thinking (TTCT) (Kim, 2006). The TTCT presents in two versions with two forms: the TCTT-Verbal has seven subtests and is 45 minutes long; the TTCT-Figural mode presents three subtests in 30-mnutes (Kim, 2006). The TTCT-Verbal provides a stimulus and asks the test-taker to respond with words; the TTCT-Figural presents a stimulus and has the test-taker respond by drawing. As an example of the testing format, the TCTT-Verbal mode could present a picture of a person doing an apparently meaningless act, and then ask the test-taker to list as many questions to ask to understand the situation, possible causes, and possible consequences of the event as possible (Horne, 1988).

The TTCT-Verbal yields scores on three "mental characteristics" or verbal characteristics of creativity: fluency, flexibility, and originality; TTCT-Figural scores on five additional mental characteristics: fluency, originality, elaboration, abstractness of titles, and resistance to premature closure (Cropley, 2000). The TTCT analyzes primarily divergent thinking and is often used in testing elementary school children (Plucker & Renzulli, 1999), but has been shown to have a positive correlation to predicting adult creative achievement (Yamada & Tam, 1996). Longitudinal studies have demonstrated a predictive validity coefficient of near .7 (Cropley, 2000) and predict about predicted about three times as much of future publicly recognized

creative achievements and participation in creative activities as does the IQ score (Plucker, 1999).

Creativity Tests: The Remote Associates Test

One creativity measure based on divergent thinking is the Remote Associates Test (RAT) developed by Mednick in 1962. In the RAT, participants are given 30 triads of apparently unrelated words (e.g., moon, cheese, and grass) and the task is to find a remote fourth word that links these words (in the case of the example just given blue would be considered a correct answer). The score is the number of correct solutions supplied within 40 minutes (Cropley, 2000).

When the test was developed in the early 1960's, Mednick reported internal consistency coefficients of .91 and .92 respectively when the test was administered to samples of male and female undergraduates, and a .70 correlation with instructors' ratings on a university-level architectural design course; however, Cropley (2000) summarized results from various studies including Kasof (1997) that, due to a reliance on purely divergent creativity, showed "the RAT has not shown more than moderate correlations with creative behavior in non-test situations" (p. 73). As other tests provide a more accurate measure of creative production that does not depend on divergent thinking alone, but also requires convergent as well, use of the RAT has decreased until the test is now out of print.

The test demonstrates the weakness of relying on divergent thinking to measure the broader definition of creativity. In the sample triad of "moon, cheese, and grass", one could potentially also answer "green" (referring to the proverbial "the moon is made of green cheese" and "green grass"), but this answer would be treated as incorrect: a "non-creative" answer. Where test-takers demonstrate greater creativity than the test-raters by producing answers

outside of their creative scope, the RAT treats these answers as wrong, a significant weakness. Modifications to this approach could provide more accurate results; however, no ongoing development is occurring on this instrument.

The project environment was designed to allow the research project to select a pre-test / post-test instrument appropriate to the research question, so an appropriate test can be selected for each study. Given the financial limitations of this study, the RAT was selected to provide baseline creativity information, even given the limitations of the test.

Team Characteristics

We commonly believe that we are more creative in groups than alone, yet research is not conclusive that this belief matches reality (Csikszentmihalyi, 1996; Drucker, 2005; Hill, 2009, Paulus, 2002). Drucker (2005) reflects this uncertainty bluntly: "Team work is neither 'good' nor 'desirable' – it is a fact" (p. 1). Yet, as much as using teams for creative work is difficult to attain, it is equally necessary for success (Donnellon, 2002; Drucker, 2005; Hill, 2009; Singh & Muncherji, 2007). "Many teams have great difficulty learning and enhancing their collective capacity to innovate – as discussed earlier, a key to success in today's dynamic environment" (Hill, 2009, p. 13). If we wish to avail ourselves of the opportunity that teams provide to generate innovative solutions, however uncertain, we must first begin by recognizing the debate about the degree to which creativity is affected by the environment in which it occurs and the characteristics that affect team creativity (Paulus, 2002).

In recent decades, teams have become commonly used structures for their ability to coordinate work (Paulus and Van der Zee, 2002); however, dysfunctional elements within the team can prevent them from achieving their goals (Thompson, L. L., 2008). Like any other organizational structure, the culture of the team can lead to a lack of success (Drach-Zahavy &

Somech, 2001). Field (2009) suggests that "Under most dysfunction lies a lack of trust, the inability to engage in productive conflict, or insufficient clarity of purpose" (p. 1). The interaction is complex: Brodt and L. L. Thompson (2001) identify three categories of psychological processes that occur within the group, in which the participant can contribute at the individual, intra-group, and inter-group levels. Some have even posited that the nature of an individual's family of origin can affect creativity later in life (Gute, Gute, Nakamura, & Csikszentmihalyi, 2008). While this psychological complexity can provide an element of stability to the group, it also makes correction of dysfunctional elements more difficult.

While an organization can and may need to effectively employ each type of group in the appropriate setting, "[t]eams are not a panacea for organizations; they often fail and are frequently overused or poorly designed" (Thompson, L. L., 2008, p. 13). Selecting the wrong format can significantly reduce the effectiveness of the group in accomplishing the task at hand effectively.

Another element believed to affect team effectiveness is team structure. Drucker (1992) compares types of teams to sports teams: the *baseball-type team*, in which players have distinct roles, duties, or positions, where they "play *on* the team" rather than "play *as* a team"; the *football-type team*, in which team members play distinct roles but follow a common game plan which coordinates their activity; and the *tennis-doubles-type team*, in which team members are constantly adjusting to their teammates and to the changing conditions of the game, where "only the team performs; individual members contribute" (p. A16). Particular types of teams are more effective with selected classes of problems; selecting an inappropriate team structure for a given task can negatively affect results (Driskell, Radtke, & Salas, 2003). While individual team members may compensate for poorly structured groups, team structure is an important

contributor to team success, especially as high-performing team members may be limited by the structure of the team (Sonnentag, 2001). Potentially high performing team members may also be constrained by their conception of the role that they should play (Islam & Zyphur, 2005) or by prior interactions with other team members (Clark, M.A. et al., 2000), or even by the desire to not be perceived as a group time-hog (Kuk, 2000), as group members conform their behavior to perceived group behavioral norms (McKimmie et al., 2003). While these members can alter the tone of the group to increase expectations (Long & Shields, 2005), these factors can alternatively reduce the effectiveness of individual high-performance members and emphaisze the importance of developing effective team structures Driskell et al., 2003).

An additional element of team effectiveness is the commitment to and expectation that a team will accomplish its goal. Hall (2009) identifies setting the agenda as one of three "critical elements" in team success. Aubé and Rousseau (2005) showed a positive correlation between team goal commitment and three criteria of team effectiveness. A study by Field (2009) further suggested that even a lack of clarity in defining the purpose of the team can result in failure. Diversity can also affect team creativity by altering the manner in which the team establishes frameworks for interpreting information and resolving conflicts in meaning, the presence of which can help reinforce team identification (Clark, M.A. et al., 2000). The degree to which these factors detract from team identification can produce a corresponding reduction in team effectiveness.

These changes in the level of team commitment can affect other elements, which can further reduce team success. More cohesive groups tend to produce more creative solutions (Craig & Kelly, 1999), so items that reduce cohesiveness will have the indirect effect of reducing team effectiveness. Cognitive narrowing – the reduction in the ability to cognitively process

many items at once – resulting from stress, for example, can both affect team members' ability to envision solutions; it can also reduce commitment to the goals of the team (Driskell et al., 1999). Stress can also influence other external factors such as getting sufficient sleep, which can produce increased feelings of hostility and fatigue and decreased feelings of joviality and attentiveness (Scott & Judge, 2006); this friction between team members can result in decreased productivity. Similar results were found among therapeutic groups where group climate and group leadership were linked to successful outcomes (Kivlighan & Tarrant, 2001). While work teams differ from therapeutic groups, climate can be an issue in achieving group goals.

Even the degree to which the team feels there is sufficient time to complete their work can alter results. Sanna, Parks, Chang, and Carter (2005) found that a sense of time pressure had not only caused teams to underestimate the time it will take to finish tasks, but also to reduce their ability to envision success; Janicik and Bartel (2003) further found that temporal planning early in the stages of team work may be required to produce effective coordination and task performance. Prior experience by individual team members with the virtual team environment can also contribute to the success of a virtual team (Clark & Gibb, 2006), even in a different virtual context, especially with relation to procedural justice and process fairness (Bauer et al., 2006). Teams which have significant doubts about their ability to reach their goals also show reduced levels of effectiveness at accomplishing the assigned task, even if the task is actually within their abilities (Aubé & Rousseau, 2005). Since time is just one of the resources made available to the team (Sanna et al., 2005), similar resource limitations may equally reduce team effectiveness such as the lack of a supportive climate for implementation of ideas (Grawitch et al., 2003) or a lack of autonomy (Grawitch et al., 2003).

The degree to which team members personally gain from the team environment may also be a factor in the degree to which they participate. Hill (2009) argues that the degree to which individual team members are satisfied and learn should be viewed as one of the measurements of team success, equal to whether the team accomplishes their stated goal. M. A. Clark et al. (2000) argued that the desire to actively participate in the team is related to their degree of satisfaction with the group process; each of these factors is related to the team's ability make decisions. Related studies of the motivations of customers contributing to firm-hosted commercial online communities, in which customers interact to solve each other's service problems, found that commitment to the online community and to the value of team work product were among the strongest motivations to actively contribute online (Wiertz & De Ruyter, 2007).

Factors which can negatively affect member satisfaction can include conflicts between self-managing team structures and individual self-management. Since self-managing teams level involve interdependent behaviors, individual self-managing activities may harm team effectiveness:

> Self-management by individuals differs from team self-management. In team situations, members work collaboratively to determine problem-solving approaches. Members have greater responsibility, but as a collectivity rather than as individuals . . . . Consistent with this viewpoint, studies have shown that some self-managing teams involve little individual self-managing and even a loss of personal control and individual empowerment for team members (Liden, Wayne, Bradway, & Murphy, 1994; Manz & Angle, 1986). Thus, team self-managing involves self-management behaviors very different from those appropriate for individuals, perhaps even behaviors that would not be considered individual self-management at all" (Uhl-Bien & Graen, 1998, p. 341).

Since loss of individual empowerment and personal control are linked to decreased creativity, management structures which cause these effects can also be expected to decrease creativity as well.

Existing relationships, prior knowledge, and experience of the team members is also an element of trust-building that can affect team effectiveness. Field (2009) listed the team's ability to develop and maintain trust as one of the key elements of team dysfunction. Sassenberg (2002) showed that members with an attachment to the group as a whole (common identity groups) showed greater adherence to the behavioral norms of the group, while those with only an attachment to another group members (common bond groups) do this less; this may have a related impact on adherence to the productive goals of the group. Discourse theory holds that communication messages gain meaning as a result of the shared context between speaker and listener; this context can be ambiguous, limited, or misread between group members with no prior interaction (Sillince, 2007).

Grawitch, Munz, and Kramer (2003) demonstrated a link between positive/negative/neutral affect and creativity: positive mood resulted in increased creativity, while negative and natural mood had no impact. Since prior interactions between members could inhibit the development of positive mood, prior relationships can reduce creativity, although depersonalization in the team has been shown to produce similar results (Postmes et al., 2002).

Virtual Teams

Virtual teams are a unique subset of teams in which team members communicate via computer mediated communication, telephone, or in recent years, video conference. Members of online groups can be identified or can be completely anonymous, known to one another only by

nicknames (McKenna & Green, 2002). Many organizations use virtual teams as a cost effective alternative to the travel costs of physically sending employees to a common physical location for a face-to-face meeting (Thompson, L. L., 2008).

This flexibility provides several advantages. First, employees can participate in meetings without travel or advance notice, allowing for a greater number of opportunities to participate in the group while reducing costs (Successful Meetings, 2010). Additionally, virtual teams can use real-time collaboration tools to facilitate the meeting; share information including documents, images, and screen displays; record the proceedings of the sessions; and, provide indexing and retrieval options to facilitate information sharing (Driskell et al., 2003; McKenna & Green, 2002).

At the same time, the virtual team environment is different from a face-to-face meeting. While some hold that CMC can effectively extend face-to-face meetings over long distances, there is disagreement how effectively this can occur, and that the nature of interaction in virtual teams may differ in a number of important ways from "normal" face-to-face team interaction:

> During face-to-face interaction, group members can see another's nods and gestures; they can observe eye contact, facial expressions, and posture; they can hear the other's tone of speech and dialect; they are aware of the timing of speech and who responds to whom; and they experience the immediacy of interacting and being involved with a physically present team member. These types of contextual cues provide important information about the individual with whom one is interacting" (Driskell et al., 2003, p. 298).

The loss of these non-verbal cues has a number of effects on the virtual team is primarily related to the use of CMC, as has been examined earlier. For virtual team members that have an ongoing relationship, this may not as significant of a factor (Driskell, Radtke, & Salas, 2003), but

the issue can become more pronounced in virtual teams composed of members without ongoing contact: the temporary virtual team.

Temporary Virtual Teams

Temporary virtual teams can be found in a wide variety of settings and are assembled to address a wide variety of issues, from implementing corporate organizational changes to university student resolving class assignments. These teams differ from generic virtual teams in two additional ways: first, the virtual team is assembled for a limited period of time, usually to accomplish a single task, or address a single issue; secondly, the team members may not have had any prior contact, and ongoing contact between members after the team has disbanded is not always likely. Like the comparison between teams and virtual teams, temporary virtual teams are more specific sub-set of teams, with additional constraints on their operation. These characteristics add an extra degree of difficulty to the goal of virtual team creativity for a number of reasons.

First, the temporary virtual team is often assembled on short notice with little thought to leadership structure, often only specifying a single member as responsible to report the team's results. This can result in either a lack of useful team structure or a structure that does not effectively direct the team activities into meeting the defined task (Drucker, 2005). Team commitment and task engagement issues may result (Grawitch et al., 2003), resulting in an initial lack of group cohesiveness, which can limit their results (Craig & Kelly, 1999).

Secondly, since the team is not likely to have ongoing contact, like other virtual teams may, the sole use of CMC may result in depersonalization which can also affect creativity (Postmes et al., 2002). Since one effect of face-to-face meetings before using CMC is to reduce the ability to develop shared vocabularies (Driskell et al., 2003), team communication may suffer

as the temporary virtual team members lack the language and artifacts (terms, definitions, and phrases with context-sensitive meanings) to explore the topic at hand. This may act as a form of cognitive narrowing as members must resolve the communication issues first, before being able to address the task assigned to the group (Driskell & Salas, 1999).

Additionally, the use of the temporary virtual team can reduce the role that local experts, organizational and informational resources on the topic, may have on the development of solutions. Since the issues being addresses by the team may require non-traditional approaches, the loss of informational resources may result in either a benefit or a loss to the group. More importantly, these in-house "gurus" play an important role in changing organizational structure as advocates of alternative approaches (Wright & Kitay, 2004). The loss of this transformational power can be a much greater loss than that of the information they provide.

Frustration with this process can lead to difficulties developing trust between team members (Field, 2009; O'Brien & Renner, 2002). While the ongoing relationship between team members is generally seen as a significant element of team evaluation, the temporary online team provides an environment in which this element is either reduced or removed. This can alter the characteristic nature of the team, as it can minimize the degree to which individuals can contribute for three reasons. First, members lack an interpretive framework to evaluate statements and actions using prior interactions; this requires that each ambiguous statement must be analyzed, rather than relying on broad judgments of intent such as "She didn't mean anything by that. She just likes to overstate things to get a reaction from others." Secondly, the lack of prior relationship can limit the degree of trust between members. Finally, those with a prior relationship may have other "out-of-group" communication channels which may aid in resolving conflict or ambiguity; if no relationship exists, these channels may not exist either.

Often the temporary virtual team exists only for the purpose of resolving a single task, one that that has not been resolved using other existing problem-solving approaches. Temporary virtual team members will often be asked to add the team duties into their present job duties. Meeting both commitments with limited time resources may result in temporal framing issues, which can affect the ability to envision success, much less achieve it (Sanna et al., 2005). Temporal framing refers to the group's ability to evaluate the time available for the task. While all team members may agree on the concrete measurement of the value "ten minutes," each may draw different subjective evaluations of that period with relation to the time required for the task: a perception that there is "too little time" to complete a task can affect team member's view that their task is achievable.

This may also cause the team members to question the organization's purpose in assigning the task; if the team questions the degree to which the sponsoring organization is committed to provide a supportive climate for the implementation of any ideas generated, they will be less likely to take the risk of suggesting ideas outside of the "accepted norm" (Grawitch et al., 2003). This, of course, is the exact opposite of what the organization needs and has requested: since the problem has resisted solution using traditional problem-solving techniques, only "the ability to transcend traditional ideas, rules, patterns, relationships, or the like, and to create meaningful new ideas, forms, methods, [and] interpretations" (Random House Webster's Dictionary, n.d.) can result in successful resolution.

The same issue can also occur at the problem definition level: poorly defined problems, with non-specific criteria, can make it difficult for the team to separate the task into soluble elements (Coskun et al., 2000). The frameworks that the team creates to define the problem and generate resolution depend

Since communication in the temporary virtual team occurs via CMC, knowledge fragmentation can also be an issue (Thompson, L. F. & Coovert, 2003). This relates to both knowledge and meta-knowledge, or knowledge about knowledge: the facts that you know directly and facts that you know that others know, but you do not, and the structures used to carry on discourse (Sillince, 2007). In groups with prior experience that do not share direct experiential knowledge, they possess the meta-knowledge to know who does possess that information and can share it with the group. In temporary virtual teams, this is most likely not present and "[a]lthough CM teams can theoretically develop mutual knowledge through interactional dynamics, in practice they do not do so effectively, as indicated by research demonstrating that electronic communication adversely affects communication thoroughness" (Thompson, L. F. & Coovert, 2003, p. 136). While some tasks fit well in this low information-richness environment, such as generational tasks, the study concluded that intellective tasks would be a marginal fit, while judgment and negotiation tasks would be a poor fit for the environment.

Team Management

Teams can be managed in many different ways. L. L. Thompson (2008) describes four models for team management: Manager-led work teams in which a manager designs the organizational context, designs the team as a performing unit, monitors and manages the performance of the team, with the team executing the task at hand; Self-managing work team, in which the team additionally performs the roles of monitoring and managing their productive output; Self-designing or self-directing teams, in which the team adds the duties of determining the structures, objectives, and methods that will best produce the output they desire; and the Self-governing team, which the team autonomously fills all four of the roles.

Pearce and Sims (2002) found a correlation between leadership and team effectiveness, regardless of whether the leadership structure is imposed from outside the group or shared within the group. Their study found that self-directing team leadership was a more effective predictor of the team's productivity after six months. While the self-designing team may at first appear to a doubtful manager to be a haphazard way to accomplish the goals of the group, the most successful extra-group leaders were the ones who managed the interface between the organization and the self-managing team (Druskat & Wheeler, 2004). Other studies have shown a correlation between the nature of the team leadership and information sharing, which can affect team results (Henningsen, Henningsen, Miller, Jakobsen, & Borton, 2004).

Regardless of leadership structure, groups frequently get their internal structure right almost by instinct, by generally tending to accurately assess the capabilities of members in the group to form structures that are more effective at accomplishing the group's goals (Sullivan & Reno, 1999). This is a "pragmatic pattern of interaction. First, group members identify capable individuals who are then allowed to dominate the interaction. Then, they attribute more responsibility to those individuals for the group outcome" (p. 203) resulting in structures that are effective in meeting team goals.

Teams can be motivated from without or from within: leadership and team commitment can at time be augmented by the motivation for personal gain. While there is not a great deal of specific evidence of the positive effects of competition on teams, competition is a common element in attempting to make teams more effective (Tjosvold, Johnson, Johnson, and Sun, 2006). Constructive competition holds an uncertain place in the research: some studies have shown that

> "being required to engage in competition with teammates was significantly related to perceived (a) increased effectiveness of task work, (b) personal benefits in self-confidence, social support, and learning, and (c) stronger relationships. These findings are unexpected, as there are social scientists who strongly state that requiring individuals to participate in competition will inevitably result in destructive outcomes (Kohn, 1992, 1993). Contrary to that proposition, being forced to engage in competition may be an accepted aspect of group and organizational life that generates little resistance" (p. 95-96)

Effective team motivation cannot only be external in nature: effective teams must be internally motivated to use their energy to accomplish team goals. This motivation requires that team members have a commitment to team goals, can identify a connection between their actions and team success, feel that their input is valued, possess a sense of social equality linking the activity (or inactivity) of the members of the team, and have a sense of responsibility for the outcome of the team (Thompson, L. L., 2008).

