Getting Serious about Games: A Study of Work and Play through Information Systems

Jeffrey K. Mullins

University of Arkansas, Fayetteville

Follow this and additional works at: https://scholarworks.uark.edu/etd

Part of the Business Administration, Management, and Operations Commons, Recreation Business Commons, Science and Technology Studies Commons, and the Technology and Innovation Commons

Citation

This Dissertation is brought to you for free and open access by ScholarWorks@UARK. It has been accepted for inclusion in Graduate Theses and Dissertations by an authorized administrator of ScholarWorks@UARK. For more information, please contact scholar@uark.edu.
Getting Serious about Games: A Study of Work and Play through Information Systems

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Business Administration

by

Jeffrey K. Mullins
University of Arkansas
Bachelor of Science in Computer Science, 1997
University of Arkansas
Master of Information Systems, 2006

December 2019
University of Arkansas

This dissertation is approved for recommendation to the Graduate Council.

______________________________
Rajiv Sabherwal, Ph.D.
Dissertation Director

______________________________
Timothy Paul Cronan, D.B.A. Varun Grover, Ph.D.
Committee Member Committee Member

______________________________
Elena Karahanna, Ph.D.
Ex-officio Committee Member
Abstract

Play and games shape, and are shaped by, culture. They represent an integral and ubiquitous component of humanity. Technological advances are blurring the lines between work and play, and their increasing convergence requires deeper understanding. Organizations seek to harness the motivational power of games to improve instrumental outcomes but face numerous challenges in doing so. Extant theory struggles to inform practice on the use of gameful experiences to achieve practical goals. This dissertation presents three essays that explore the domain of gameful information systems (IS), defined as IS that are designed or perceived to afford or support user experiences similar to those associated with play or games. Essay 1 develops a theoretical classification of gameful IS and then refines it using field interviews and text mining. Essay 2 develops a process theory of online competition and tests it using a longitudinal field study in the context of a gamified online analytics community. Essay 3 develops a theory of emotion, cognition, and coordination in the context of a competitive business simulation to examine how these team processes can affect important team outcomes. Overall, this dissertation offers the IS literature foundational theory focused on processes and player experiences through IS in the important interface between work and play.
**Acknowledgements**

I thank my advisor, Dr. Rajiv Sabherwal, for his unyielding support through my dissertation, and for always pushing me to do my best work. I also thank my dissertation committee members, Dr. Paul Cronan, Dr. Varun Grover, and Dr. Elena Karahanna, for their valuable feedback and guidance. I am grateful to the Department of Information Systems faculty, and to other faculty and administrators, who have contributed to my development as a scholar and supported me throughout my doctoral education.

I could not have done this without the support of my amazing partner, Michelle, and my wonderful daughters, Maddie and Devon. I follow in the footsteps of my father, brother, and sister in earning a doctorate and pursuing a scholarly career, and I thank my mother for creating and sustaining a nurturing environment that enabled all of us to succeed in those pursuits. Thanks also to other colleagues, family, and friends who have walked beside me on this path, in whole or in part.
# Table of Contents

Chapter 1. Introduction ........................................................................................................... 1  
Gameful Experiences ............................................................................................................ 1  
Cognition, Emotion, And Games .......................................................................................... 4  
Essays, Research Objectives, And Methods ........................................................................... 6  
References ............................................................................................................................... 9  
Appendices ............................................................................................................................... 13  
Appendix 1.1. Glossary ........................................................................................................... 13  
Appendix 1.2. IRB Protocols ................................................................................................. 14  

Information Systems And A Research Agenda ...................................................................... 17  

Introduction ............................................................................................................................. 17  

Theoretical Development ....................................................................................................... 19  
Defining Gameful IS .............................................................................................................. 19  
Level Of Theorizing: The IS In Use ....................................................................................... 24  
Needs-Affordances-Features In Gameful IS ......................................................................... 25  