Method

The purpose of this project was to identify if it is possible to increase the creativity of temporary virtual teams by modifying components of the environment in which the team operates. The question is a useful one, as creative solutions are one of the frequent expectations when a temporary virtual team is assembled. At the same time, the problem of establishing an experimental environment in which various environmental elements can be modified is anything but trivial. The very strengths of the virtual team – geographical and organizational dispersion, provided through flexible computer-mediated communications – make it very difficult to isolate the team from its environment, or to consistently alter elements in the interaction of the team

members. Members can participate in widely differing environments which can have an effect on their ability to participate effectively (Driskell at al., 2003).

As a result, this project was defined as combining two distinct elements: (1) the creation of a controlled online environment; and (2) the subsequent use of that environment to evaluate the research question related to improving creativity in temporary virtual teams.

Software Design Characteristics

While the focus of this document is not to address the software development from a computational viewpoint, design characteristics play an important role in being able to successfully control the experimental environment in such a way as to minimize the effects of these outside influences, while providing the ability to selectively manipulate the participants' experiences to examine the effect on creativity (Driskell, Radtke, & Salas, 2003).

Given the initial uncertainty regarding the environment in which the research project would be carried out, the choice was made early in the process to select a web-based design which could be implemented in the widest possible range of hosted environments, rather than relying on a model in which participants would be brought to a common location to perform the testing. Conceptually, this would allow testing to occur in a real-world environment: users would be working at their own computers, using the same browsers that they would for other work-related and personal matters. This also provided for the widest range of potential subjects, allowing the design to follow either experimental of quasi-experimental models through the appropriate selection of study subjects. To support the widest range of web servers, "open source" or "community supported" tools were preferred, meaning that the software is available to the general public at no charge, an additional benefit for the reuse of the project in the university environment.

After an evaluation of current technology, a design was selected using an AJAX front-end that would fit into the PHP code used for the project, storing data in a mySQL database. AJAX, an acronym for "Asynchronous JavaScript and XML" allows a web developer to update portions of a web page from the client-side, rather than sending a new request to the server to build a new page. This approach allows client-side requests to reduce the demands made on the web server, while providing a smoother user interface, as information updates do not require reloading the entire page. Additionally, as this combination of the PHP programming language with a mySQL database server is one of the more ubiquitous hosting platforms available, this provided a wider range of potential implementations. This was deemed to be a significant advantage since, at the time the project was begun, details regarding where the research environment would be hosted were as yet unknown, and requiring changes later could significantly delay the completion of the project. The completed virtual online environment project consists of about 30,000 lines of PHP application program files, including support library functions, so extensive modifications could be very time consuming.

Secondly, the project was designed to be modular in nature. Rather than creating a single, monolithic application that carried out the execution of the research question, the design was to be created in small, independent pieces. This would allow one study to select a different pre- and post-test than another using the same testing environment. Group assignment could be sequential assignment of conveniently available volunteers for a quasi-experimental research project, while random assignment to control and treatment groups of a true random sample of participants would allow for a full experimental design to be carried out. Since the goal as to design a platform which could be used to study more than just this one question, this modular

layout would provide the flexibility to implement the characteristics of a specific research methodology.

Third, the project was designed to support the widest range of user platforms possible. Testing was performed using Microsoft Internet Explorer 7, 8, and 9, Firefox, Google Chrome, Opera, Safari, and Dolphin on Windows, Linux, and Apple Mac OS X systems. The goal was to insure that any user could participate using the environment in which they were most comfortable.

Finally, the project controls were designed to be rule-based and data-driven, rather than controlled by making modifications directly to the programs. This provides the flexibility to perform multivariate analysis through manipulation of more than one variable between study groups. Since creativity is a complex concept, the choice was to provide sufficient computational complexity to adjust the study groups based on design rules, rather than constant program requirements, to match the nature of the subject under study.

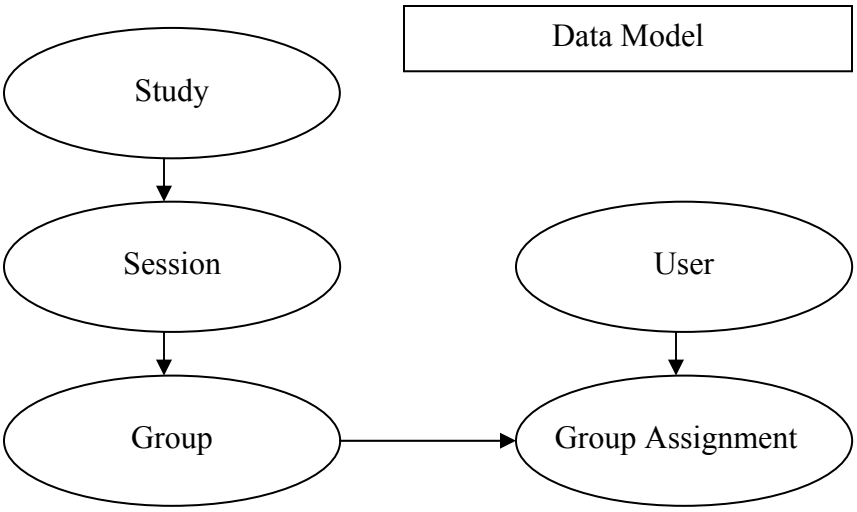
Data model

The data model for the project was a tiered hierarchical model, in which characteristics set at a higher level would flow through as default values to the lower levels, or could be passed to the lower levels for assignment. For example, the specific pre- and post-tests can be selected at the session level, while allowing actual test questions to be selected at the group level, or randomly assigned to each user at the time of participation. Control rules can specify static values (i.e. each group contains 6 members) or can be algorithmically defined (i.e. “generate a session every Wednesday at 7:00 PM CST”), at the discretion of the principal investigator. Rules include those needed to insure informed consent, collect required demographic, survey subjects about study-level information, manage pre- and post-testing, assign subjects to groups,

select study questions, and manage any required subject compensation. The data model is shown in Figure 1:

Figure 1

Software Data Model



The highest level defined is the Study, containing the research question being addressed, with rules that define the defaults for all lower levels. The Study contains the conceptual level design of the research material and selects the environment to research that hypothesis, in one or more Sessions. Sessions are the next level, containing information related to a single "meeting" of the groups. While virtual teams may not physically meet, virtual sessions are still typically arranged to take place at specific times with definite start and end times to insure enough participants to form a Group. For each Session, Groups are formed subject to the controls defined at higher levels, frequently along control/treatment group models, as research subjects log into the system and choose to participate in the selected study session. Subject information would be stored in the Users table, allowing for both ad hoc and longitudinal studies. The final table, the Group Assignment, was used to track the groups in which subjects participated, to store

pre-test, post-test, and user specific study information. For example, in groups which allowed the user to select a screen name, this information was stored in the assignment.

Testing process control flow

The choice was made to design the control flow to provide the researcher with the ability to control threats to internal validity using a traditional experimental or quasi-experimental design ("R O X O / R O _ O") model. Study participants are broken into two or more types of groups, for example, a control group, presented with a pre-test, a baseline operational process, and a post-test; and a treatment group, presented with a pre-test, a specific "treatment" operational process, and a post-test.

To minimize selection threats, subjects can be assigned sequentially into each type of group, or can be assigned randomly. This means that a specific subject has an equal opportunity to be assigned into treatment or control groups. Further, assignments to control or treatment groups can be random or sequentially assigned, allowing for the selection of experimental or quasi-experimental designs, limited only by the appropriate random selection of subjects to fit an experimental design model.

Software design of the non-study elements of the environment

To implement a controllable virtual online environment in which key environmental variables could be controlled, the first operational need was to automate a number of issues that could normally be taken for granted in the real world: identifying members, assembling teams, providing a communication platform to enable communications between members, and providing a support structure to resolve issues and questions that might arise during the exercise. In most companies, for example, there already exists a communication structure that employees can use to communicate with each other: to control the environment, this project must provide a

functional equivalent. Most organizations also have support structures in place to support the use of technology by their members. If an employee forgets a password, many have “help desks” or “support centers” that will aid the employee through the process of resetting a password. Since the communication environment is detached from any such systems, the project needed to provide tools to create accounts, assign passwords, aid users in recalling their passwords, and provide options to reset forgotten passwords.

Software modules were created to accomplish these tasks, and integrated to form an operational platform into which the higher tiers would be connected. First, the ability to allow research subjects to create user accounts for research subjects was developed. Since the environment was configured to allow both short-term and longitudinal studies, the information collected included contact information, email, password, and a password reminder hint. These features can be flagged as mandatory or optional, as required for the specific study: for example, in the exercises run related to this project, users were recruited through the Amazon Mechanical Turk system (MTurk), which prohibits tasks requiring disclosure of the worker's identity or e-mail address, either directly or indirectly. To meet these requirements, the email notification features of the site were disabled using the project management features and messages added indicating that users could create fictitious email accounts. This allowed greater flexibility in completing research, while reducing threats to external validity due to limits placed on the selection of users by the requirements of the research environment.

Software design of the CMC chat components

Establishing and controlling a computer mediated communication (CMC) environment was the next issue to be addressed. Based on the design choice to develop the system in a modular format, each study could select the CMC communication tools most appropriate to the

research at hand. Quickly, though, it became clear that while voice and video interactions are possible future extensions to the virtual environment, they would be excluded at this stage in favor of textual chat. While voice chat, providing a communication experience similar to that of a conference call, would provide a richer communication experience between users, textual chat modes were selected for three reasons. First, text chat is a common form used by many distributed organizations as it is less intrusive to existing employee workloads, especially where it does not require that information be held in "working memory" (Olson & Olson, 2003). Employees can participate in text chat while performing other work duties, so the "multi-tasking" ability can be viewed as a way to accomplish another task "for free" in an already busy schedule (Mellander, 2001). Secondly, many organizations use textual chat as it provides a low-cost alternative to voice or video conferencing, especially as there is a wide variety of free commercial CMC tools which provide textual chat, including In Real-time Chat (IRC) systems such as Yahoo! Chat, AOL Instant Messenger (AIM), MSN chat (a/k/a Windows Live Messenger), ICQ, and Google Talk. Additionally, many systems with other primary components such as voice or web interactions include textual chat such as Skype, and Facebook chat. The preponderance of these tools makes them a common choice in the real-world, so the tools created in the virtual world of this project should reflect those choices. Finally, the choice of text chat provided an easier research environment. Conference calls, especially in an interactive creative group, can be difficult to transcribe correctly and elements of vocal communication such as sarcasm or doubt can be lost in the transcription process. Since one purpose of the study was to examine the effect of this reduction on creativity, using textual chat best fit the project goals. As a result, only text chat is supported in the current design, although this could be extended at a future date.

Implementing a group text chat system required identifying and resolving four key issues. First, while one of the current commercial chat tools could be used, it would be impossible to reduce the distractions resulting from simultaneous conversations from other "friends". Additionally, selecting a tool that was common to all group users (i.e. Yahoo! Chat) would either require participants to sign up for additional services or would unnecessarily reduce the available pool of research subjects. Insuring participant anonymity and implementing various parametric controls provide almost impossible. Finally, recording the conversations was, at best, problematic for a number of reasons. As a result, a custom communication tool was created.

A chat log area to show the prior conversation in a scrolling window was defined on screen with a multi-line HTML "textarea" to allow the user to submit text entries. When the user clicks the submit button or presses the [Enter] key, this text is sent to the web server. Entries are dated and logged to the user and stored in a chat table in mySQL. Once a second, an AJAX function polls the server to request the highest entry number in the chat for this exercise. It compares the last line displayed on screen, and requests the new material for display. As compared to an initial approach of reloading the complete chat on screen at each update, use of this two-stage differential approach resulted in a 600x reduction in reduced the internet bandwidth requirements while reducing the on screen delay to acceptable levels. This model also provided the ability to implement various parametric controls such as depersonalization, which are described below.

A similar technique was used to define a process to submit results, also selected to be textual in nature. While the chat log could be used to determine the results of the group, most real-world groups have formal submission processes, whether in the form of a report or verbal recommendations to a superior. For the exercises, an area of the screen was reserved to display

the list of ideas submitted; selected group roles were provided with the ability to submit results using an HTML "textarea" field, which were processed in the same manner as chat entries. By limiting the ability to submit results to a group leader and a group recorder, the virtual environment more closely reflects the situation that would exist in a the real-world, and provides the researcher the ability to examine the difference between ideas generated and ideas submitted, and possible correlations to group affect.

Finally, most online chat environments provide some form of "traffic control" or visual display that various group members are preparing to make a comment. An AJAX function was defined on the entry text area to set a server-based status flag upon entry of the first character in the box and to subsequently clear it when the entry was submitted or if the user deleted all text from the entry area. This model follows the approach taken by most of the online chat services and was a common user expectation uncovered during early testing. This status is shown in the member roster by changing the member name to bold in a different color when an entry is in progress. Additionally, directions for each role assigned, specific to the role that each plays, were displayed on screen.

Depersonalizing research data

Chat entries are stored in real-time in a mySQL database table. In most projects, following the study, the primary researcher must manually edit the logs to remove personally identifiable information. Since the study is quantitative in nature and could include as many as 1,000 participants each typing for approximately 30 minutes, this task was felt to be non-trivial, so several tools were also developed to highlight chat lines containing likely issues. A translation table of terms to be identified and replaced was defined and extended as work on the virtual environment continued. Initially, the table was populated with the fifty states

("Wisconsin" becomes "[A Midwestern state]"), the top 1,000 US cities by population ("Chicago" becomes "[a large Midwestern city]"). Next, the top 1,000 baby names for the years 1935 to 2010 were retrieved from the Social Security Administration, duplicates removed and a translation entry to "[name]" added into the table. This table is used to remove personally identifiable information from the logs, and was used to implement a portion of the "depersonalization" feature, described below. In addition to the translation table, filters were added to check for email address and telephone numbers. This allowed the data to be adjusted in real time while users were chatting.

Study management and reporting capabilities

Next, the development focus was placed on issues related to managing the research process and evaluating results. Study management controls provide functional control over all areas of the research project, grouped into three categories: user, study, and session management. User management features include the functions listed earlier with the addition of informed consent process controls and various features to simplify compensation to research subjects. Study management includes features to specify the research parameters and provide on-going statistical analysis of the research groups, to allow the researcher to adjust study parameters or abandon unproductive lines of research. Finally, session management enables subjects to participate in study groups subject to study requirements; create and assign groups, including generation and random selection of study materials; allow users to resume an interrupted session; and provide time management for study groups.

To simplify reporting and analysis, a complete statistical library was implemented using program code developed earlier by the principal researcher. In most research work, raw data is collected from the experimental environment, exported to a common format such as the Comma

Separated Values (CSV) format, imported into a statistical analysis tools like SPSS, and analyzed. Given the availability of these statistical functions, the reporting tool was enhanced to allow online statistical analysis immediately after each group completed. This provides the researcher with the ability to calculate both basic descriptive statistics, such as mean, standard deviation, and variance, as well as perform more complex analysis, such as a heteroscedastic Student's T-test to determine if statistically significant differences exist between the study groups. With the presence of this software library, such analysis could be carried out in three PHP program lines, dramatically reducing the analysis time on the data. Full combinatorics, tests for normality, calculations of beta and power (1 – ß) given the research alpha level, and a variety of other test statistics such as Chi-square and the F-test were also implemented to facilitate testing variances in addition to the mean-testing functions. These allow a researcher to define a report file which provides raw data and performs statistical analysis in a very small number of lines of PHP code.

Pre-testing and post-testing capabilities

All tests were also defined in a similar modular PHP format, including pre- and post-tests. Tests can be defined by adding a single PHP module to the server and applying the test to the study using the management tools, allowing new tests to be added over time. Having the ability to select different pre- and post-tests allows for evaluation of threats to internal validity resulting from maturation and testing threats. For longitudinal studies, this also allows evaluation of history threats, as subjects gain mastery on the studies topic over time. Individual questions for both pre- and post-tests can be generated at the study session level, in which all subjects in that study session receive the same test; at the study group level, where the members

of the same online group receive the same test questions; or at the individual level, where each subject receives a unique version of the test.

This ability to define a parameter at any of the four levels shown in Figure 1 was extended to all elements of the study, including pre-test, post-test, and primary research exercises. Additionally, the study automation features were designed to allow more that an "all-or-nothing" approach: settings can be defined at the study level using rules that identify which settings to apply to each session, capable of implementing any research requirement. For example, rules can be defined to create sessions very Wednesday at 4 PM, with pre-post questions defined randomly for each user, while study questions will be selected once for each session. If the requirement can be defined, it can be automated by the study management features. This level of automation also applies to the actual elements of the test environment which can be manipulated.

Organization of the testing process

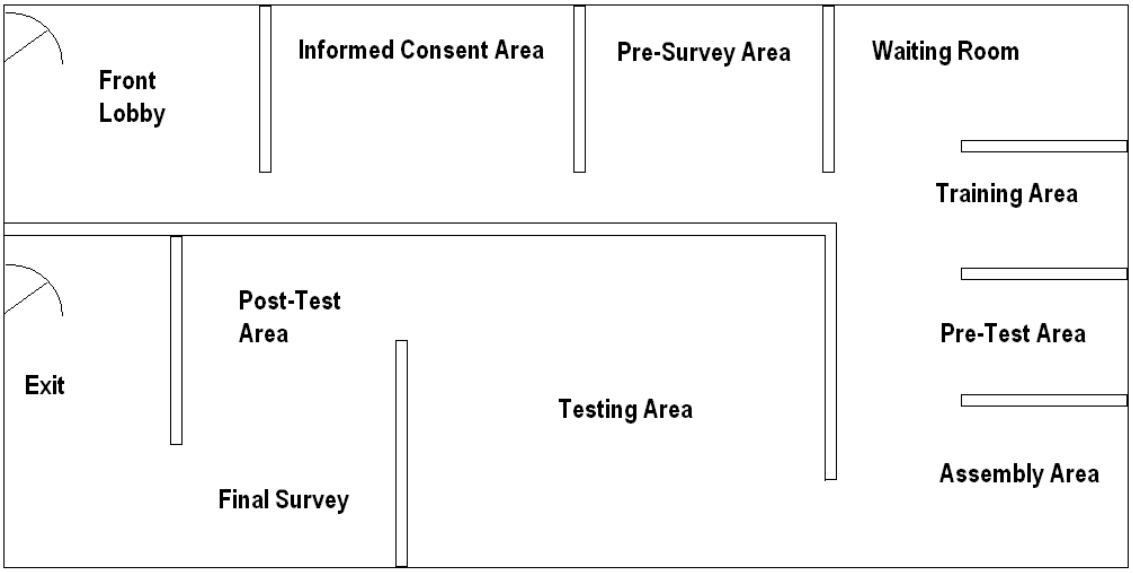
Early feedback on the software design indicated that subjects wanted to understand how far along in the process they were, as the research progressed. To facilitate subject this, two models were explored. The first was a "percent complete" bar which could be displayed on-screen; this was rejected after several attempts, as the time and effort required for each step was not identical at each phase of the process, and posting this visual element on the screen was reported as confusing by initial reviewers of the software.

A second approach was taken, in which a visual representation of the study flow was created, and the process flow through the study was described using the model of walking through the rooms in an office. Each functional step in the process was assigned a "room name", and each screen displayed to the user is labeled with the name of the room. A "map" of the

process was created and is displayed as part of the training information presented to all users, as shown in Figure 2:

Figure 2

Study "Floor Plan"



Each study screen reports this information to give participants an idea of where they were in the process flow for the study session. For example, the user is in the "Testing Area" on the screen shown in Figure 8.

Creativity testing controls

Eight characteristics were selected for manipulation: degree of group autonomy; group affect and mood; temporal framing; depersonalization; positive/negative expectation; clarity of purpose; supportive climate; degree of distracting "noise"; and range of categories of potential solutions provided. The difference between the two groups defines the parameters under investigation. For example, if the research question under consideration was "Does depersonalization and increased time pressure lead to a decrease in the number of ideas

generated?", the Session settings specified in Table 1 would implement a test environment in which the Treatment and Control groups will be configured to analyze the difference.

Table 1

Definitions to Compare the Effect of Time Pressure and Depersonalization

[Control]	[Treatment]
depersonalization=no	**depersonalization=yes**
time_pressure=no	**time_pressure=yes**
noise=none	noise=none
organization=minimal	organization=minimal
autonomy=high	autonomy=high
range_of_categories=small	range_of_categories=small
expectation=negative	expectation=negative
clarityofpurpose=low	clarityofpurpose=low
personalgain=no	personalgain=no

Depersonalization: one of the limiting factors of CMC is the reduced communication bandwidth and the reduction in the ability to connect on a personal level. For groups that do not have depersonalization applied, users are identified using self-defined screen names and, while revealing personally identifiable information is discouraged in the Informed Consent process, users can provide personal details on screen. With depersonalization enabled, users identified with screen names like "Participant 8" rather than the provided names. Further, any texts that post personal information are edited upon posting: "I'm Mike from Milwaukee" would appear on all other chat screens as "I'm [name] from [a large Midwestern city]." This editing is done in real-time by the software as users chat to further reduce any personal interaction. While it can be circumvented, all 50 states, the top 1,000 cities by population, and the 1,000 most popular baby names of each year from 1935 to 2010 are automatically reduced to non-personal equivalents.

Time pressure: With time pressure enabled, users all view a countdown clock on screen, starting at the maximum study time (typically ten minutes) which counts down second by second to zero; at two minutes remaining, the color of the clock text is changed to red. With

time pressure turned off, users see a message that indicates "You have about ten minutes remaining." This message is updated at five minutes, two minutes, and one minute, with the one minute message reading "About a minute remaining: do you need more time?" Both groups are provided a button that appears on screen during the last 90 seconds, labeled "Add 3 minutes"; the difference is not how much time is provided to the group, as this is identical, but how the time limit is perceived.

Noise: Noise provides two features: random audio beeps and visual "noise" in the form of randomly timed screen updates with information unrelated to the study content, typically in the form of interesting quotes. Noise can be set to values "no," "audio," "visual," and "both," with the corresponding effects during the study session. Audio beeps appear randomly between once every three to thirty seconds; a longer random delay is used for visual "noise" updates.

Organization: Each group is assigned a named organizational structure, and a few are pre-defined by the software. Required organizational roles are presented to users during training, and users are asked to volunteer for roles; the group is held in the training screens until all roles have been filled. Structures can vary: the single role of "Leader/Recorder" is a required role for "minimal" organizations. Additional roles can be defined for more detailed structures, and any group can have this organizational structure applied to the group. The required roles are presented to users in the Training Area, asking for volunteers to fill the role. Roles are granted "abilities" including the ability to report results, to extend the time of the study, and to terminate the study, with the ability to define additional abilities for each study.

Autonomy: Autonomy settings control the degree to which the group believes it can control the process of defining results. "High" autonomy alters the instructions and some on-screen messages to reflect the idea that the group has been granted control over the process;

"moderate" alters the screen messages and instructions to indicate limited abilities to adjust the process and content; "low" alters messages, requires external approval to extend time, and requires that any content questions be approved by the "boss" using a separate request (a dedicated chat channel to the supervising researcher). "Low" was not implemented at the time of this study. "High" autonomy would be seen in training statements such as "As a group, you get to decide what is useful;" "low" produces directions like "Remember that the goal is to generate creative ideas -- ideas that are both novel and useful -- and your virtual bosses in this exercise decide what is useful, so be reasonable."

Range of categories: On-screen, users are provided categories to suggest possible solutions, at three levels "small," "medium," and "large," each including the values included in the lower levels.

Expectation: Expectation is a way to attempt to change group affect by presenting instructions in a manner than reflects the potential results. "Negative" expectation results in messages like "each question has at least five answers," "when you run out of ideas," or "don't worry about answering all; no one ever does" and similar negative affect statements. "Positive" expectation produces directions such as "groups have produced as many as 30 answers." While the environment reduces the effect of such statements, negative statements such as "Remember, no one wants to get fired here, even virtually! Heads will role if we can't find the answer!" are intended to reflect workplace pessimism about the potential outcome. Additionally, if "noise" is enabled, negative expectation selects only quotes with famous bad predictions or bad advice, where positive expectation produces quotes encouraging further effort, such as the quote from Alexander the Great: "There is nothing impossible to him who will try."

Clarity of purpose: Clarity is expressed in the training materials provided: “low” clarity will direct the group to “solve the problem” and “come up with ideas” while “high” clarity would direct “To succeed, the goal is to produce the widest range of specific reasonable options. Be specific: rather than suggesting someone talks to an expert, add separate entries for a lawyer, accountant, and tax analyst, since each could be a separate follow up step. For questions examining travel, saying "ride" isn't as helpful as suggesting take a bus, driving a car, or riding in a truck, since each would require a different series of steps to apply.”

Personal gain: For groups that have the setting “personal gain” enabled, participants are encouraged to produce results for a potential personal gain. This can be implemented as a timed message appearing during the exercise indicating that the group that produces the largest number of acceptable answers could be promised an additional bonus.

Each study, session, or group can have any combination applied, although by convention, the “control” group is typically associated with the option believed to have the most negative effect on creativity. Additionally, multivariate studies are not limited to control and treatment groups, but could define multiple groups with parameters appropriate for evaluation via ANCOVA or other multivariate analysis techniques. Each group is defined by name, with the parameters required, as shown in Table 1, so data analysis is very open-ended. The eight parameters are summarized in Table 2.

Table 2

Configurable Settings for each Study Session

Setting	Values	Description
depersonalization	Low, medium, high	With "depersonalization" high, users are referred to as "Participant 3" and any user-identifiable information is filtered out of the on-screen chats; medium does not affect chat contents; low allows all user information to be displayed, including avatars or photos.
time_pressure	Yes, no	With time pressure=yes, groups are presented with a one second (00:00:00 format) countdown clock and instructions that state the project time firmly; "no" replaces the clock with a message that "you have about five minutes remaining", instructions that indicate that the time period is flexible, and provides a button to extend the time by three minutes.
Noise	Visual, audio, both, none	"Visual" provides a series of interesting quotes on screen, unrelated to the topic at hand; "audio" generates tones on a random basis; both provides both audio and visual distraction; "none" does not intentionally generate any distractions
organization	<user defined>; predefined values include minimal, extended	These are user defined names and values, with a few pre-defined values: "minimal " organization asks the group to fill one role, that of leader/recorder'; extended fills four roles: Leader, the recorder who submits results; the time keeper, who has the ability to extend the clock; and the tie-breaker who is given *a priori* authority to break deadlocks. Organization values are defined in a separate table, allowing this setting to have many values, each linked to a list of roles which is applied to the group.
autonomy	Low, high	Low/high autonomy is expressed in the wording of the instructions: "you have the freedom to define…"
range_of_categories	Small, medium, high	On screen, groups are provided with potential lists of categories of answers to aid in generating ideas. Small typically provides one or two; medium three to five; large five to fifteen.
expectation	Negative, positive	Expectation is expressed in the wording of instructions: "negative" includes phrases like "when you run out of ideas", "each has at least five answers"; "positive" includes phrases like "here are some categories to get you started" and "some groups have generated over 30 ideas for this question".
clarityofpurpose	Low, high	"Low" results in instructions like "generate ideas" while "High" provides more specific instructions: "build a list of anything that you might need: tools, supplies, information, people, or other resources"
personalgain	Yes, no	Personal gain allows for extra incentives for the group ("if your group generates the most 'novel and useful' solutions, you will each receive an extra $xxx")

Research Question

With this software environment in place, the next process was to apply it to creativity research. A qualitative study format was selected and the specific research question was defined as: "Does the imposition of a prescribed communication environment increase the creativity of temporary virtual teams?" with corresponding alternative and null hypotheses:

H_A: There is an increase in the creative idea generation ability of temporary virtual teams using a selected creativity environment as compared to temporary virtual teams without the specified elements of the structured framework.

and

H_0: There is no difference or decreased creative idea generation ability of temporary virtual teams using a selected creativity environment as compared to temporary virtual teams without the specified elements of the structured framework.

Based on the nature of the question under evaluation, $\alpha = .05$ was selected as appropriate for the analysis for this hypothesis.

Configuring the Online Environment to Evaluate the Research Question

Creativity, for this research question, was to be measured using the number of novel ideas generated. While the framework of the online creativity environment was designed for ANCOVA multivariate analysis, a simple linear model would suffice for this research question, evaluating the number of novel ideas generated as the dependent variable, with a fixed set of parameters as the independent. Given the characteristics of the project, $\alpha = .05$ was selected as appropriate for the research, and an attempt to establish bounds for the number of trials required (N) and the statistical power $(1 - \beta)$ of the study was performed.

Since no data was available to estimate the likely change between control and treatment groups, it was necessary to make and test several assumptions about the resulting change. First, given the nature of the task, it was assumed that the distribution of the quantity of ideas produced will follow a normal Gaussian distribution. Given the potential change in number of ideas between the control and treatment groups, equal variances could not be assumed, so an analytic method allowing for either homoscedastic samples or samples with unequal variances, such as the Student's T-test, was selected.

To estimate the sample size required, several simplifying assumptions were made. First, the ideas selected all had at least five answers that could be generated by a group. This number was taken as the number of ideas to be produced by the control group, with a standard deviation of one. To predict the performance of the treatment group, initial thought were that the change in environment would produce at least a ten percent improvement by the treatment groups. Power analysis then indicated that a sample size of 43 groups would be required, for a total of 516 participants. A second analysis, positing a 25% improvement in the treatment groups resulted in the requirement that a sample size of seven groups would be required, for a total of 84 participants. Approval was sought and was granted for twice the higher number to insure that sufficient sample could be collected; however, the limited improvement required indicated that a smaller number of subjects would likely be sufficient. As a result, the initial minimum goal of 84 participants was selected. To allow for subject mortality due to the one hour duration of the online study, the goal for participants was adjusted upward to 144.

These 144 subjects would be broken into groups of six, equally divided into control and treatment groups, resulting in 12 groups of each type. The software settings necessary to create the environmental framework for the study groups are as follows:

Table 3

Study Settings for Control and Treatment Groups

[Control]	[Treatment]
depersonalization=yes time_pressure=yes noise=visual organization=minimal autonomy=low range_of_categories=small expectation=negative clarityofpurpose=low personalgain=none	depersonalization=no time_pressure=no noise=none organization=extended autonomy=high range_of_categories=large expectation=positive clarityofpurpose=high personalgain=none

The control group would be subject to depersonalization effects, greater time pressure, periodic distraction from visual "noise," would be provided an organizational structure requiring one member to act as Leader/Recorder, would be given limited autonomy with negatively stated expectations and limited instruction, and a small set of potential solution categories. The treatment group, on the other had, would allow personal interaction and screen names, would provide minimal time pressure and no on-screen distractions, would be given instructions that indicated they had extensive autonomy with respect to the study, positive expectations and detailed instructions, a large set of categories of potential solutions, and an organization structure assigning a Recorder, a Leader, a Time-Keeper, and a member given *a priori* authority to break group deadlocks.

Given the limits selected in the research protocol approved by the Institutional Review Board and the requirements of MTurk, the personal gain feature was not deployed for this research. Additionally, audio noise was not used for the research associated with the initial use of this environment, due to cross-browser compatibility issues discovered when the project went online.

As this project did not have sufficient resources available to carry out a full-blown pre-post test using a more appropriate convergent and divergent creativity test, a reduced question count version of the Remote Associates Test (RAT) was selected as the pre- and post-tests. To keep the total time for the study down, items were selected randomly at the Session level, meaning all groups that were formed during a session would take pre- and post-tests using the same questions. The automatic assignment insured that the same item would not appear on both pre- and post-tests, so 24 unique RAT items would be presented to each group, separated into 12 pre-test and 12 post-test items.

Selection of subjects

Since the model selected for this study was a quasi-experimental model, subjects could be selected using non-random methods. In this case, convenience sampling of volunteers was the method used to enroll subjects. One of the potential limitations of the study, as originally envisioned, was the potential threat to the applicability of the study findings related to the subject pool. As the original pool was planned to be volunteers from the student pool of a single Midwestern college campus, an effort was made to widen the pool. At first, the effort focused on expanding the population being sampled to the population of the surrounding metropolitan area; later it was realized that the online, web-based design of the research environment allowed a much wider scope. In selecting a source of subjects, several methods, including the use of social media tools like Facebook or Twitter were examined. These were rejected as it was believed that the snowball sampling method that would result would tend to produce subjects that were similar to the source subject. Given the limited number of study subjects desired, this was felt to be a significant enough limitation to require an alternative approach.

The final selection focused on the Amazon MTurk.com web site. The Amazon site connects workers, the humans who carry out simple tasks not well suited for automation, with requesters, those with tasks they need performed. The tasks are typically simple tasks for humans but computationally difficult, such as comparing two photos to determine if they contain the same product. MTurk workers tend to be a diverse group, could be assembled quickly and easily, and could be compensated for participating in a manner that would easily allow anonymity. Given these characteristics, this was selected as the method of enrolling subjects. While the sample was hoped to be diverse, the expectation was that this would produce one of the study limits: participants would be selected using a convenience sampling approach which would eliminate the possibility of a true experimental design.

Using convenience sampling of the MTurk worker pool available at the time of the study would produce several biases in the sample selected. First, the workers selected were already demonstrating an above normal comfort level with the Internet and online applications, as they were essentially applying for very short-term jobs, most of which required use of a web browser and some basic Internet skills. Secondly, this would also tend to over-select those who spent more time on the Internet than those who spent very little time online. Finally, the study times would limit participants based on time-of-day issues, as a posting placed online at 2 PM Central Standard Time would correspond to a 1:30 AM local time for a subject located in New Delhi.

These limitations were not considered to be a fatal factor to the design, however, for these reasons. First, the self-selection of technological comfort levels would also be similar to the business environments in which this study could be applied. Organizations forming ad hoc virtual teams must have a technological infrastructure in place to allow the formation of such teams; this in itself would perform a similar pre-selection bias toward employees with higher

levels of technological comfort and skill. Secondly, since the primary goal was to study the subject to allow organizations to apply the findings internally, they would encounter the same issues: the New Delhi staff and the San Francisco offices would be still be twelve and one half hours apart for much of the year. Since the real-world applications to any study findings could have the same limitations as the study groups, the sampling model was felt to be sufficient for the project.

Creation of study groups

A trial session was scheduled and direct personal invitation made to invite people to the initial group. Since some of the group knew other members, participants were asked to use a non-typical screen name for their participation in the project. Two study sessions were announced, at 6:00 p.m. and 8:00 p.m. Seven subjects reported at the 6:00 PM scheduled time, six were assigned to the first group and one, after waiting a few minutes for additional participants, left the study. The group worked their way through Training, Pre-Test, and Assembly and began the Creativity Testing. At that point, an initial bout of issues related to the AJAX screen updates in the Chat system prevented two of the subjects from participating. This was determined to be related to issues specific to the browsers in use; a few adjustments were made to the software which allowed the study to proceed, and the later 8:00 p.m. group did not encounter this issue.

From comments submitted by the participants, a few additional changes were made to the environment. First, on-screen instructions were added for display to all users, not just the assigned roles such as Leader/Recorder. This helped resolve a number of questions associated with the execution of the study (as opposed to content-related questions). Secondly, a five minute time clock was placed on the pre- and post-test screens to reduce the time the group

might have to wait for one member who took the pre-test more seriously than the others. This was felt to be appropriate since the original Remote Associates Test was also timed, and it maintained the focus on the creativity exercise portion of the experiment.

Next, an overview screen was developed to allow the researcher to view the currents status of all of the study teams and interact if needed. This allowed one group to report that their leader had dropped out of the study and that they were unable to terminate the session. Communication from the researcher was reported as from "[Researcher]" in the chat log to avoid confusion as to whether the message came from one of the normal group members. A few extra online tools allowed the researcher to terminate a study question, if there were problems, or to reset the group to the same point in the study, if members became lost. While it was anticipated that these might be useful, those features were not used for this study.

Finally, modifications were made to allow the size of the group to be changed dynamically. This was necessary as the number of participants in a session was not always an integral multiple of the group size. Group size was not a study parameter so, to prevent having to turn away five potential study participants when a sixth did not join the group in a reasonable period of time, the ability to reduce the size of that group was included. These groups were flagged to later determine if the reduction in group size affected the idea generation abilities of the group in the reporting area.

A report file was generated to analyze the data, providing a summary screen with the mean, standard deviation, statistical power, and a Student's T-test analysis of the null hypotheses upon completion of each study group. This file was later altered to also evaluate differences between groups with six members that remained throughout the testing process to evaluate mortality effects on group idea generation.

Study questions and screen formats

Study questions were assigned in common to all sessions: Question One was: "Your friend calls, asking for help, and tells you where they are and that their car is stuck on the side of the road, but their cell phone dies before they can explain why. What should you bring?"; Question Two was: "You walk into a room and find it filled with smoke. Why?" and Question Three for all groups was: "You picked up the phone to call the pizza store two hours ago, but a pizza hasn't arrived yet. Why not?" Pre-test and Post-test items were also fixed for all participants to minimize changes due to different question selections. After these changes were mode, the addition study sessions were listed on MTurk and additional study groups were created as subjects enrolled in the study. When the last group had the sixth member join, the study was closed to new participants to prevent the final group for only having a single member.

The resulting screen format used for the creativity exercise portion of the study is shown in Figure 8. The top area of the screen, shown in the darker blue color contained common header to the study and informed the user as to the current phase of the project, using the "room" metaphor. The column to the left contained the clock: displayed as a countdown clock for groups with "time pressure" enabled, and message like "you have about five minutes remaining" for the others. Below the clock, a group roster was displayed, with user names for non-depersonalized groups and "Participant xxx" shown for depersonalized groups. The color of the line would also change when the user began typing in the chat area, and would reset when the user submitted their comment or deleted all entry text. The center column contained an area in which random quotes would appear for groups if visual "noise" was enabled; if not, this area was combined into the chat log area which appeared below, with an entry box for users to type comments at the bottom. The next column to the right contained a list of potential solution

categories, which would vary in length based on the "range_of_categories" setting. Finally, the right contained the list of group submissions, as submitted by the group Recorder or Leader in an entry box visible only to them. The settings that produced the screen in Figure 8 are shown in Table 3.

Results

A total of 136 participants enrolled in the study. Due to mortality waiting for groups to form, fifteen subjects that started the process dropped out before participating in the creativity exercise portion of the study. A few participants who had dropped out of the study rejoined later and were reassigned to a new group. These participants created a total of twenty groups with six initial members. As a result of the members who dropped out of partial groups, three groups provided no data; additional two additional groups did not provide answers for all of the study questions due to a probable software issue. The group Recorder for one group dropped out of the study, so the group generated results but did not submit anything: this data was posted by the researcher. Otherwise, only the data the groups selected to report were considered in the analysis. Given the non-reporting groups, this provided a sample size of N=27 control groups and N=21 for the treatment groups for all questions combined.

Demographic and online activity data

Subjects were asked to provide basic demographic information to insure compliance with research controls, and to provide answers to some very basic information regarding their online activity. Ninety responses were recorded regarding the birth year, with a minimum value of 1950 and a maximum of 1993. Translating this data into ages, two participants were under 20, 24 were between 20 and 25, 16 between 25 and 30, 23 between 30 and 35, seven between 35 and 40, three between 40 and 45, four between 45 and 50, seven between 50 and 55, and one over 60.

Sixty two participants reported their gender as male, 28 as female, two chose not answer or did not select a value. Birth year data is summarized in Table 6.