The Initial Theoretical Taxonomy .......................................................................................... 33  
Gameful IS And Modalities Of Play ...................................................................................... 35  
Gamification / Taskification ................................................................................................. 36  
Serious Games ...................................................................................................................... 37  
Playful Design ....................................................................................................................... 38  
Games As Entertainment ....................................................................................................... 39  
Metagames ............................................................................................................................ 41  
Commodified Play .................................................................................................................. 42  
Hacking For Fun .................................................................................................................... 43  
Playful Attitude ..................................................................................................................... 44  

Empirical Methods ............................................................................................................... 46  
Interviews ............................................................................................................................... 47  
Theoretical Coding .................................................................................................................. 48  

Results ..................................................................................................................................... 49  
Toward A Refined Taxonomy ................................................................................................. 51  
Cluster Summary .................................................................................................................... 52  
Cluster A: Gameful Adaptation ............................................................................................... 57  
Cluster B: Enjoyable Discovery ............................................................................................... 60
Introduction .............................................................................................................. 142
Theoretical Development ....................................................................................... 145
Performance And Transition In Coordination Of Action .................................... 148
Emotions And Cognitions In Team Processes ...................................................... 150
Emotional, Cognitive And Coordination Outcomes Of A Gameful Is Experience ...... 152
Data .......................................................................................................................... 156
Study 1 Context ...................................................................................................... 156
Study 2 Context ...................................................................................................... 157
Levels Of Analysis ................................................................................................. 160
Data Collection ........................................................................................................ 161
Chat Communications ............................................................................................ 162
Variables .................................................................................................................. 164
Analyses And Results ............................................................................................ 167
Performance And Coordination Change ............................................................... 168
Emotions And Cognitions In Process Phases ......................................................... 170
Post-Game Emotional, Cognitive, And Coordination Outcomes ......................... 172
Discussion ............................................................................................................... 176
Limitations ............................................................................................................... 178
Contributions To Theory ....................................................................................... 179
Contributions To Practice ...................................................................................... 181
Conclusion ............................................................................................................... 181
References .............................................................................................................. 182
Appendices ............................................................................................................. 189
Appendix 4.1. Chat Communication Coding Process ............................................. 189
Appendix 4.2. Measurement Items ........................................................................ 192
Appendix 4.3. Descriptive Statistics And Correlations ......................................... 193
Appendix 4.4. Changes In Cognition And Emotion .............................................. 194
Appendix 4.5. Factor Loadings in Confirmatory Factor Analysis .......................... 196
Appendix References .............................................................................................. 198
Chapter 5. Conclusion ........................................................................................... 199
References .............................................................................................................. 202
Chapter 1. Introduction¹

“Is this the real life?
Is this just fantasy?
Caught in a landslide
No escape from reality…”
- Queen 1975

Throughout their history, information systems (IS) have focused on goals such as improving organizational efficiency, enabling business transformation, identifying market opportunities, and complying with regulatory requirements (Pearlson et al. 2016; Venkatraman 1994): in short, on serious business. In parallel, video games provide an escape from the ordinary life, affording freedom within a simulated environment and creating order through the actions of the player – key elements associated with the notion of “play” (Caillois 1962). Despite seeming at odds with each other, the concepts of play and seriousness overlap²: for example, “… [p]lay is a thing by itself. The play-concept is of a higher order than is seriousness. For seriousness seeks to exclude play, whereas play can very well include seriousness” (Huizinga 1949, p. 45). Thus, harnessing the power of games to achieve real-world outcomes is a topic of substantial practical and theoretical interest. The following dissertation explores this topic by adopting a cognitive-emotional view and a multi-method approach to study gameful experiences using IS.