Ethnic data was collected using the categories provided by the Institutional Review Board application and data collected reflected the online nature of the platform: 45.6% of respondents identified themselves as Asian or Pacific Islanders, 4% as Black, 1% as Hispanic, and 39% as White. Given an analysis of the Internet IP addresses from which subjects participated, a large portion of the "Asian or Pacific Islander" responses came from India. Future use of an expanded list of ethnicities, such as that used by the 2010 Census, might provide a more accurate grouping for future studies. Raw data related to ethnicity is provided in Table 4, and country of origin, as determined by IP address, is summarized in Table 8.

Subjects were also asked to identify common online services which they used regularly: 84 indicated that they used Facebook, 53 checked Yahoo, 19 checked MSN, 35 checked Skype, 27 use Twitter, 61 regularly visit YouTube, 47 identified as Google users, 23 checked LinkedIn, 8 selected AOL Instant Messenger, 10 checked Flickr, and 11 are MySpace users; 10 indicated that they use another form of in-realtime-chat (IRC); 10 frequent blog sites. Thirty-two indicated that they use one email account, while 18 have two, another 18 have three accounts, 10 have four, four have five accounts, four have between six and ten accounts, four have between ten and twenty accounts, with two reporting over 40 different email accounts.

Number of text messages sent and received varied widely: 16 reported sending no text; 17 received none; 14 sent and 18 received less than 20 messages each month; another 18 sent and 27 received 20 to 100 messages or less each month; 26 reported sending and 21 reported receiving 100 to 1,000 text messages each month; while 8 send and nine receive over a thousand text messages each month, with one over half of the busiest group in the 2,500 to 10,000

messages per month range. The adoption of technology was not constant across age or media: the high text group accounted for only 36.4% of the email accounts, while the over-50 age group accounted for 20% of the top fifteen users by number of email accounts.

Combined Creativity Exercise Data

The core research data was analyzed to compare total number of ideas by generated by both Control and Treatment groups. Control groups answered 27 questions with a mean of 6.5 and standard deviation of 3.08; Treatment groups (N=21) reported a mean of 20.2 with a standard deviation of 8.84. Given the clear differences in variance, a pooled degree of freedom value of 23 was calculated, resulting in a T(23) = -6.81. At 23 degrees of freedom, this corresponds to a $t(23) = 7.78 \times 10^{-7}$, clearly less than $\alpha = .05$, so the null hypothesis may be rejected: there is a statistically significant improvement in the Treatment group as compared to the Control group. To check for the possibility of a Type II error, ß and power were also calculated for the sample. With $\alpha = .05$, the corresponding Z value in the Control groups is 11.54, placing ß at .1629; this results in statistical power of .8371. Statistically, this is evidence of a dramatic difference between groups which is unlikely to be caused by random variations in the samples. The raw data is presented for Control and Treatment groups in Tables 3 and 4. Cohen's *d* was calculated on the combined data set and returned a value of 2.322, indicating a very large effective size.

Exercise Data evaluated by Study Question

A similar analysis was done on a question by question basis. On question Test 1, 'Control' groups overall report an average of 6.8 ideas (s= 2.28, on 9 observations) while 'Treatment' groups overall report an average of 18.6 ideas (s= 6.74, on 8 observations). This produces a T-Test statistic = -4.738, at 8 degrees of freedom and a 1-tailed t value = .0017.

Again, at α = .05, the null hypothesis can be rejected with statistical power of .8853. Cohen's *d* for this question was 2.63, indicating a very large effect size. For question 'Test 2', 'Control' groups overall report an average of 5.3 ideas (s= 2.29, on 9 observations) while 'Treatment' groups overall report an average of 15.3 ideas (s= 5.09, on 6 observations). The resulting T-Test statistic = -4.52, at 6 degrees of freedom, results in a 1-tailed t value = .0046, so the null hypothesis can be rejected at α =0.05 with statistical power of .8897. Cohen's *d* for this question was calculated at 2.83, indicating a very large effect size. Finally, for question three, 'Control' groups overall report an average of 7.3 ideas (s= 4.24, on 9 observations) with 'Treatment' groups overall reporting an average of 26.3 ideas (s=10.77, on 7 observations) for a T-Test statistic = -4.399 at 7 degrees of freedom, resulting in a 1-tailed t value = .0037. For question 3, the null hypothesis can be rejected at α = .05 with corresponding statistical power of .8670. Cohen's *d* for question three was calculated 2.59, indicating a very large effect size.

The data also indicated that the quality of the study question could also potentially limit creative output, as groups generated differing numbers of answers for the three study questions: the first test question produced an average of 6.8 answers from control groups and 18.6 for treatment groups; the second gathered 5.3 from control groups and 15.3 for treatment groups; the third question generated an average of 7.3 answers from each control group and 26.3 from the treatment groups. Even with these inter-question differences, the clear conclusion is that the environment provided allowed the Treatment groups to be significantly more creative.

Pre-Test and Post-Test Data

Analysis of the pre-test to post-test provided little useful data. The pre-test was introduced as "a warm-up exercise and provides a creativity baseline which we can compare later." While some users spent as much as 15 minutes on the pre-test (to the frustration of other

group members waiting), many provided no answers to any question or answers such as “this,” “is,” and “silly” (Participant 37). Of the Control group members, 23 provided answers to the pre or post test, with an average pre-test “correct” count of 1.91 and a post-test “correct” count of 1.91 as well; 30 Treatment group members returned an average of 2.33 for the pre-test and 1.73 for the post-test. Given that the standard deviation of the pre-test for control groups was 1.75 and was 2.02 for treatment groups, no statistical conclusion can be drawn from the pre-post test results.

Chat Log Data

The groups submitted 1,416 lines of chat during the study. Textual analysis of the chat conversations is revealing about the group attitudes. Control groups were provided with the information that each question had at least five answers, while Treatment groups were told the same, but also provided with the average number of answers provided by other treatment groups (the initial group was not provided with a number), with most groups receiving values over 25. The difference in goal commitment was clear, as control group members made comments revealing that their goal was to generate five ideas: “one more” (Group 16 with four answers already provided). Treatment groups provided with positive expectations for accomplishment appeared to set higher goals: “need 2 more yeah” (Group 15 with 23 answers already provided) and “Guys we need more answers” (Group 5, with eight answers already provided).

Additionally, Treatment groups chat logs showed more items that were suggested in jest but never posted. Aliens life forms were an answer to the pizza delivery delay in several Treatment groups, and answers that linked multiple problems (the pizza didn’t make it since the store is on fire) were part of several Treatment groups, but none of the Control groups.

Time management was another significant difference between the groups. Treatment groups spent on average 35.7 minutes on the three exercises, while Control groups spent 18.3 minutes. The fastest Treatment group completed the creativity exercises in 26.5 minutes, producing a total of 65 ideas for the three questions. Only one Control group took more than 26 minutes, this group produced 36 ideas in 40.2 minutes and was the most productive of the Control groups, submitting over twice the average of the other Control groups. Both groups were given the option to extend the time allotted to each exercise by three minutes; every Treatment group used this option on at least one test question, while Control groups only used the feature on two questions. The pattern seems to indicate that the Treatment groups were more engaged in the task than the Control groups.

Subjects for the study came from 19 countries, based on the IP address from which they participated. India provided the largest number of participants at 63, with the United States at 57; Canada, Romania, and Pakistan provided two each; Serbia, Chile, Slovenia, Taiwan, Philippines, Spain, Macedonia, United Kingdom, Russian Federation, Portugal, Italy, and Australia provided one subject each; no country could be ascertained for two users whose service was provided via Satellite Provider, and could not be localized to a geographical location. This geographical mix was due to the use of MTurk as a recruitment tool for subjects, as the MTurk user base is international in nature, with users participating in projects around the clock from every time zone.

Post Survey Data

Upon completion of the post-test, subjects were provided with a survey to allow self-reporting of affect and subject perceptions about the study. Sixty seven respondents completed

the survey, 36 Control group subjects and 31 Treatment group members. Since subjects did not provide an answer to every item, the total number of responses is noted for each survey question.

The groups generally seemed comfortable with the study process. Fifty one of 67 respondents reported that the process was easy to accomplish; 59 of 65 reported that the process was fun; 44 of 65 reported that their group worked together well; 57 of 66 reported the study as a positive experience; 52 of 66 reported that they knew what was expected of them. These results held across both control and treatment groups, with approximately equal responses from each.

The subjects showed positive affect across the groups, with 44 of 67 respondents reporting positive affect for the pre-test, 51 of 66 for the creativity exercises, and 52 of 65 for the post-test. There was a slight over decrease in positive affect in these ratings: 44 remained at the same level, eight showed an increase in positive affect, while 15 reported a decrease, with the changes balanced across over both control and treatment groups.

For this study, group structure was minimal in nature, but perceived to be useful: 41 of 66 subjects agreeing that the group was comfortable in their roles and 42 of 66 believed that group structures were effective. Control group subjects strongly agreed that their group could have been more effective at double the rate (of the Treatment groups (14 Control compared to 6 Treatment), while other responses were balanced across both groups; 44 of 66 total subjects believed their group could have been more productive.

The widest range of responses was found on the question of whether the subject could have been more productive working along: 10 strongly disagreed, 22 disagreed; 7 were neutral, 17 agreed and 9 strongly agreed. The split was divided along group lines: 13 subjects in Control groups disagreed or strongly disagreed compared to 19 in Treatment groups, while 16 agreed or strongly agreed in Control groups while only 10 in Treatment groups agreed.

Discussion

From the data analysis, it is clear that the research hypothesis can be accepted: temporary virtual teams can be made more creative by building the right environment. This is consistent with prior research that links environmental factors to creative ability. The eight factors that were selected – depersonalization, time pressure, noise, level of organization, degree of autonomy, range of potential solution categories provided, expectation, clarity of purpose, and potential personal gain – altered the creative environment in very significant ways. Since this initial study was intentionally limited to a simple linear analysis of two environments, future research should be done comparing the contribution of each of the eight factors. Of particular interest is the combination of positive expectation and the range of potential solutions offered as these appear to have played a role in the difference between control and treatment groups, at least based on anecdotal evidence from the group chat logs. A more complete ANCOVA analysis should be performed on additional subjects to evaluate how these components combine to alter the creative environment.

Differences in the number of answers between the three study questions also indicate the importance of asking the right question in the right manner. The average number of answers generated by treatment groups varied from a low of 15.3 on question two to a high of 26.3 on question three. This seems to indicate that the treatment groups operationalized the questions in different ways or that the potential categories of solutions was not as effective as the set provided for the other questions, as the category list and study question were the only items varied for the three exercises.

Given the demographics of the subject pool that participated in the study, it is possible that this is a cultural issue, as the pizza delivery problem may not have the same meaning to a

Chicago resident as it does to a resident of Novosibirsk, Russia. This was an unexpected situation as an expected study limitation was the anticipated homogeneity of the sample, originally volunteers from a single Midwestern metropolitan area. With the use of MTurk, the alternate problem may have occurred, as nearly half of the sample came from India, based on the IP addresses used by subjects. This convenience sample also likely pre-selected users with a strong comfort level with CMC and may have affected results. Repeating the experiment with a truly random sample, including those without a likely enhanced level of comfort with CMC would be a useful area of future research. At the same time, the question that generated the largest number of answers was the pizza delivery question and the one that generated the fewest was the "smoke in the room" question; even if pizza delivery is not culturally constant, smoke probably is, so this concern may be overstated.

This pre-selection was also seen in relationship between comfort level with CMC and age. The expectation in the study was that there would be a correlation between age and online activities; the information that can be drawn from the data did not completely support this belief. For example, there was a clear correlation between age and text activity, as the 20-29 year old group accounted for 83.7% of all text activity. On the other hand, a significant correlation was not found between age and number of hours online, between age and number of email accounts, or between number of online services used and age. While there were more total selections made by the younger half of the group, the ratio of selections to percentage of the group makeup was fairly consistent across age groups in the study.

The implementation of the pre-test and post-test proved problematic, either due to the selection of the RAT as the testing instrument, or due to the manner in which it was implemented. While this could have been a limitation of the RAT, it may also have been the

result of how the pre-test and post-rest was presented, as warm-up and cool-down exercises. The use of an alternate test, such as the TTCT, would be suggested for future studies, even with the added cost; alternately, performing additional analysis on subjects' view of the pre-test may provide a better understanding of low scores and apparent low interest in this part of the study protocol.

The software environment provided a useful research platform, but additional testing should be performed to insure that the issues encountered by some users which affected the process for several groups are resolved. In comparison with other manual attempts to perform the same tasks that were observed, the process flow was efficient and painless to users. Mortality issues were primarily linked to wait times for group formation, so future studies should limit enrollment to a small period of time to insure that the largest number of users can assemble at the same time. Software modifications could also be put in place to immediately close the enrollment process when a particular number of groups were formed, rather than leaving the process open for a specified period of time. Related to mortality, a technique should be provided to allow group members to switch roles in the event that an assigned role drops out of the study, as this prevented one of the groups in this study from submitting any results, and should be prevented in future groups.

Conclusion

The ability to examine creativity using a control software environment provides a significant research tool in the study of creativity in virtual teams. Since the purpose of this project was to develop and test such an environment, the research question that was analyzed was linear in nature: can creativity be improved? Future research should focus on identifying an additional environmental factors which should be included, and performing a more thorough

analysis of the hierarchy of effect and interaction between these parameters. Based on the research data, it would appear that setting positive expectations for the group may be one of the key factors in enhancing creativity, but is this factor dependent on another to have this effect? Additional study sessions which alter the individual make up of the groups with a connected ANCOVA data analysis will provide a clearer picture of the interplay between elements. Additional elements may also need to be added: for this study, potential personal gain was excluded. Since the software framework provides for the addition of and manipulation of new elements, this and other potential environmental factors should be included in future research.

For organizations looking to use temporary virtual teams to address recalcitrant problems, this study gives hope that temporary virtual teams can provide the creative answers they need, if they provide the right environment for the team. Setting positive expectations, having a clear purpose, providing autonomy to the group, reducing distractions, limiting the team's sense of time pressure, limiting depersonalization effects, establishing an effective team organizational structure, and aiding the team by providing sufficient potential categories has been shown to dramatically improve the success of the team, particularly when idea generation is the goal. While future research may provide a clearer picture of the interplay between these elements, this model provides an easily implemented recipe for success. Temporary virtual teams can be more creative and the opportunity for creating success lies with how organizations create those teams.

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Appendices

Table 4

Control Group Response Summary

Group Number	Test Question	Number of Responses
Group 2	Test1	9
Group 2	Test2	10
Group 2	Test3	17
Group 4	Test1	5
Group 4	Test2	5
Group 4	Test3	5
Group 6	Test1	9
Group 6	Test2	2
Group 6	Test3	3
Group 8	Test1	5
Group 8	Test2	5
Group 8	Test3	5
Group 12	Test1	5
Group 12	Test2	5
Group 12	Test3	5
Group 14	Test1	11
Group 14	Test2	3
Group 14	Test3	10
Group 16	Test1	6
Group 16	Test2	7
Group 16	Test3	7
Group 18	Test1	6
Group 18	Test2	6
Group 18	Test3	9
Group 20	Test1	5
Group 20	Test2	5
Group 20	Test3	5
'Control' groups overall report an average of 6.5 ideas (s= 3.08, on 27 observations)		

Table 5

Treatment Group Response Summary

Group Number	**Test Question**	**Number of Responses Submitted**
Group 1	Test1	18
Group 1	Test2	15
Group 1	Test3	29
Group 3	Test1	22
Group 3	Test2	10
Group 3	Test3	30
Group 5	Test1	29
Group 5	Test2	22
Group 5	Test3	29
Group 11	Test1	25
Group 11	Test2	11
Group 11	Test3	14
Group 13	Test1	16
Group 15	Test1	19
Group 15	Test2	21
Group 15	Test3	28
Group 17	Test1	11
Group 17	Test3	11
Group 19	Test1	9
Group 19	Test2	13
Group 19	Test3	43
'Treatment' groups overall report an average of 20.2 ideas (s= 8.84, on 21 observations)		

Table 6

Reported Year of Birth Data

Birth Year Reported	**Number of Responses**
I choose not to answer / no answer given	2
1950	1
1953	1
1956	2
1958	1
1960	3
1962	3
1964	1
1965	2
1966	1
1968	1
1970	1
1972	1
1973	3
1974	2
1977	2
1978	4
1979	5
1980	4
1981	4
1982	6
1983	1
1984	5
1985	6
1986	2
1987	2
1988	7
1989	7
1990	7
1991	1
1992	2
1993	2

Table 7

Summary of Reported Ethnicity

Ethnicity	**Number of Reponses**
Asian or Pacific Islander	42
Black, not of Hispanic Origin	4
Hispanic	1
I choose not to answer / no answer	3
Other or Unknown	6
White, not of Hispanic Origin	36

Table 8

Summary of Subject Country, from IP Address

Country	**Number of Subjects**
India	63
United States	57
Canada	2
Romania	2
Pakistan	2
Serbia	1
Chile	1
Slovenia	1
Taiwan	1
Philippines	1
Spain	1
Macedonia	1
United Kingdom	1
Russian Federation	1
Portugal	1
Satellite Provider	2
Italy	1
Australia	1

Table 9

Raw Pre-Survey Data – Demographics, Online Time, and SMS Use

UserID	Age	BirthYear	Number of EmailAccounts	Ethnicity	Gender	HoursOnline	HoursOnline In Chat	Texts Received	Texts Sent
1	50	1962	50	White, not of Hispanic Origin	Male	20	50	100	100
2	52	1960	4	White, not of Hispanic Origin	Female	30	4	100	100
3	52	1960	10	White, not of Hispanic Origin	Male	40	1	4	2
4	56	1956	2	White, not of Hispanic Origin	Male	12	0	25	25
5	52	1960	10	White, not of Hispanic Origin	Male	50	4	0	0
6	44	1968	2	White, not of Hispanic Origin	Male	10	2	0	0
7	NA	I choose not to answer	2	White, not of Hispanic Origin	Male	15	2	0	0
8	47	1965	2	White, not of Hispanic Origin	Male	10	0	50	50
9	56	1956	1	Other or Unknown	Female	15	1	3	2
10	62	1950	1	White, not of Hispanic Origin	Female	10	0	0	0
11	46	1966	1	White, not of Hispanic Origin	Male	2	0	0	0
12	59	1953	2	Black, not of Hispanic Origin	Male	5	10	0	0
13	47	1965	4	White, not of Hispanic Origin	Female	10	1	45	45
17	30	1982	1	Asian or Pacific Islander	Male	2	5	50	20
18	22	1990	1	Asian or Pacific Islander	Male	0	0	0	0
20	24	1988	3	White, not of Hispanic Origin	Female	50	20	30	50
21	30	1982	4	White, not of Hispanic Origin	Male	30	0	500	700
22	28	1984	5	Asian or Pacific Islander	Male	30	20	250	150
24	20	1992	4	White, not of Hispanic Origin	I choose not to answer	24	60	2	2
25	34	1978	8	Asian or Pacific Islander	Female	10	10	50	4
28	31	1981	3	White, not of Hispanic Origin	Male	15	45	300	100
29	42	1970	3	Black, not of Hispanic Origin	Male	60	10	0	0
32	31	1981	3	Asian or Pacific Islander	Male	30	5	15	50
33	30	1982	3	Other or Unknown	Male	50	20	200	50
35	27	1985	1	Other or Unknown	Male	7	1	20	0
37	38	1974	3	White, not of Hispanic Origin	Female	30	0	100	100
38	33	1979	1	Asian or Pacific Islander	Female	14	30	100	80