GAMEFUL EXPERIENCES

The emergence of video games as a cultural medium, which some consider as the “ludification of culture” (Bouça 2012, p. 296), blurs the boundary between work and play (Deterding et al. 2011). Organizations inject elements of game design into activities that are traditionally not associated with games, develop full-fledged games to achieve desirable

¹ Key terms used throughout the dissertation are defined in Appendix 1.1. All primary data collection involving human subjects was approved through the Institutional Review Board. Appendix 1.2 contains protocol approvals.
² Moreover, games are serious business, with an estimated 2.2 billion gamers spending U.S. $101.1 billion in 2016 and expected market growth of 6.2 percent through 2020 (McDonald 2017).
organizational outcomes, and infuse traditional games with goals tied to traditionally non-game activities. At the convergence of game design and productivity lie several distinct concepts pertaining to “gameful experiences.” A *gameful experience* refers to some combination of conditions leading to the self-perception that a subject is playing a game, irrespective of the context (McGonigal 2011). Technology is not a necessary component of a gameful experience, but technology increasingly enables and enhances such experiences. We thus adopt a working definition (to be further developed in Essay 1) of a *gameful IS* as an IS that enables or enhances gameful experiences. This dissertation focuses more specifically on gameful IS experiences with practical outcomes and the mechanisms through which those practical outcomes emerge, and thus refers primarily to such experiences when using the term “gameful IS.” Two commonly studied types of gameful IS are “gamified” systems and serious games.

The term *gamification* refers to the “incorporation of game design elements into a target system while retaining the target system’s instrumental functions” (Liu et al. 2017, p. 1013), specifically indicating “the incorporation of game design elements” as opposed to full-fledged games. For example, a recent study of an IS for knowledge sharing and collaboration illustrates the impacts of game design elements on flow and aesthetic experiences, which subsequently impact continued use intention (Suh et al. 2017).

Prior literature views gamification and serious games as distinct (Deterding et al. 2011; Liu et al. 2017). In contrast to the above conceptualization of gamification, *serious games*, or “games with a purpose,” are full-fledged games that serve an instrumental purpose in a traditionally non-game context (Susi et al. 2007; Walz and Deterding 2015). Considerably pre-dating (Abt 1970) gamification, serious games typically have a higher-level objective, such as IS or business process training, which does not depend upon specific game actions or outcomes.
However, serious games and gamification do not represent an exhaustive list of phenomena at the intersection of work and play, leaving room for research to explore and more distinctly situate concepts such as taskification, playful design, sandboxes, and mini-games. *Taskification*, for example, pivots the concept of serious games to the domain of a traditional game that incorporates tasks with direct non-game value (Prestopnik and Crowston 2012). In a “taskified” game, players undertake generative activities that offer direct benefits either to the player or to the organization promoting the game. In the popular mobile game Pokémon Go, walking in the real world is an integral determinant of success in the game, causing players to get off the couch, exercise, and explore their real-world environments – generative activities not typically associated with games. It is estimated that during a three-month period following its release, Pokémon Go added 144 billion steps to physical activity in the United States, with effects observed across genders, weight status, and prior activity levels (Althoff et al. 2016).

Early work on serious games and gamification has shown promising practical results (Hamari et al. 2014), but lacked strong theoretical foundations and comprehensive, context-sensitive and longitudinal empirical research (Kankanhalli et al. 2012; Seaborn and Fels 2015). Highlighted as an emerging area of research (Chen et al. 2012; Liu et al. 2017), gamification and related concepts are beginning to appear in the top IS journals (e.g., Santhanam et al. 2016), and are the topic of special issues in reputed business and IS journals (e.g., *Journal of MIS, Journal of Business Research, International Journal of Human-Computer Studies, European Journal of Information Systems*). The gamification literature has most commonly used self-determination theory (Deci and Ryan 2000), focusing on intrinsic and extrinsic motivators of action (Seaborn and Fels 2015), and given less attention to cognition and emotion. This gap is surprising given the centrality of emotions in creating engaging experiences through games (Lazzaro 2009;
Mekler et al. 2016; Bopp et al. 2018), and the importance of cognitions in achieving desired outcomes of gameful IS, such as increased attention (e.g., Hamari et al. 2016), improved decision making (e.g., Morris et al. 2013), and enhanced memory (e.g., Ninaus et al. 2015).

**COGNITION, EMOTION, AND GAMES**

*Cognition* refers to mental activities pertaining to acquisition and application of knowledge, including processes such as attention, learning, language processing, problem solving, and memory (Anderson 2005). Goals of gameful IS are often cognitive in nature (Hamari et al. 2014; Lumsden et al. 2016), and gamification receives significant attention in the literature on education and training (e.g., Kapp 2012). Gameful experiences are a promising avenue to create and sustain engagement in cognitive tasks that are often effortful, repetitive, or frustrating (Lumsden et al. 2016).

Games evoke emotions — both positive (e.g., joy, satisfaction) and negative (e.g., anger, envy) (Isbister 2016) — from players. *Emotion* refers to a mental state of varying intensity representing an evaluative (i.e., positive or negative) reaction to environmental stimuli (Ortony et al., 1990). To the extent that game design elements can influence the emotions felt by the users of a gameful IS (e.g., Liu et al. 2013), designers may be able to better achieve desired outcomes. However, a failure to evoke the expected emotions may adversely affect outcomes such as motivation and attitudes (Robson et al. 2015). Cognitive theories of motivation are also useful in studying gameful IS through design elements such as time pressure, tasks, and quests (Seaborn and Fels 2015). Many gamers relish the cognitive immersion, or flow (Csikszentmihalyi 1990), in identifying cause-effect relationships and solving in-game challenges.

Research in neuroscience has begun to consider the interdependencies between cognition and emotion in the neural processes leading to behavior, with a consensus emerging that
cognitive and emotional processes are practically inseparable (Dolan 2002; Pessoa 2013; Phelps 2006). In many cases, “emotion and cognition conjointly and equally contribute to the control of mental activities and behavior” (Pessoa 2010, p. 444). We therefore use the term cognitive-emotional to refer generally to mental activities involving a combination of cognitive and emotional aspects, acknowledging their inseparability while recognizing the need to consider their individual and joint influences in the study of human behavior. Several such processes are highly relevant in the convergence of work and play through the use of IS. For example, emotion can affect memory (a cognitive aspect) via the amygdala, a brain region that regulates the flow of information in cognitive-emotional interactions, and supports the encoding, storage, and retrieval of memories tied to strong emotional stimuli (Pessoa 2013). Emotional stimuli are also more likely to capture attention (Dolan 2002), an increasingly scarce cognitive resource in organizations. Finally, emotions play a key role in decision making processes as the amygdala and pre-frontal cortex interact to compute expected rewards for decision options (Pessoa 2008).

The capacity of gameful experiences to affect cognition and emotion is a topic of emerging theoretical inquiry (e.g., Deterding 2015; Mullins and Sabherwal 2020), but additional theoretical and empirical work is needed. Adopting a view of gameful design that incorporates both cognitions and emotions promotes a more nuanced understanding of motivation and behavior in gameful IS. The cognitive-emotional view of gamification (Mullins and Sabherwal 2020) seeks to inform gamified design. We acknowledge the importance of designing for gameful experiences and believe that such a view can meaningfully inform research and practice in this design process. This dissertation shifts from the paradigm of design to the paradigm of experience, adopting a process perspective of gameful experiences by “players” that are enabled or supported by an IS.
ESSAYS, RESEARCH OBJECTIVES, AND METHODS

Given the nascent stage of research on the role of IS in the convergence of work and play, this dissertation aims to help develop a stronger theoretical foundation and incorporate multiple methods and multiple levels to study gameful IS. The proposed dissertation includes three essays that combine qualitative and quantitative methods using secondary and primary data collected through interviews, surveys, system logs, and message boards, and analytical tools such as structural equation modeling, panel regression, text mining, and survival analysis.

Three themes are common across the essays. First, they examine the broad phenomenon of gameful experiences with practical outcomes using an IS. Second, they share a common focus on the player experience through gameful IS. Finally, each essay adopts a multi-method approach to inquiry.