39	29	1983	3	Asian or Pacific Islander	Male	15	15	250	105
44	31	1981	1	Asian or Pacific Islander	Male	9	90	500	500
45	24	1988	1	Asian or Pacific Islander	Male	30	2	2	1
46	30	1982	1	Asian or Pacific Islander	Male	20	40	80	60
48	27	1985	3	Asian or Pacific Islander	Male	28	4	100	250
49	23	1989	2	Asian or Pacific Islander	Male	40	10	300	300
50	35	1977	5	White, not of Hispanic Origin	Male	35	1	45	30
51	32	1980	4	Asian or Pacific Islander	Male	40	30	400	250
52	24	1988	1	Asian or Pacific Islander	Male	5	3	100	2
53	28	1984	1	Asian or Pacific Islander	Male	30	35	150	60
54	24	1988	1	Asian or Pacific Islander	Female	35	1	100	15
55	27	1985	1	White, not of Hispanic Origin	Male	20	2	250	300
58	34	1978	2	Asian or Pacific Islander	Male	70	10	500	300
60	23	1989	6	Asian or Pacific Islander	Male	20	10	500	500
61	23	1989	2	White, not of Hispanic Origin	Female	3	1	12	15
62	25	1987	4	Asian or Pacific Islander	Female	40	5	25	20
63	32	1980	3	Asian or Pacific Islander	Male	20	2	500	100
64	39	1973	2	Asian or Pacific Islander	Female	20	15	40	30
65	39	1973	3	Asian or Pacific Islander	Male	30	30	150	150
66	19	1993	3	Asian or Pacific Islander	Male	20	50	500	200
67	28	1984	3	Asian or Pacific Islander	Male	45	25	350	125
68	23	1989	1	Asian or Pacific Islander	Female	30	2	100	10
69	48	1964	1	Other or Unknown	Male	30	20	10	10
70	40	1972	5	White, not of Hispanic Origin	Male	20	20	1000	1000
71	24	1988	1	Asian or Pacific Islander	Male	60	100	300	200
73	50	1962	3	White, not of Hispanic Origin	Female	30	5	0	0
76	32	1980	1	Black, not of Hispanic Origin	Male	22	8	10	10
77	22	1990	11	White, not of Hispanic Origin	Male	70	50	5	5
78	33	1979	3	Asian or Pacific Islander	Male	25	30	150	100
79	22	1990	2	White, not of Hispanic Origin	Male	65	20	20	20
80	23	1989	4	Asian or Pacific Islander	Male	28	28	4000	1500
83	31	1981	4	White, not of Hispanic Origin	Female	50	24	750	750
85	28	1984	2	Asian or Pacific Islander	Male	14	10	300	1000
86	39	1973	2	Asian or Pacific Islander	Female	20	20	40	30

87	50	1962	2	Hispanic	Female	40	0	0	0
88	27	1985	3	Asian or Pacific Islander	Male	40	20	2000	1000
89	30	1982	1	White, not of Hispanic Origin	Female	40	10	0	0
90	22	1990	3	White, not of Hispanic Origin	Female	20	30	500	500
91	33	1979	1	Other or Unknown	Female	48	1	90	150
92	27	1985	1	Asian or Pacific Islander	Male	40	40	400	400
96	23	1989	1	Asian or Pacific Islander	Male	30	10	80	50
97	19	1993	3	White, not of Hispanic Origin	Female	10	4	600	500
98	21	1991	2	Asian or Pacific Islander	Male	35	100	2500	3000
99	32	1980	40	Asian or Pacific Islander	Male	40	40	40	40
100	35	1977	2	Asian or Pacific Islander	Male	28	4	0	0
103	22	1990	3	White, not of Hispanic Origin	Male	40	4	1000+	1000+
104	20	1992	15	White, not of Hispanic Origin	Female	30	8	30	30
106	24	1988	6	White, not of Hispanic Origin	Male	95	250	600	500
109	26	1986	2	White, not of Hispanic Origin	Female	70	200	2	4
112	34	1978	4	Other or Unknown	Male	50	90	120	60
114	27	1985	1	White, not of Hispanic Origin	Male	40	40	85	75
116	25	1987	5	Asian or Pacific Islander	Male	35	150	800	1000
117	NA	--Please select--	1	--Please select--	--Please select--	10	3	50	25
118	30	1982	4	Asian or Pacific Islander	Male	30	15	100	100
120	22	1990	2	Asian or Pacific Islander	Male	70	280	10000	455
121	38	1974	1	Asian or Pacific Islander	Male	20	2	0	0
122	22	1990	2	--Please select--	Female	70	0	100	90
123	33	1979	1	I choose not to answer	Male	0	0	0	0
124	24	1988	1	Asian or Pacific Islander	Male	10	60	4000	3000
125	26	1986	8	White, not of Hispanic Origin	Male	50	5	17	15
127	28	1984	1	White, not of Hispanic Origin	Female	40	0	0	0
128	23	1989	1	White, not of Hispanic Origin	Male	20	4	2,000+	2,000+
129	54	1958	1	White, not of Hispanic Origin	Female	30	0	0	0
130	33	1979	1	Black, not of Hispanic Origin	Female	40	1	4	4
132	34	1978	1	Asian or Pacific Islander	Female	20	30	60	50

Table 10

Raw Pre-Survey Data – Online Services

UserID	AIM	Facebook	Flickr	Google	IRC	LinkedIn	MSN	MySpace	NA	Skype	Twitter	Yahoo	YouTube	blogs
1		1					1			1	1	1	1	
2		1					1						1	
3		1		1		1	1						1	
4		1				1							1	
5	1	1		1						1			1	1
6		1	1			1								
7				1									1	1
8		1				1				1		1	1	
9		1								1		1	1	
10		1											1	
11		1											1	
12							1						1	
13										1				
17		1												
18		1											1	
20				1						1		1	1	1
21		1		1				1			1		1	
22		1		1		1				1	1	1	1	1
24	1	1	1								1	1		
25		1		1		1	1					1	1	
28		1		1						1				
29							1					1	1	
32		1		1									1	
33	1	1		1		1					1	1	1	1
35		1										1	1	
37		1	1			1		1			1			
38		1		1								1		
39		1	1		1	1	1	1		1	1	1	1	1
44		1		1						1		1		
45		1								1		1		
46		1		1								1		
48		1		1		1							1	

49		1		1		1		1			1	1	1	1	1
50	1	1			1			1	1			1	1	1	1
51		1			1						1	1	1	1	
52		1			1						1			1	
53		1			1										
54		1			1						1		1		1
55		1										1		1	
58		1			1								1	1	1
60		1			1								1		
61		1						1							
62		1		1	1		1					1	1	1	
63		1			1		1					1	1	1	
64		1			1										
65		1			1		1					1	1	1	1
66		1			1		1							1	
67		1			1						1		1	1	
68		1									1		1		
69		1						1			1			1	
70		1			1							1	1		
71		1			1			1			1		1		
73		1		1			1			1		1			
76				1			1							1	
77		1											1	1	
78		1			1		1				1	1	1	1	1
79	1	1									1		1	1	1
80		1			1		1			1	1	1	1	1	1
83		1			1						1	1			
85		1											1	1	
86		1			1						1		1		
87		1						1					1	1	
88		1			1		1	1	1		1	1	1	1	
89		1											1	1	
90		1			1						1			1	1
91		1			1								1	1	
92		1													
96		1			1								1	1	
97	1	1							1		1		1	1	
98		1			1						1	1	1	1	

99		1												
100		1		1		1							1	
103		1											1	
104		1					1			1	1		1	
106	1	1		1	1		1	1		1	1	1		
109		1	1							1	1	1	1	1
112		1		1		1	1			1	1	1	1	1
114		1		1		1						1	1	
116		1		1	1			1		1	1	1	1	1
117		1												
118		1		1								1		1
120		1		1								1		
121		1		1							1		1	
122		1								1			1	1
123									1					
124		1											1	
125	1	1	1		1		1					1	1	
127		1												
128		1						1			1	1	1	
129												1		
130		1					1						1	
132		1										1		

Table 11

Raw Post-Survey Data – Attitude

UserID	Group	Comfortable Roles	Easy To Accomplish	Effective Roles	Fun To Do	Group Attitude Exercise	Group Could Have Been More Creative	Knew What Was Expected	More Productive Alone	My Cooldown Attitude	My Warmup Attitude	Positive Experience	Use Elsewhere	Warm Up	Worked Together Well
1	1T										5				
2	1T	3	4	3	5	4	2	4	1	4	3	4	3	4	4
3	1T	2	4	3		4	2	4	4	2	3	3	2	3	
5	1T	3	4	4	4	4	3	3	2	3	4	4	4	3	4
7	2C	2	3	5	5	4	2	4	2	4	3	4	3	4	4
8	2C	3	4	4	5	4	2	3	2	2	3	4	4	3	4
9	2C	4	5	3	5	4	5	3	3	4	4	4	4	4	3
10	2C	4	3	2	5	4	2	3	2	5	2	4	4	4	5
11	2C	4	4	4	4	4	3	3	2	3	3	4	3	4	4
12	3T	4	4	4	4	4	3	4	2	4	4	4	3	3	4
13	3T	4	2	4	4	4	2	3	1		3	4	3		4
17	4C	5	4	5	4	5	5	4	4	5	5	5	5	4	4
18	4C	4	5	5	5	5	4	1	4	5	5	5	5	5	5
20	4C	4	4	4	4	4	3	4	4	3	4	4	4	3	4
21	4C	2	4	2	5	3	5	4	3	4	4	5	2	3	2
22	5T	3	4	4	4	4	4	4	2	4	4	4	4	4	4
24	5T	4	5	5	5	4	3	5	1	3	5	5	4	5	5
25	5T	4	5	5	5		5	5	2	4	4	5	5	5	5
28	5T	3	5	4	4	4	3	4	2	4	4	4	3	3	5
29	5T	4	4	2	4	4	4	2	4	4	3	3	3	3	3
32	6C	3	5	2		4	5	4	2	4	4	5	5	4	
33	6C	5	5	5	5	5	5	5	5	5	5	5	5	5	5
35	6C	4	4	4	4	4	5	4	5	4	4	4	4	4	3
38	6C	3	3	3	4	4	3	3		4	4	4	4	4	4
44	20C	4	4	4	5	5	5	5	5	5	5	5	4	4	5
45	8C	4	4	4	4	4	4	4	4	4	4	4	4	4	4
46	8C	4	4	4	4	4	5	5	4	4	3	4	5	3	5

48	8C	5	5	3	4	3	5	2	4	4	3	4	1	4	3
50	8C	5	5	5	5	5	4	4	4	5	5	5	4	4	4
51	9T	4	4	3	5	4	4	4	5	5	4	5	4	4	3
53	9T	3	2	3	4	3	3	3	4	4	4	4	4	3	3
60	10C														
62	10C	4	5	4	5	4	4	4	3	4	3	4	5	2	5
63	11T	4	2	4	5	5	4	4	1	5	5	5	4	4	5
64	10C	4	4	4	4	4	3	4	2	4	4	5	5	4	4
65	11T	4	4	4	4	5	4	2	1	5	4	5	4	4	4
66	11T	3	4	4	4	4	4	3	3	3	4	4	4	2	3
67	11T		3		4	3				3	3			3	2
68	11T	4	4	4	4	4	4	4	4	4	4	4	4	4	4
69	11T	2	4	2	3	2	5	3	5	4	5	2	2	3	1
70	12C	2	3	2	4	4	4	2	3	4	4	2	1	3	2
71	12C	5	4	4	4	4	5	5	4	5	5	4	4	4	4
73	12C	2	2	2	3	3	4	3	4	3	3	3	3	3	3
76	14C	1	3	1	2	2	5	3	5	2	3	2	1	3	1
77	13T	2	1	2	2	4	3	4	5	4	3	2	2	3	2
78	13T	3	4	3	4	3	4	2	1	4	4	4	3	4	3
79	14C	3	4	3	2	1	5	2	4	3	3	1	1	1	1
83	13T	2	4	2	4	3	5	4	2	4	4	5	4	4	2
87	15T	3	4	2	5	5	1	5	2	4	4	4	3	3	5
90	15T	3	4	3	4	3	4	3	2	4	4	4	2	4	3
91	15T	4	3	5	5	5	5	5	1	4	3	5	5	5	5
96	16C	4	4	4	5	4	2	4	1	5	3	5	4	4	5
98	16C	5	4	5	5	5	3	5	1	4	3	5	4	3	5
100	16C	5	5	5	5	5	3	5	2	5	4	5	5	4	5
103	18C	4	5	4	5	5	3	4	3	5	5	5	5	3	5
106	18C	2	3	4	5	5	3	3	2	4	4	5	4	3	5
109	17T	1	1	1	2	1	4	1	5	2	2	2	1	3	2
112	17T	5	5	5	5	4	5	5	2	4	5	4	5	4	4
114	18C	4	3	4	5	5	4	5	1	4	4	5	4	4	5
117	17T	4	5	4	5	5	4	4	5	5	5	5	4	5	5
118	18C	5	5	5	5	5	5	5	3	5	5	5	5	4	5

120	18C	4	4	4	4	3	4	4	4		2	4	4	3	4
121	18C	5	4	5	5	5	5	5	2	4	3	5	5	3	5
123	19T	5	5	5	5	3	4	5	2	3	3	4			5
124	19T	3	2	3	5	4	3	3	4	4	4	4	4	3	3
125	19T	5	5	5	5	3	5	5	2	4	4	5	4	4	4
127	19T	4	4	4	4	5	2	4	2	4	4	5	4	2	5
129	20C	4	4	2	4	4	4	3	2	4	4	4	2	3	4
132	20C	4	4	5	4	4	4	4	4	4	4	5	4	4	3

NOTE: Group numbers shown are identified with “C” for Control Groups and “T” for Treatment groups. Values shown correspond to the selection from a 5-point Likert scale, as shown in Figures 9 and 10, and are presented numerically only to reduce space requirements.

Table 12

Raw Post-Survey Data – Affect and Comments

User	Group	I would have Done the exercise differently by	Experience Adjectives Selected	Generate More Ideas	I Felt During Process	Improve Process	Make Group More Effective	Role Advice	Tell Researchers
1	1T								
2	1T		Creative; Imaginative;		funny		larger variety of backgrounds	tell them they have to summarize as they go	it was fun
3	1T	OK for what it was	Creative; Imaginative; Inventive; Purposeful; Agitating; Apathetic; Involved;	The warm up and cool down did not seem to relate.	Wondering where this was all going	I don't know about frustrating, but we didn't work as a team. We just spewed things out, which is fine for a while... but when looking for a solution, the set needs to narrow at some point.	Let anarchy happen for a while. Then ask everyone to review the thought prompter list again. Build on others' answers.	Hit the button sooner. Watch out for tinfoil hats.	Software testing is essential. Interface needs more instruction. Not clear how to use it. Screen real estate could be used better.
5	1T		Effective; Contagious; Creative; Imaginative; Inventive;	In a second or third run, having gotten a better understanding of the tool.			We were pretty effective as it was.	Didn't.	The tool seems to work.
7	2C	linking to possible ideas from the web (within the chat) so as to modify or actually use them.	Imaginative; Positive; Interesting; Detailed; Fun; Purposeful; Pleased;	we had a option to upvote/ downvote ideas (if the chat would have been long term)	awkward at first due to talking to strangers, but calm after adjusting.	suggesting use of emoticons for their original use: conveying exact emotions.	a generator that makes random word combinations, with certain parameters. the 'Story Generator' at	Leader: merge similar ideas for a shorter and more relevant list.	that generator idea (again, like at http://tvtropes.org/pmwiki/storygen.php) sticks in my head, as well as the idea of upvoting/ downvoting. also, the scrollbar for the chat window seems cut off at the bottom (firefox 10, Win XP SP2), and the submission of chat dialogues is a bit delayed; they somethings appeared out of order (e.g. I post something and three other posts are somehow shown as being before mine). otherwise it seems alright.
8	2C		Contagious; Creative; Imaginative; Inventive; Interesting; Fun;	I'm not sure if we could have. We pretty much exhausted	I was having fun - trying to	There was a bit of delay between typing the answers and having them appear on the	I thought we were pretty effective, but we seemed to get better as we	N/A (I didn't have a role)	

				ideas, from what I could tell.	be serious at times, playful at others.	screen - led to some double-entries.	got through more questions.		
9	2C	by remaining inside the box	Creative; Imaginative; Positive; Enjoyable; Pleasant; Enthusiastic; Fun; Energizing;	they would think more outside of the box and be more accepting of others ideas	confused, but enjoyed it	responses posted more quickly	acceptance of some of the outside of the box ideas		it is really scary that the kids today have little or no imagination these days. if this trend continues, we will have fewer creative thinkers
10	2C	Better defining what we were supposed to accomplish - were we actually supposed to solve the problem, or just brainstorm ideas?	Contagious; Creative; Imaginative; Positive; Ineffective; Enjoyable; Fascinating; Enthusiastic; Fun; Expressive; Free; Involved;	I had more time or could go back to the exercises later. Often, a lot of ideas occur to me "after the fact". Guess my subconcious is at work.	I was enjoying it, but feeling we weren't very effective.	Getting the techn ology to work better. I had to wait a long time at the beginning and kept frefreshing my screen. I got behind in the discussions because the next exercise didn't start and I had to refresh my screen to get it to start. Also previous item just above doesn't have an appropriate option to answer.	Larger group? Seems we didn't really solve anything, but then this was just a "fake" exercise, not real problems to solve.	Didn't have a role other than participating. Seemed we were just brainstorming, so I'd say just participate as much as possible.	I found the cool down exercise way easier than the warm up exercise, even though they were the same format, just different sets of words. Was that because my imjagination was warmed up? Or the sets of words were just easier in the cool down?
11	2C	better explanation of what I was supposed to do	Productive; Creative; Positive; Interesting; Enjoyable; Pleasant; Enthusiastic; Fun; Happy; Pleased; Satisfied; Energizing;			I didn't know what I was doing at first.	We did a good job creating ideas		
12	3T	don't know	Creative; Inventive; Interesting; Pleasant;			fix website problem at start			
13	3T		Enjoyable; Fun;		like i need more info				
17	4C		Imaginative; Positive; Enjoyable; Fun; Expressive; Constricted; Unappreciated; Exhilarated; Joyful; Depressed;						
18	4C	individual chat	Effective; Productive; Creative; Imaginative; Inventive; Enthusiastic; Peaceful; Joyful; Measured;	we have much more time	enthusiastic	being patience and listening	Brief conversation.	Just fit to the current discussion. That is what	Afford some more time

								required.	
20	4C	Nothing, liked the process	Effective; Contagious; Productive; Creative; Imaginative; Positive; Inventive; Interesting; Detailed; Enjoyable; Pleasant; Fascinating; Relieved; Fun; Directed; Expressive; Pleased; Aggravating; Free; Excited; Exhilarated; Satisfied; Energizing; Measured; Involved; Understood;	Everyone participated	Creative and Enthused	Improving Crashing Issues	My screen did not update well when task changed. Thus I did not participate much in later activities		Interesting Idea! Enjoyed myself
21	4C	Requiring everyone to participate	Effective; Creative; Inventive; Enjoyable; Pleasant; Enthusiastic; Fun; Purposeful; Happy; Excited; Energizing; Involved;	Everyone had participated	Motivated	Making everyone get involved	If they were more involved	Just try your best	Make it a requirement to participate, at least one idea.
22	5T	asking to give counter view on every idea.	Effective; Productive; Creative; Imaginative; Positive; Interesting; Enjoyable; Pleasant; Fascinating; Fun; Expressive; Charming; Purposeful; Happy; Thrilled; Pleased; Excited; Satisfied; Joyful; Energizing; Involved; Understood;	we are discussing face to face.	excited	process in not frustrating at all.	Offer Incentive for best ideas	Know your limits.	nothing
24	5T		Effective; Productive; Creative; Imaginative; Positive; Inventive; Interesting; Detailed; Enjoyable; Pleasant; Fascinating; Relieved; Enthusiastic; Fun; Peaceful; Directed; Expressive; Charming; Purposeful; Happy; Thrilled; Pleased; Free; Exhilarated; Fulfilled; Satisfied; Joyful; Energizing; Involved; Understood;	the 6th person had participated.	intrigued	using a clearer website. (See my comments on MTurk.)	More discussion amongst ourselves, I guess?		This was an interesting exercise, and more of its type should be done.
25	5T	This is a good exercise and i dont think so that I can do it differently	Effective; Productive; Creative; Imaginative; Positive; Inventive; Interesting; Detailed; Enjoyable; Enthusiastic; Fun; Purposeful; Happy; Thrilled; Pleased; Empathetic; Fulfilled; Satisfied; Joyful; Energizing; Grateful;	more instructions on the actions performed by each roles (like, how to end the session for the current question? As I	Happy, warm and encourages	providing meaningful names to the command buttons used for various actions	Team was interactive and so everyone know others ideas and encouraged others to come up with new ideas	I was the time keeper and I would advise to consult the team for time extension and that	Overall the experience was good and I enjoyed a lot. It would be good to provide information on how to move on to next screen (wait till your leader to close current question and refresh your browser etc)

				time keeper, I got the Time extension button. similarly, did the leader get the End session button) and on navigation to next screen.				works great.	
28	5T		Productive; Creative; Interesting; Detailed; Fun; Purposeful;				nothing	copy and paste works fsater than retyping	problem with clock in first question
29	5T		Productive; Creative; Imaginative; Positive; Inventive; Interesting; Ineffective; Enthusiastic; Frustrating; Anxious; Directed; Expressive; Stifled; Purposeful; Constricted; Excited; Involved; Annoyed;	they would have relaxed more first.	a little frustrated for a while. I had issues with my ideas not showing up that I was typing.	Being more expressive as a team leader. Highlighting the team leaders words to stand out more.	Better communication from the team leader would have perhaps generated better ideas.	I didn't have a role, but I would suggest that the team leader perhaps write in ALL CAPS to distinguish from the rest of the group, or something so it's clear to the participants to know what's next or even current.	Some where in your directions let the participants know that if their words aren't showing up on the screen to refresh their browser.
32	6C	STARTEGY	Effective; Productive; Creative; Positive; Interesting; Enjoyable; Pleasant; Enthusiastic; Fun; Peaceful; Expressive; Happy; Thrilled; Free; Excited; Empathetic; Satisfied; Energizing;	EVERY BODY INTERACTED	SLOW	RESPONDING	MORE INTERACTION	BE QUICK	INTERACTION IS IMPORTANT
33	6C	nothing.	Effective; Creative; Imaginative; Positive; Inventive; Interesting; Detailed; Enjoyable; Pleasant; Fun; Peaceful; Expressive; Charming; Purposeful; Happy;	they imagine more and more.	Interest.	Being patient.	Imagine.	When fill-up the form, should be cool and positive.	They should give more task to imagine.

			Pleased; Free; Fulfilled; Satisfied; Joyful; Grateful; Understood;						
35	6C	improving the webpage	Effective; Creative; Imaginative; Positive; Interesting; Enjoyable; Pleasant; Fun; Charming; Purposeful; Joyful; Involved;	they think deeply	good	fixing the bugs in the webpage like chat box was too small at first and never that webpage moves on by it self i had to refresh it	thinking deeply	think carefully before posting	improve the webpage
38	6C	friends	Positive; Enthusiastic; Happy; Thrilled; Satisfied; Joyful;		energetic	more techniques	will make much more better	useful advice	nothing
44	20C	creativity	Effective; Productive; Creative; Imaginative; Positive; Inventive; Interesting; Enjoyable; Pleasant; Fascinating; Relieved; Enthusiastic; Fun; Peaceful; Directed; Expressive; Charming; Happy; Thrilled; Pleased; Free; Excited; Satisfied; Joyful; Energizing; Grateful; Involved;	we work more closely	energetic	adding few good participents	giving new ideas by thinking and encouraging others	must be energetic	make it more role for the leader
45	8C		Effective; Enjoyable; Fun; Happy; Thrilled; Pleased; Free; Excited; Joyful; Creative;						
46	8C	group members	Effective; Productive; Creative; Imaginative; Positive; Enjoyable; Enthusiastic; Fun; Peaceful; Directed; Happy; Thrilled; Pleased; Joyful;	time permits	good	adding more games task	chatting	work as team	improve more such research for generating ideas
48	8C	Making everyone participate	Effective; Productive; Creative; Imaginative; Positive; Inventive; Enjoyable; Enthusiastic; Fun; Expressive; Purposeful; Excited; Unappreciated; Energizing; Involved;	We discussed more	Alone	Effective participation	Discussion	Do well	To make everyone participate
50	8C	working with a group.	Effective; Productive; Creative; Imaginative; Positive; Inventive; Interesting; Enjoyable; Pleasant; Fun; Peaceful; Happy; Thrilled; Pleased; Free; Exhilarated; Joyful; Energizing; Grateful;	we worked together.	good.	having more time with the group.	Working together more.	Gather ideas and make therm work.	the study seemed to just include those word associations. Two sets of them.
51	9T	taking	Effective; Productive; Creative;	we able to	contacti	interacting, planning and	utilize the	be positive	to generate goal oriented

		interaction form all the group	Imaginative; Positive; Inventive; Interesting; Enjoyable; Pleasant; Fascinating; Relieved; Enthusiastic; Fun; Peaceful; Charming; Happy; Thrilled; Excited; Satisfied; Joyful; Energizing; Measured; Grateful; Involved; Understood;	understand how to interact each other	ng all the team	reading all the instructions as i did it so far.	resources and understand quickly to keep helping hand in lifting final result.	and sportive and let the mind play a creative role.	approach
53	9T	refreshing	Effective; Imaginative; Purposeful; Thrilled; Constricted; Unappreciated; Measured; Depressed; Involved;	the link worked properly	confuse d	do nothing	co-operation and reasons	Be sincere in your work	Please do something to sort the problems in doing this work
60	10C								
62	10C	if you given more options	Effective; Interesting; Enjoyable; Pleasant; Fun; Peaceful; Charming; Thrilled; Excited; Satisfied; Energizing; Involved;		jittery	not minding the time	to think newly	team mate- in order to discuss about the products	participants get late to settle.if you could do it quickly our time would choice.
63	11T	NONE	Effective; Productive; Creative; Imaginative; Positive; Inventive; Interesting; Enjoyable; Pleasant; Enthusiastic; Fun; Peaceful; Expressive; Charming; Purposeful; Happy; Thrilled; Pleased; Free; Excited; Fulfilled; Satisfied; Joyful; Energizing; Grateful; Involved; Understood;	WE WERE MORE UNDERSTANDI NG PRIOR TO TRIAL	GOOD	ADDING MORE FUN	INDIVIDUAL BRILLIENCE SHOULD CONTRIBUTE FOR LARGER GOAL	BETTER THAN ME AND MORE CREATIVE.	I ENJOYED
64	10C	taking the leadership position	Effective; Productive; Imaginative; Positive; Inventive; Interesting; Enjoyable; Pleasant; Fascinating; Enthusiastic; Fun; Peaceful; Anxious; Directed; Expressive; Purposeful; Happy; Thrilled; Pleased; Excited; Exhilarated; Fulfilled; Satisfied; Joyful; Energizing;	given little hints and with more collaboration among group members	extreme ly happy	making it more fast	each coming out with different ideas	give him positive advice and help him out	that it is really very innovative.
65	11T	allowing the time keeper even to contribute ideas.	Creative; Enjoyable; Pleasant; Happy; Pleased; Satisfied; Grateful; Involved;	all of them had gone through the instruction/ Hints for arriving at ideas on right	excited by looking at ideas.	allowing all to contribute ideas.	The person entering the final ideas must enter promptly. All giving ideas	Keep looking at the number of ideas. If you feel that	Good job to involve everyone. We can achieve a lot together.

				side of test screen.			should speak in words and not in sentences.	they are less then extend time promptly to help all to submit more ideas.	
66	11T		Effective; Enjoyable; Pleasant; Enthusiastic; Fun; Peaceful; Expressive; Pleased; Excited; Satisfied; Wounded; Joyful;	we have more time	good		Time limit	Choose best that you like.	make it more interesting.
67	11T	By reducing the users to 3-4	Aggravating; Annoyed;			Save the process time and cutting off the excessive other user waiting time.	Another private chat window		
68	11T		Imaginative; Detailed; Enthusiastic; Peaceful; Directed; Charming; Thrilled; Flattered; Excited; Joyful; Grateful; Creative;						
69	11T	working alone!	Relieved; Frustrating; Stifled; Aggravating;	they worked together.	little cohesion.	Screening the applicants for the roles.	Some basic English lessons.	Don't restrict your thoughts.	Make entry to this hit to those competent in English and genuinely motivated. You could do this by some pre-screening questions.
70	12C		Imaginative; Inventive; Ineffective; Negative; Guarded; ClosedOff;				it didnt work	i didnt see anyone give advice	
71	12C	other team	Effective; Productive; Creative;	more members	fair enough	adding catching menus	encouraging	drive a team	fair job done
73	12C	more organized, more coordination	Ineffective; Frustrating; Aggravating;	there had been better coordination	not sure	defining all roles and telling us what they are	more work	none	see above
76	14C	having an effective program and active participants	Inventive; Drudgery; Frustrating; Anxious; Bored; Annoyed;	they tried	frustrated	better software	active participants and a chat system that didn't eat messages	don't expect anyone else to do anything	not sure if they problems were intentional...
77	13T	smaller team with the same roles	Interesting; Ineffective; Monotonous; Annoyed;	the question would of offered room for imagination	bored	improving the chat system	better means of communication	we should work together	workers should be able to select their own questions
78	13T	Making it more	Productive; Creative; Imaginative; Positive;		involved and	more interactive features	The chat function has limited	Push the group to	In such settings (especially with defined roles), groups may lack

		interactive	Inventive; Interesting; Enjoyable; Enthusiastic; Frustrating; Directed; Expressive; Purposeful; Excited; Fulfilled; Involved; Annoyed; Understood;		focused .		'functionality'. Team members or at least members with defined roles (leader, time-keeper etc.,) should be able to communicate with each other.	complete the task in the stipulated time. Keep prodding them when the energy level is down, so that they can generate as many ideas in the given time.	motivation to achieve the common objective, which could be avoided by adding more tools (like the warm-up one) during the process of generating of ideas.
79	14C	Nothing	Ineffective; Frustrating; Bored; Stifled; Monotonous; Constricted; ClosedOff;	they had paid attention	bored and frustrate d	Making sure participants paid attention	If the group had paid attention to the task, it might have fostered creativity	Pay attention to your web browser	Make sure your participants pay attention by staggering the entry times. It is absolutely possible to design a paradigm where your participants have some reason to talk to each other.
83	13T		Creative; Interesting; Frustrating; Aggravating; Free;				The enter button does not work. Most of my ideas I had to reenter		
87	15T	the only thing Id di different is the thing with the enter buttn vs using the surveys own enter button which is what you had to use. Also Id explain to the data entry person how they could do their job instead of us figuring out out	Effective; Contagious; Productive; Creative; Imaginative; Positive; Inventive; Interesting; Detailed; Enjoyable; Pleasant; Fascinating; Enthusiastic; Fun; Expressive; Purposeful; Happy; Pleased; Exhilarated; Satisfied; Joyful; Energizing; Involved; Understood;	if every person in the group jad participated but it seemed that only me, SC and pa were the main ones actually giving suggestions	good, happy, producti ve	some way of making all participants participate - some just sat there and earned money for not doing anything	it was very open to interpretation so Im not sure what else would have helped - hints were given to the right of the chat box and they helped alot to imagine the scenario better - to get you to think outside the box	leave it all open and listen to all suggestions - be a leader and not a dictator	I like the way this was done for the most part - just a couple of minor things i said above Id change otherwise a cool experience
90	15T	i don't think i would have done it	Creative; Positive; Interesting;	everyone had contributed	interest ed but also like	using smaller groups	if more people had contributed to the group	make sure you spend time both	the web interface was kind of awkward w/chat boxes and such

		differently			it was difficult			suggesting new ideas and entering in the group's ideas	
91	15T	Image based exercise	Creative; Interesting; Detailed; Enjoyable; Pleasant; Fun; Free; Excited; Satisfied; Understood;	the chatting windows are user firendly	Happy , ex	giving easy scenarios	team spirit	I would give easy to follow advice	please remove the bugs
96	16C	adding more people.	Effective; Productive; Creative; Imaginative; Positive; Inventive; Interesting; Detailed; Enjoyable; Pleasant; Fascinating; Enthusiastic; Fun; Peaceful; Purposeful; Happy; Thrilled; Aggravating; Free; Excited; Fulfilled; Satisfied; Joyful; Energizing; Involved; Understood;	a bit more time was given.	energeti c.	It was not frustrating at all.	More interaction.	Be confident in what you are doing.	increase the number of output results expected from the participants.
98	16C	if i were the leader of the group .	Effective; Productive; Creative; Imaginative; Positive; Interesting; Enjoyable; Pleasant; Fascinating; Enthusiastic; Fun; Peaceful; Anxious; Expressive; Charming; Purposeful; Happy; Pleased; Free; Excited; Fulfilled; Satisfied; Joyful; Understood;	the 2 nd question was little easier .	very creative .	assigning two leaders .	if the leader encourages others .	try to give more opinions even if they are wrong .	to make 2 persons as leaders .
100	16C	-	Effective; Creative; Imaginative; Positive; Interesting; Enjoyable; Fun; Happy; Pleased; Excited; Fulfilled; Energizing; Involved;	they think more creatively	Energet ic & creative	asking for more interesting questions	The group task is doing fine.	Just to think differently	It's excellent!!!
103	18C	Making the damn chat client better.	Effective; Productive; Creative; Imaginative; Positive; Inventive; Interesting; Detailed; Enjoyable; Pleasant; Fascinating; Relieved; Enthusiastic; Fun; Peaceful; Expressive; Charming; Purposeful; Happy; Pleased; Free; Fulfilled; Satisfied; Energizing; Involved;	The chat client worked better.	Like the chat client needed to be better.	Making the chat client better.	A better chat service with a faster response time and easier posting method.	Leader: keep everyone guessing, give hints, and encourage thinking outside the box.	I hated your chat client.
106	18C	/	Effective; Contagious;	there would be	comfort	improving code of	Posting answers	exchange	thank you for chance to being part

			Productive; Creative; Imaginative; Positive; Inventive; Interesting; Enjoyable; Pleasant; Fascinating; Enthusiastic; Fun; Peaceful; Anxious; Directed; Charming; Purposeful; Happy; Thrilled; Constricted; Free; Excited; Exhilarated; Fulfilled; Satisfied; Joyful; Energizing; Grateful; Involved; Understood;	better description of problem, I don't mean that answers would be served on a plate, but a bit more detailed description	able, satisfied , happy to colabor ate	webpage :) I wasn't able to post when there was actual problem, but it worked on test	was very hard, it didn't work, I wasn't able to post all answers	as many ideas as possible	of it
109	17T	letting everyone record answers	Drudgery; Negative; Frustrating; Aggravating; Annoyed;	Everyone was actually present	frustrate d that not everyon e was there/ doing their job and that the progra m did not work very well	Making the program actually work	If they knew how to use the system/ if the program worked	None really ...	I tried my best but the recorder was not recording our answers and I hope I will still be compensated since I did what I was supposed to.
112	17T	introducing scene and a pre-input discussion	Productive; Creative; Imaginative; Positive; Inventive; Enjoyable; Fun; Excited; Joyful; Measured;	Well set group discussion forum would be available	there is some technic al issue in commu nication in browser	having chatting type forum and easy view for every one	if all information is seen in the room and researcher would respnd query quickly	should keep a watch on the situation and keep team spirit high	that they should be communicating to the leader at least
114	18C	no changes	Effective; Productive; Inventive; Interesting; Detailed; Enjoyable; Pleasant; Fascinating; Pleased; Free; Fulfilled; Energizing; Involved;	more time	good	no changes	nothing, was free flowing	be open minded	no changes
117	17T		Positive; Enjoyable; Fun; Expressive; Monotonous; Constricted; Exhilarated; Joyful; Depressed;						

			Understood;						
118	18C	-	Effective; Productive; Creative; Imaginative; Positive; Inventive; Interesting; Enjoyable; Pleasant; Fun; Happy; Pleased; Excited; Satisfied; Wounded; Joyful; Grateful; Involved;	-	on the toe	Nothing is frustrating.	Focus on the task and think differently	No idea is a bad idea	Hope this excerice is serving the purpose
120	18C		Creative; Ineffective; Relieved; Bored; Happy; Agitating; Excited; Baited; Involved;						
121	18C	More Group bonding	Effective; Creative; Imaginative; Positive; Inventive; Interesting; Enjoyable; Pleasant; Fun; Happy; Satisfied; Joyful; Energizing; Involved;	no comments	Excited	more communication among members	additional hints would work better	Thinking out of the box is the key	The idea was excellent
123	19T	nothing	Effective; Productive; Creative; Imaginative; Positive; Inventive; Interesting; Detailed; Enjoyable; Pleasant; Fascinating; Enthusiastic; Fun; Directed; Expressive; Purposeful; Thrilled; Pleased; Free; Fulfilled; Joyful; Energizing; Involved; Understood;	we had a little more time.	excited	i couldnt input text with enter key i had to use mouse to click the arrow	more time.	be creative	nice.
124	19T	more enthusiasm.	Effective; Interesting; Peaceful; Charming; Thrilled; Free; Satisfied; Energizing;	they were more interactive.	very thrilled about what will happen next.	giving more attention.	Make me leader, then group will be more effective.	Be serious in your works.	make this little more simple.
125	19T	Tried to think of weireder ideas sooner to encourage the group.	Productive; Creative; Positive; Inventive; Interesting; Enjoyable; Pleasant; Fascinating; Enthusiastic; Fun; Purposeful; Happy; Pleased; Fulfilled; Satisfied; Joyful; Energizing; Involved;	Perhaps if we had a stronger leader or more examples.	Interested and challenged to come up with weird ideas.	Again just by making the instructions clearer and possibly giving us a separate place to chat.	If there had been more group communications and clearer instructions on how to use the system.		Very fun unique survey that really challenges us!
127	19T	nothing, worked well	Productive; Creative; Imaginative; Positive; Inventive; Interesting; Enjoyable; Enthusiastic; Fun;	more direction from those in roles	creative	More direction from the leader	I think we did pretty well	Did not have a role	Great job

			Expressive; Involved;						
129	20C		Productive; Imaginative; Interesting; Detailed; Pleasant;		wonderi ng what was next	making site easier	if everyone had answered at least 5 times		make it more clear of what to do
132	20C	watching	Effective; Productive; Enjoyable; Joyful; Creative; Understood;	leader guided well first	having fun	adding new menus	congratulating	be quick learner	role the leader as a model

NOTE: Group numbers shown are identified with “C” for Control Groups and “T” for Treatment groups.