The essays are complementary in their foci but distinct in the research questions they address, their theoretical foundations, and their levels of analysis. Essay 1 draws on literature from sociology, psychology, and technology affordances to define and develop a classification of gameful IS. It primarily considers experiences at the individual level, but we suggest that the resulting taxonomy is homologous across levels (Klein and Kozlowski 2000). Essay 2 develops and tests a process theory of online competition by integrating the social comparison model of competition (Garcia et al. 2013) with the input-process-output-input process model (Ilgen et al. 2005). It draws upon complementary perspectives from social comparison (e.g., Festinger 1954), feedback literature (e.g., Kluger and DeNisi 1996), psychological ownership (e.g., Karahanna et al. 2015), and cognitive neuroscience (e.g., Pessoa 2008) literature to illustrate the effects of a gameful IS experience on both desirable and undesirable behaviors and outcomes. Essay 3 focuses on games being increasingly social in nature (Hamari and Keronen 2017) and their
ability to simulate complex real-world processes. It draws upon literature in task coordination (Crowston 1997; Knoblich and Jordan 2003; Sabherwal 2003) and team processes (Marks et al. 2001) to study the coordination of ‘work’ in games, the relationships among emotions, cognitions, coordination, and performance during the experiential cycle of play, and how a gameful IS experience impacts shared emotional, cognitive, and coordination outcomes.

The proposed essays also differ in the practical contexts and outcomes under investigation. Essay 1 seeks to develop a generalizable taxonomy. It draws on literature and interviews with professionals in different types of organizations and roles, with a focus on how gameful experiences are enabled and supported by IS. Essay 2 investigates the effects of feedback, accumulated effort, emotions, and cognitions on player engagement in the context of a gamified data analytics community. Essay 3 investigates team emotion, cognition, coordination, and performance using survey and longitudinal field data from teams in a business simulation game as part of gamified enterprise IS training. Each essay uses a different combination of methods suited to answer its respective research questions. Table 1.1 summarizes the research questions and methods for each essay.

Figure 1.1 presents a high-level model of the dissertation, to be further developed in Essays 2 and 3. The model consists of an “experiential loop” of motivation, generation, and interpretation, in which each state and transition may be affected by the context of the game, player, technology, and task. Consistent with Liu et al. (2017), we position meaningful engagement as the dual experiential and instrumental outcomes resulting from a gameful IS experience. Importantly, as the experiential loop represents the cyclical process of “playing,” there is no “starting point” and the positioning of factors is arbitrary.
<table>
<thead>
<tr>
<th>Essay</th>
<th>Research Objective / Question</th>
<th>Methods</th>
<th>Individual</th>
<th>Team</th>
<th>Qualitative</th>
<th>Quantitative</th>
<th>Process</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Essay 1</strong></td>
<td></td>
<td>Multi-level</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>* Define and establish a classification of gameful IS to provide a foundation for future research.*</td>
<td>Data: Interviews</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Analyses: Text Mining, Clustering</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Essay 2</strong></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* Develop a process theory of online competitions (PTOC)*</td>
<td>Data: Secondary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Analyses: Text Mining, Mixed-effects Panel Regression, Survival Analysis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Essay 3</strong></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>* How do teams coordinate ‘work’ in games, and how do emotions, cognitions, and coordination support recurrent team processes? How do performance outcomes from business simulation-based training influence emotions, cognitions, and coordination in individuals and teams?*</td>
<td>Data: Survey, Secondary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Analyses: Text Content Analysis, Panel Regression, GLM Binomial Logit Regression, Structural Equation Modeling, Mixed-effects Regression</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 1.1. Proposed Essays through a Process View**
REFERENCES


Appendices

APPENDIX 1.1. GLOSSARY

Cognition: mental activities pertaining to acquisition and application of knowledge, including processes such as attention, learning, language processing, problem solving, and memory (Anderson, 2005)