Figure 3

Public Front Lobby of the Study Site

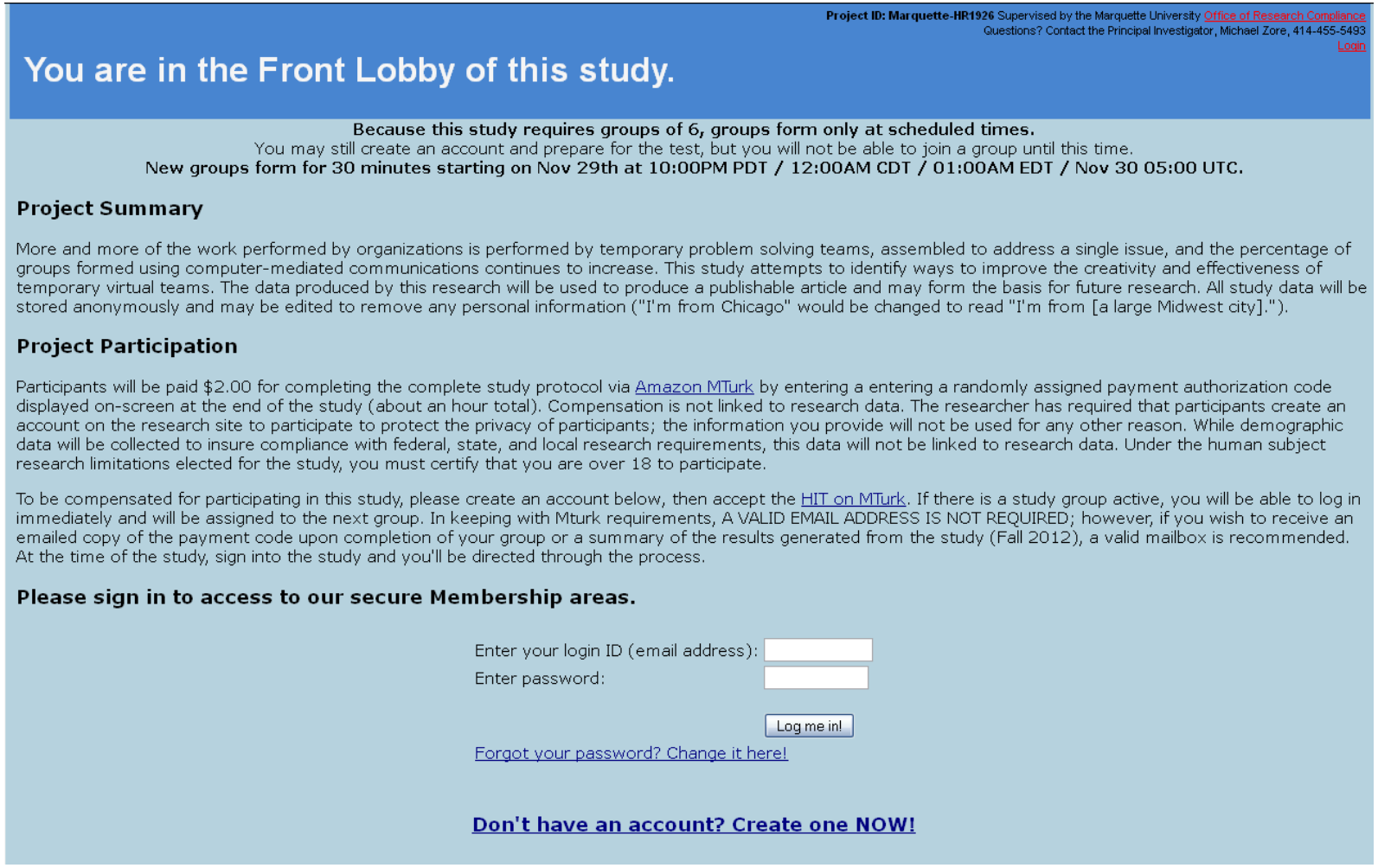
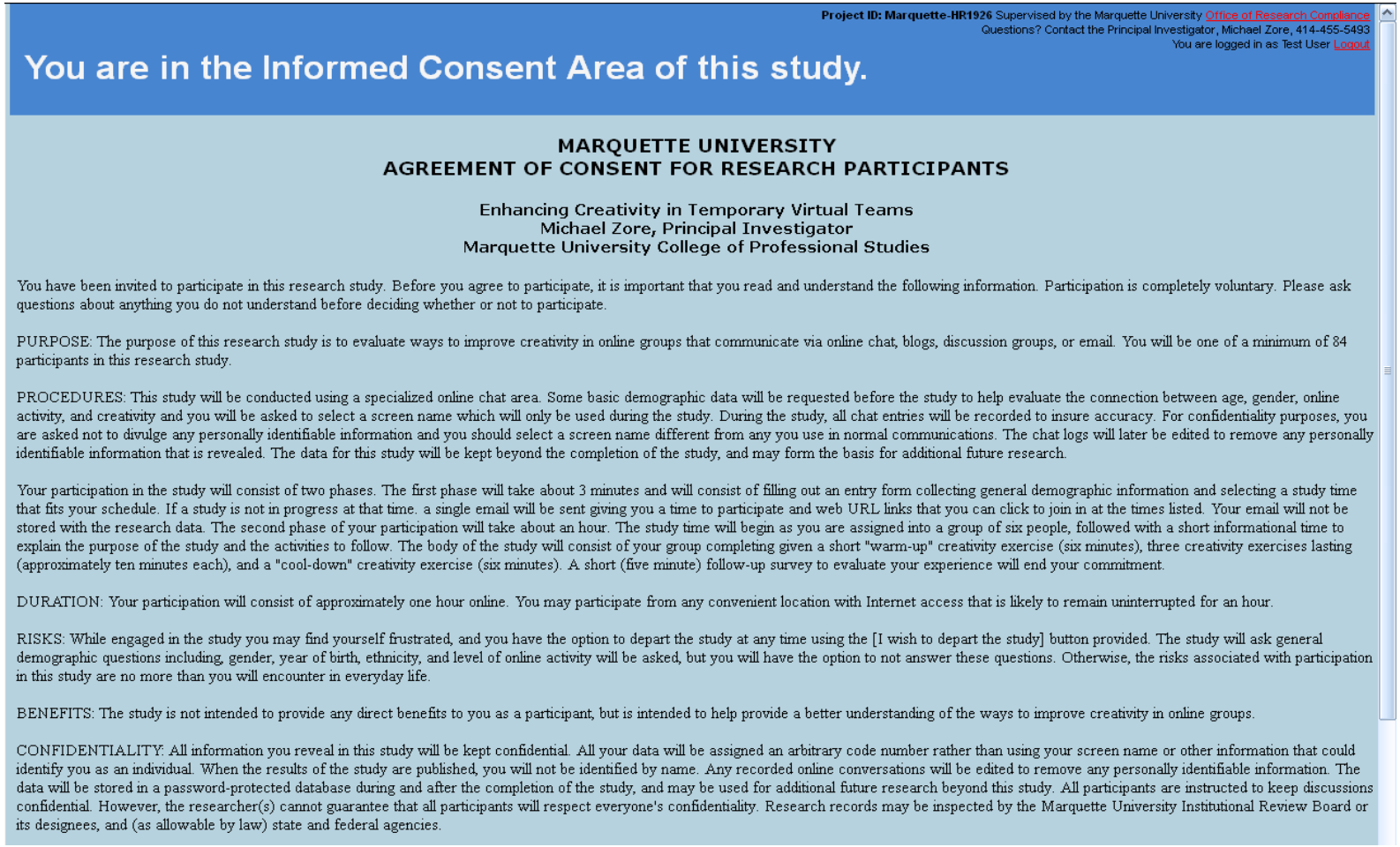


Figure 4

Informed Consent Information from the Study Site, first screen



Project ID: Marquette-HR1926 Supervised by the Marquette University Office of Research Compliance
Questions? Contact the Principal Investigator, Michael Zore, 414-455-5493
You are logged in as Test User Logout

You are in the Informed Consent Area of this study.

MARQUETTE UNIVERSITY
AGREEMENT OF CONSENT FOR RESEARCH PARTICIPANTS

Enhancing Creativity in Temporary Virtual Teams
Michael Zore, Principal Investigator
Marquette University College of Professional Studies

You have been invited to participate in this research study. Before you agree to participate, it is important that you read and understand the following information. Participation is completely voluntary. Please ask questions about anything you do not understand before deciding whether or not to participate.

PURPOSE: The purpose of this research study is to evaluate ways to improve creativity in online groups that communicate via online chat, blogs, discussion groups, or email. You will be one of a minimum of 84 participants in this research study.

PROCEDURES: This study will be conducted using a specialized online chat area. Some basic demographic data will be requested before the study to help evaluate the connection between age, gender, online activity, and creativity and you will be asked to select a screen name which will only be used during the study. During the study, all chat entries will be recorded to insure accuracy. For confidentiality purposes, you are asked not to divulge any personally identifiable information and you should select a screen name different from any you use in normal communications. The chat logs will later be edited to remove any personally identifiable information that is revealed. The data for this study will be kept beyond the completion of the study, and may form the basis for additional future research.

Your participation in the study will consist of two phases. The first phase will take about 3 minutes and will consist of filling out an entry form collecting general demographic information and selecting a study time that fits your schedule. If a study is not in progress at that time. a single email will be sent giving you a time to participate and web URL links that you can click to join in at the times listed. Your email will not be stored with the research data. The second phase of your participation will take about an hour. The study time will begin as you are assigned into a group of six people, followed with a short informational time to explain the purpose of the study and the activities to follow. The body of the study will consist of your group completing given a short "warm-up" creativity exercise (six minutes), three creativity exercises lasting (approximately ten minutes each), and a "cool-down" creativity exercise (six minutes). A short (five minute) follow-up survey to evaluate your experience will end your commitment.

DURATION: Your participation will consist of approximately one hour online. You may participate from any convenient location with Internet access that is likely to remain uninterrupted for an hour.

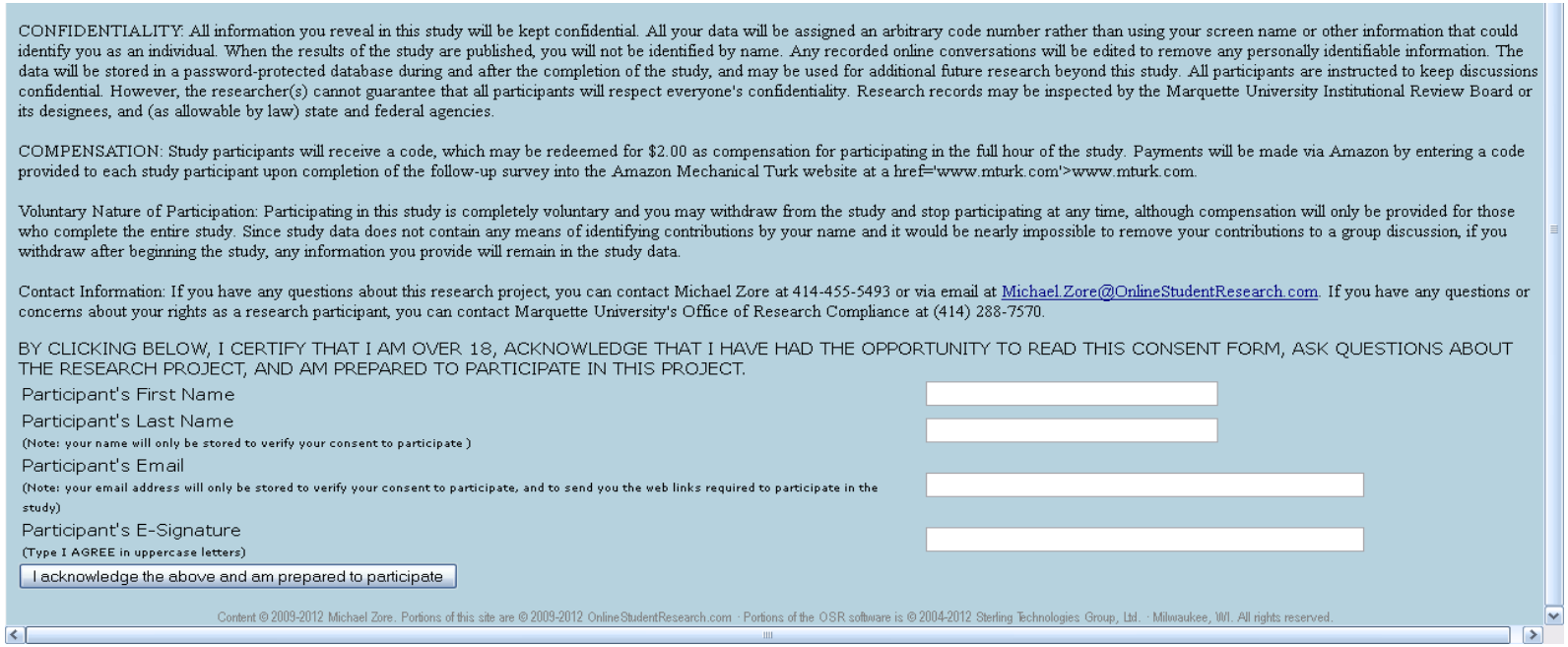
RISKS: While engaged in the study you may find yourself frustrated, and you have the option to depart the study at any time using the [I wish to depart the study] button provided. The study will ask general demographic questions including, gender, year of birth, ethnicity, and level of online activity will be asked, but you will have the option to not answer these questions. Otherwise, the risks associated with participation in this study are no more than you will encounter in everyday life.

BENEFITS: The study is not intended to provide any direct benefits to you as a participant, but is intended to help provide a better understanding of the ways to improve creativity in online groups.

CONFIDENTIALITY: All information you reveal in this study will be kept confidential. All your data will be assigned an arbitrary code number rather than using your screen name or other information that could identify you as an individual. When the results of the study are published, you will not be identified by name. Any recorded online conversations will be edited to remove any personally identifiable information. The data will be stored in a password-protected database during and after the completion of the study, and may be used for additional future research beyond this study. All participants are instructed to keep discussions confidential. However, the researcher(s) cannot guarantee that all participants will respect everyone's confidentiality. Research records may be inspected by the Marquette University Institutional Review Board or its designees, and (as allowable by law) state and federal agencies.

Figure 5

Informed Consent Information from the Study Site, continued



CONFIDENTIALITY: All information you reveal in this study will be kept confidential. All your data will be assigned an arbitrary code number rather than using your screen name or other information that could identify you as an individual. When the results of the study are published, you will not be identified by name. Any recorded online conversations will be edited to remove any personally identifiable information. The data will be stored in a password-protected database during and after the completion of the study, and may be used for additional future research beyond this study. All participants are instructed to keep discussions confidential. However, the researcher(s) cannot guarantee that all participants will respect everyone's confidentiality. Research records may be inspected by the Marquette University Institutional Review Board or its designees, and (as allowable by law) state and federal agencies.

COMPENSATION: Study participants will receive a code, which may be redeemed for $2.00 as compensation for participating in the full hour of the study. Payments will be made via Amazon by entering a code provided to each study participant upon completion of the follow-up survey into the Amazon Mechanical Turk website at a href='www.mturk.com'>www.mturk.com.

Voluntary Nature of Participation: Participating in this study is completely voluntary and you may withdraw from the study and stop participating at any time, although compensation will only be provided for those who complete the entire study. Since study data does not contain any means of identifying contributions by your name and it would be nearly impossible to remove your contributions to a group discussion, if you withdraw after beginning the study, any information you provide will remain in the study data.

Contact Information: If you have any questions about this research project, you can contact Michael Zore at 414-455-5493 or via email at Michael.Zore@OnlineStudentResearch.com. If you have any questions or concerns about your rights as a research participant, you can contact Marquette University's Office of Research Compliance at (414) 288-7570.

BY CLICKING BELOW, I CERTIFY THAT I AM OVER 18, ACKNOWLEDGE THAT I HAVE HAD THE OPPORTUNITY TO READ THIS CONSENT FORM, ASK QUESTIONS ABOUT THE RESEARCH PROJECT, AND AM PREPARED TO PARTICIPATE IN THIS PROJECT.

Participant's First Name

Participant's Last Name
(Note: your name will only be stored to verify your consent to participate)

Participant's Email
(Note: your email address will only be stored to verify your consent to participate, and to send you the web links required to participate in the study)

Participant's E-Signature
(Type I AGREE in uppercase letters)

I acknowledge the above and am prepared to participate

Figure 6

User Account Screen (required fields: name, email, password)

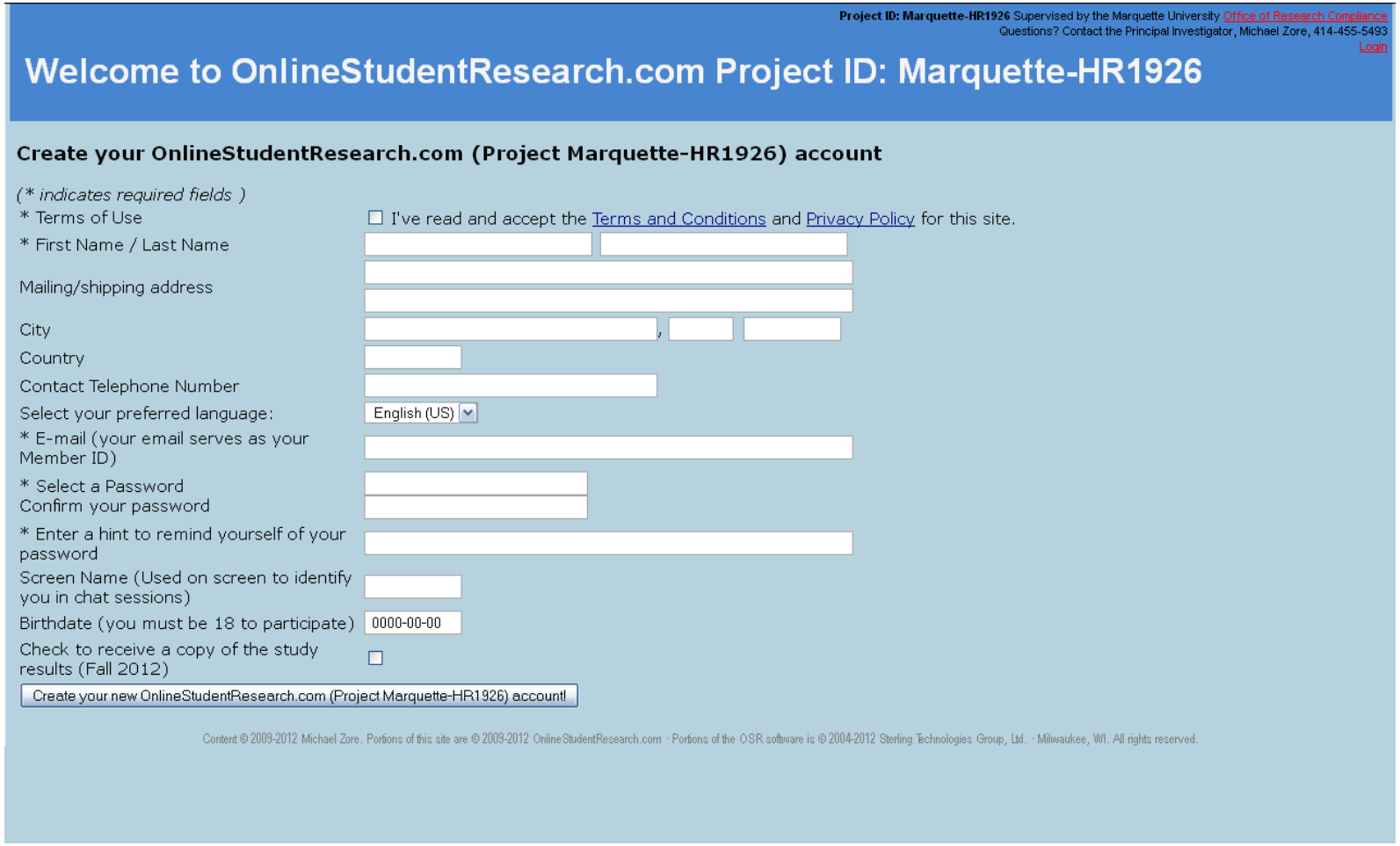


Figure 7

Screen Shot of Pre-test Screen

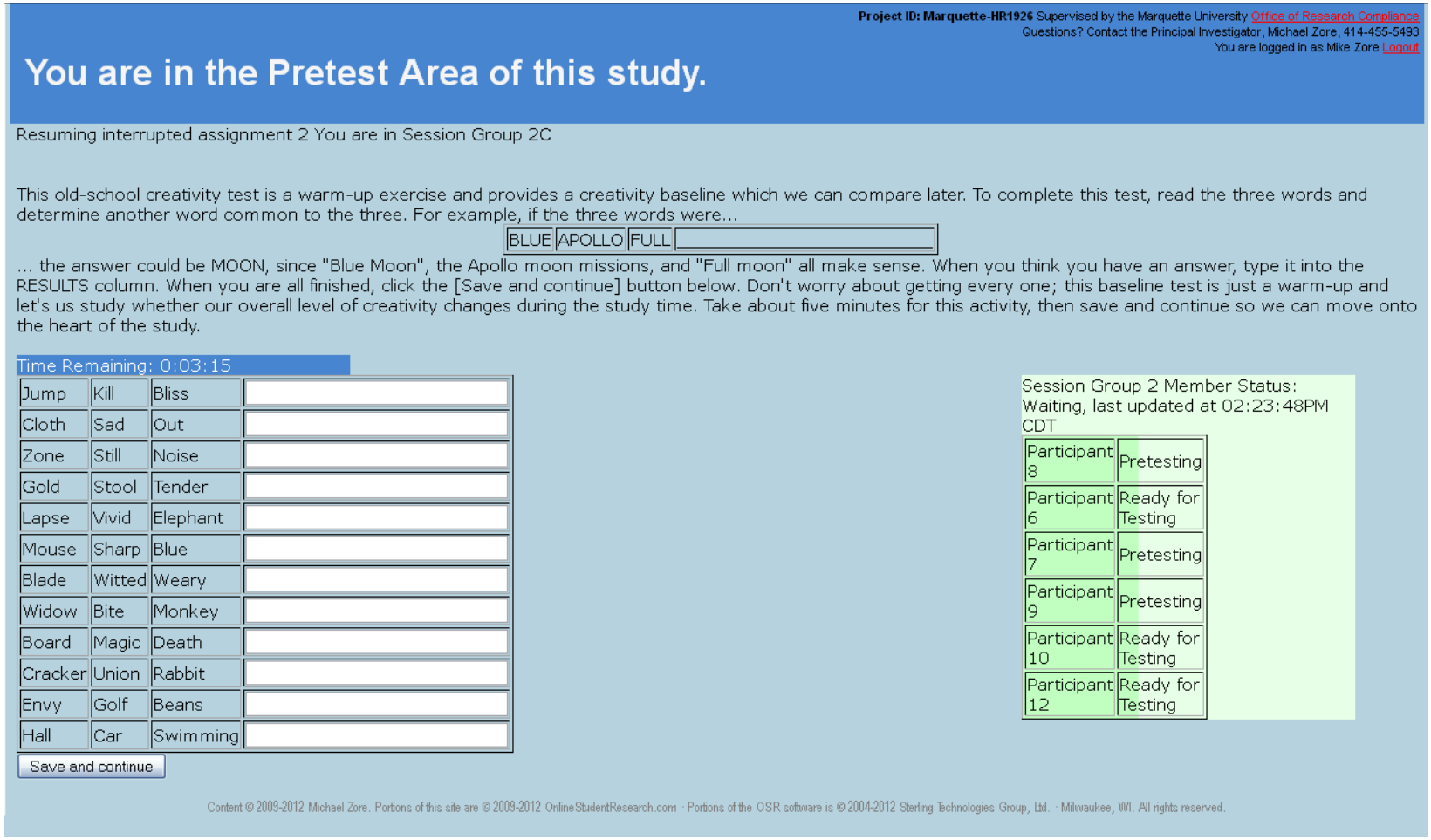


Figure 8

Screen Shot of Live Study Group (Control Group 2)

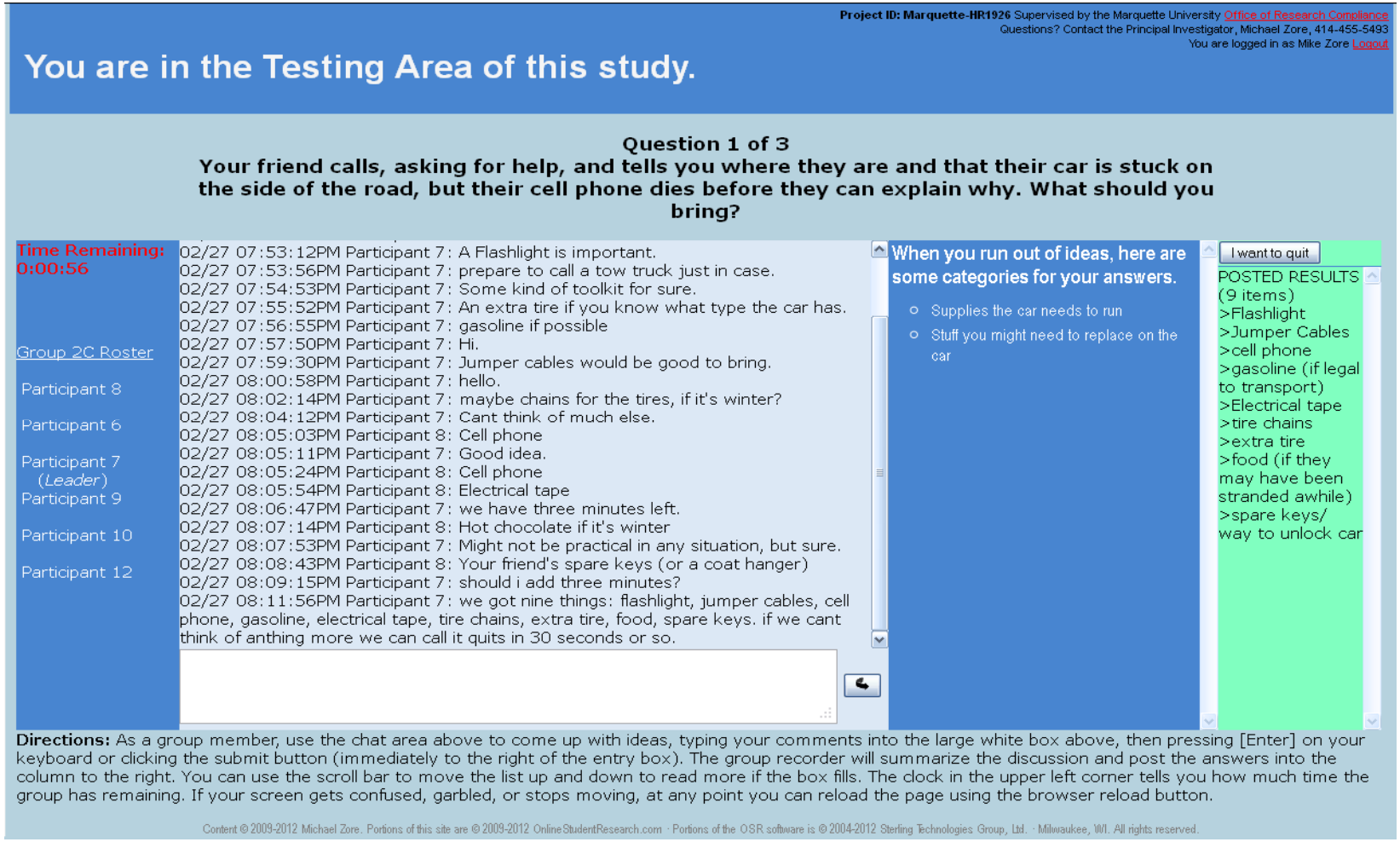
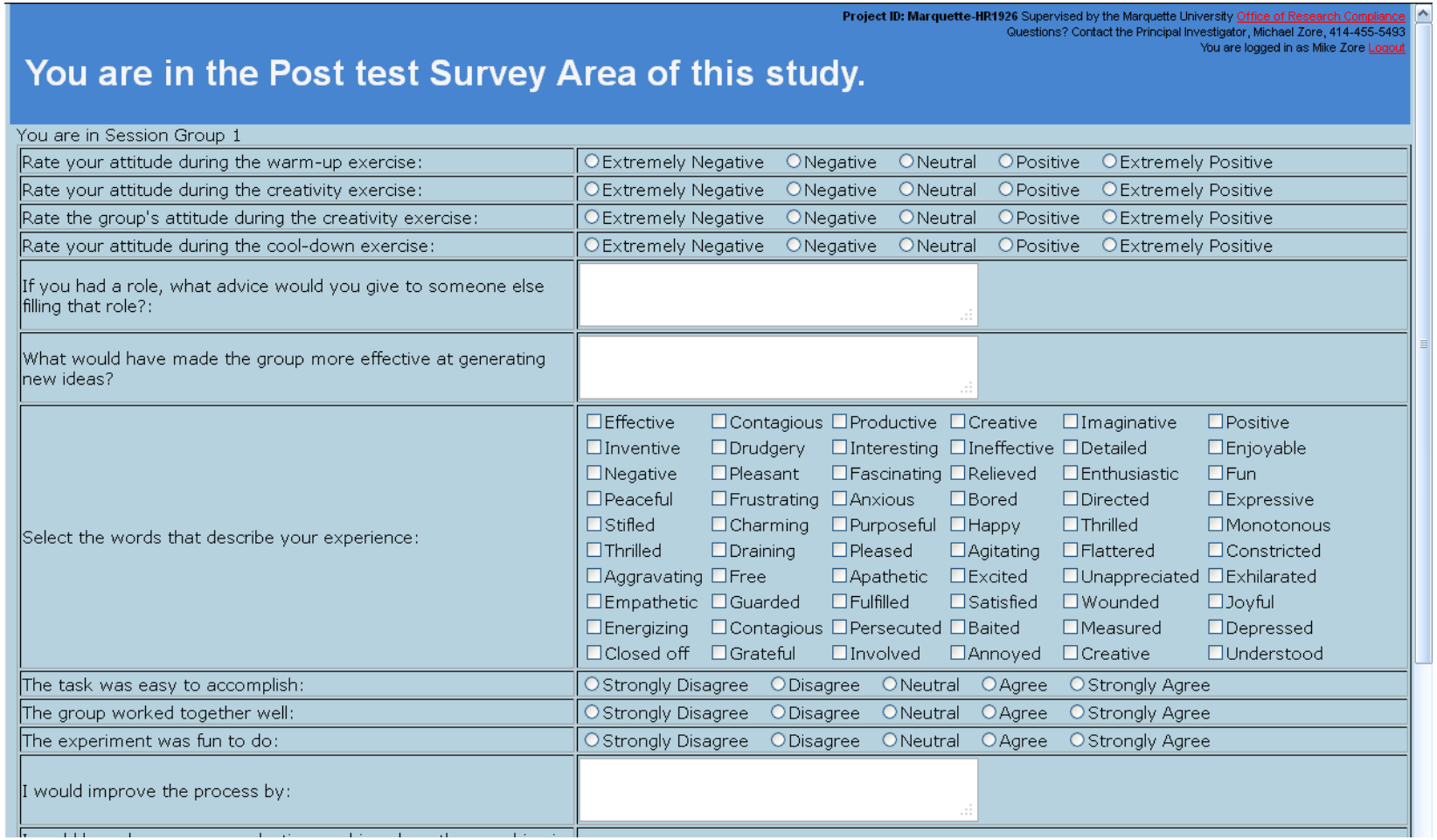


Figure 9

Screen Shot of Follow-up Survey



Project ID: Marquette-HR1926 Supervised by the Marquette University Office of Research Compliance
Questions? Contact the Principal Investigator, Michael Zore, 414-455-5493
You are logged in as Mike Zore Logout

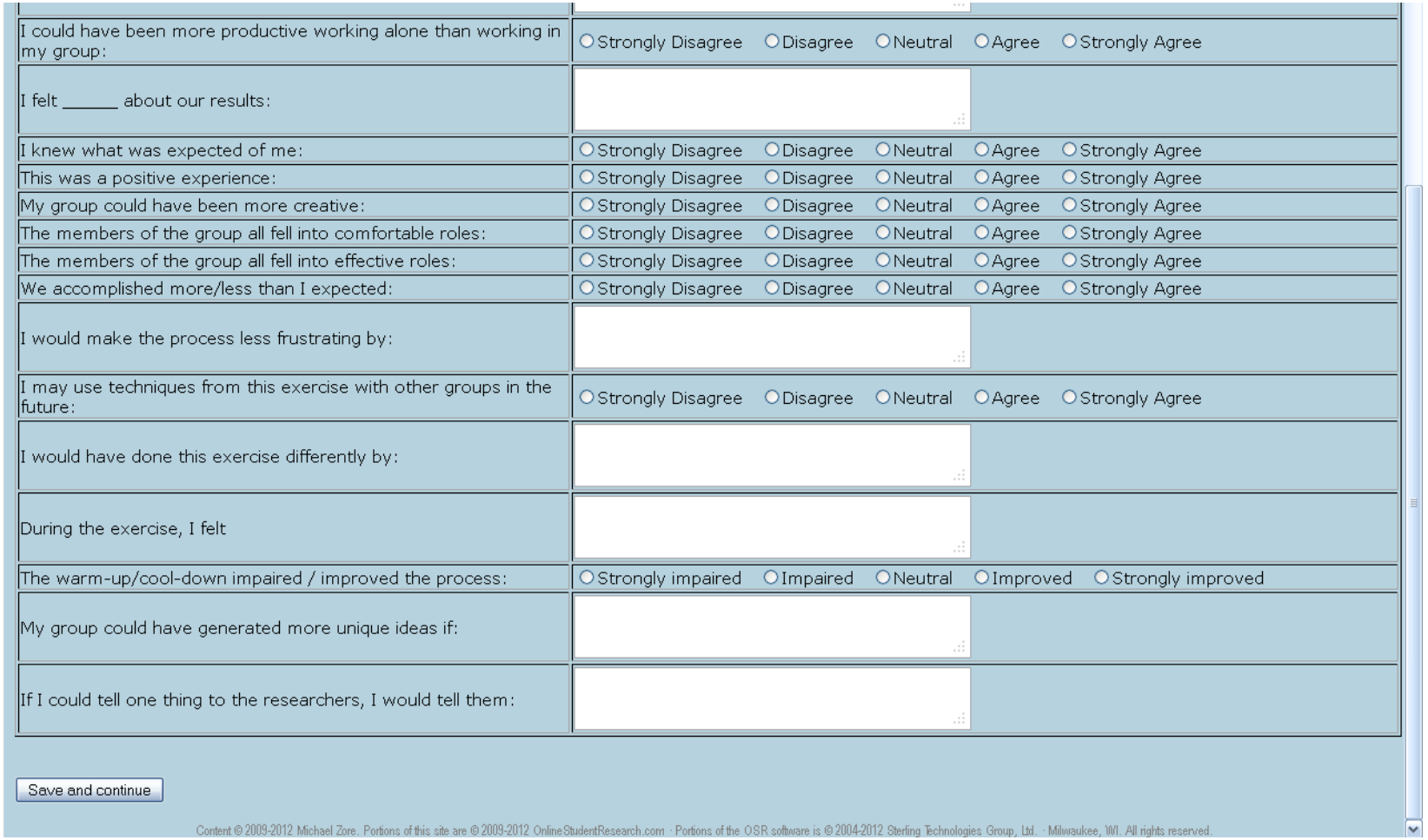
You are in the Post test Survey Area of this study.

You are in Session Group 1

Rate your attitude during the warm-up exercise:	○ Extremely Negative ○ Negative ○ Neutral ○ Positive ○ Extremely Positive
Rate your attitude during the creativity exercise:	○ Extremely Negative ○ Negative ○ Neutral ○ Positive ○ Extremely Positive
Rate the group's attitude during the creativity exercise:	○ Extremely Negative ○ Negative ○ Neutral ○ Positive ○ Extremely Positive
Rate your attitude during the cool-down exercise:	○ Extremely Negative ○ Negative ○ Neutral ○ Positive ○ Extremely Positive
If you had a role, what advice would you give to someone else filling that role?:	
What would have made the group more effective at generating new ideas?	
Select the words that describe your experience:	☐ Effective ☐ Contagious ☐ Productive ☐ Creative ☐ Imaginative ☐ Positive ☐ Inventive ☐ Drudgery ☐ Interesting ☐ Ineffective ☐ Detailed ☐ Enjoyable ☐ Negative ☐ Pleasant ☐ Fascinating ☐ Relieved ☐ Enthusiastic ☐ Fun ☐ Peaceful ☐ Frustrating ☐ Anxious ☐ Bored ☐ Directed ☐ Expressive ☐ Stifled ☐ Charming ☐ Purposeful ☐ Happy ☐ Thrilled ☐ Monotonous ☐ Thrilled ☐ Draining ☐ Pleased ☐ Agitating ☐ Flattered ☐ Constricted ☐ Aggravating ☐ Free ☐ Apathetic ☐ Excited ☐ Unappreciated ☐ Exhilarated ☐ Empathetic ☐ Guarded ☐ Fulfilled ☐ Satisfied ☐ Wounded ☐ Joyful ☐ Energizing ☐ Contagious ☐ Persecuted ☐ Baited ☐ Measured ☐ Depressed ☐ Closed off ☐ Grateful ☐ Involved ☐ Annoyed ☐ Creative ☐ Understood
The task was easy to accomplish:	○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
The group worked together well:	○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
The experiment was fun to do:	○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
I would improve the process by:	

Figure 10

Screen Shot of Follow-up Survey (Second page)

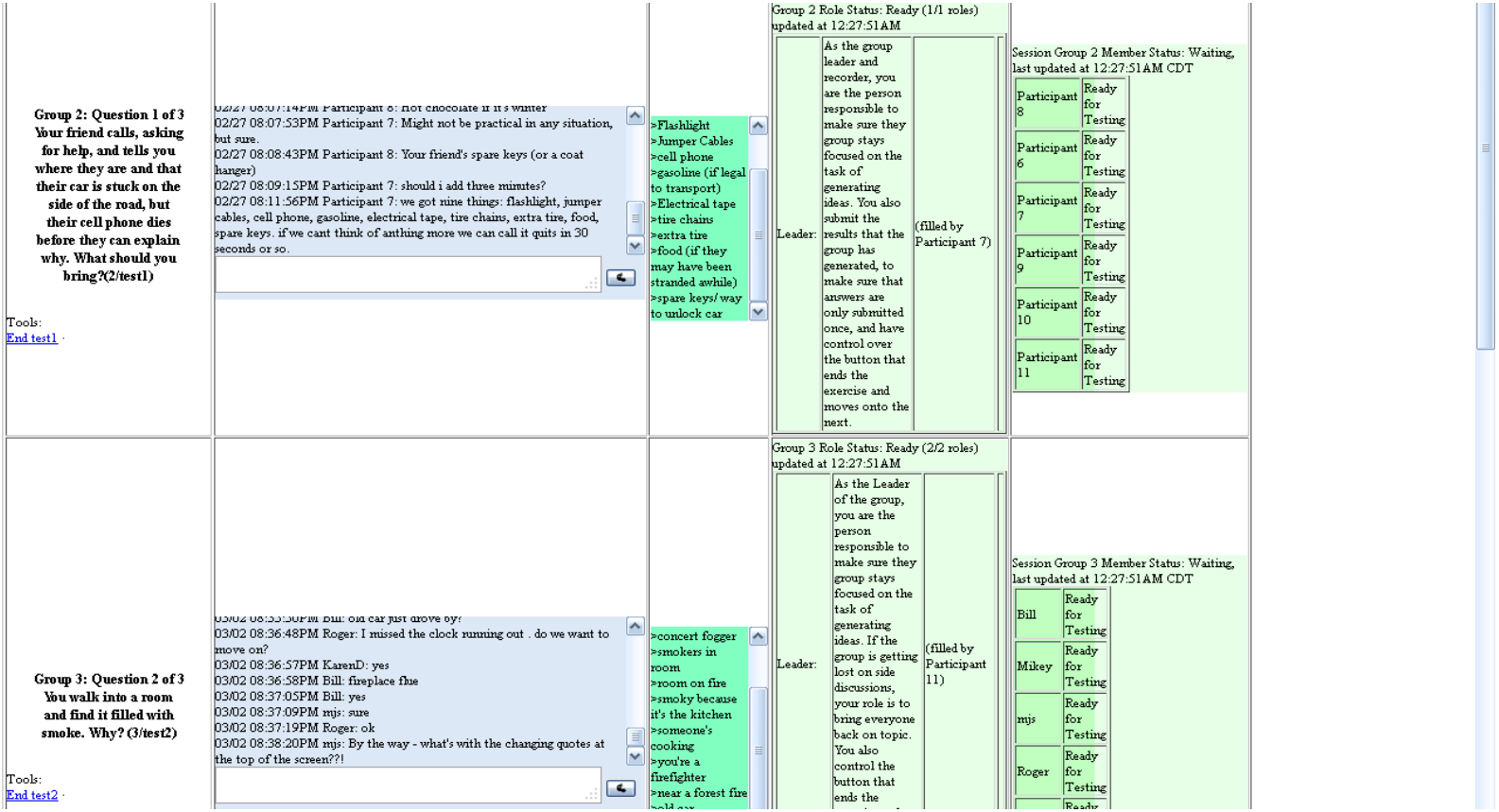


I could have been more productive working alone than working in my group:	○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
I felt _____ about our results:	
I knew what was expected of me:	○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
This was a positive experience:	○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
My group could have been more creative:	○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
The members of the group all fell into comfortable roles:	○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
The members of the group all fell into effective roles:	○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
We accomplished more/less than I expected:	○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
I would make the process less frustrating by:	
I may use techniques from this exercise with other groups in the future:	○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
I would have done this exercise differently by:	
During the exercise, I felt	
The warm-up/cool-down impaired / improved the process:	○ Strongly impaired ○ Impaired ○ Neutral ○ Improved ○ Strongly improved
My group could have generated more unique ideas if:	
If I could tell one thing to the researchers, I would tell them:	

Save and continue

Figure 11

Simulated Screen Shot of Researcher Overview screen



Note: this is a simulated screen shot of the Researcher's Overview screen, allowing the researcher to view the current status of each study group, containing live, updating contents of the current chat, results, and group status. This screen shot contains real data from Groups 2 and 3 but was not taken during the study.