Cognitive-emotional: mental activities involving a combination of cognitive and emotional aspects, acknowledging their inseparability while recognizing the need to consider their individual and joint influences in the study of human behavior

Emotion: mental states of varying intensity representing evaluative (i.e., positive or negative) reactions to environmental stimuli (Ortony et al., 1990)

Game: “a semibounded and socially legitimate domain of contrived contingency that generates interpretable outcomes” (Malaby, 2007, p. 96)

Gamification: (1) the process of enhancing services through gameful experiences to support value creation (Huotari and Hamari, 2017); (2) “the use of game design elements in non-game contexts” (Deterding et al. 2011, p. 10); (3) “incorporation of game design elements into a target system while retaining the target system’s instrumental functions” (Liu et al. 2017, p. 1013)

Gameful Experience: some combination of conditions leading to the self-perception that a subject is playing a game, irrespective of the context (McGonigal, 2011)

Gameful Information System: an information which is designed or perceived to afford or support user experiences that are associated with play or games

Player: a unit actively and knowingly involved in a gameful experience

Serious Game: full-fledged games that serve an instrumental purpose in a traditionally non-game context (Susi et al. 2007; Walz and Deterding 2015)
APPENDIX 1.2. IRB PROTOCOLS

MEMORANDUM

TO: Jeff Mullins
    Rajiv Sabherwal

FROM: Ro Windwalker
      IRB Coordinator

RE: New Protocol Approval

IRB Protocol #: 15-10-193

Protocol Title: *Individual Differences, Decision Making, and Performance in Information Systems (IS) Use*

Review Type: ☑ EXEMPT ☐ EXPEDITED ☐ FULL IRB

Approved Project Period: Start Date: 10/26/2015 Expiration Date: 10/25/2016

October 27, 2016

Your protocol has been approved by the IRB. Protocols are approved for a maximum period of one year. If you wish to continue the project past the approved project period (see above), you must submit a request, using the form *Continuing Review for IRB Approved Projects*, prior to the expiration date. This form is available from the IRB Coordinator or on the Research Compliance website (https://vpred.uark.edu/units/scr/index.php). As a courtesy, you will be sent a reminder two months in advance of that date. However, failure to receive a reminder does not negate your obligation to make the request in sufficient time for review and approval. Federal regulations prohibit retroactive approval of continuation. Failure to receive approval to continue the project prior to the expiration date will result in Termination of the protocol approval. The IRB Coordinator can give you guidance on submission times.

**This protocol has been approved for 1,100 participants.** If you wish to make any modifications in the approved protocol, including enrolling more than this number, you must seek approval prior to implementing those changes. All modifications should be requested in writing (email is acceptable) and must provide sufficient detail to assess the impact of the change.

If you have questions or need any assistance from the IRB, please contact me at 109 MLKG Building, 5-2208, or irb@uark.edu.
September 21, 2017

MEMORANDUM

TO: Jeff Mullins
    Rajiv Sabherwal

FROM: Ro Windwalker
      IRB Coordinator

RE: EXEMPT PROJECT CONTINUATION

IRB Protocol #: 15-10-193
Protocol Title: Individual Differences, Decision Making, and Performance in Information Systems (IS) Use

Review Type: ☒ EXEMPT

New Approval Date: 09/21/2017

Your request to extend the referenced protocol has been approved by the IRB. We will no longer be requiring continuing reviews for exempt protocols.

If you wish to make any modifications in the approved protocol that may affect the level of risk to your participants, you must seek approval prior to implementing those changes. All modifications should be requested in writing (email is acceptable) and must provide sufficient detail to assess the impact of the change.

If you have questions or need any assistance from the IRB, please contact me at 109 MLKG Building, 5-2203, or irb@uark.edu.
To: Jeff Mullins  
WCOB 220

From: Douglas James Adams, Chair  
IRB Committee

Date: 04/09/2019

Action: Expedited Approval

Action Date: 04/09/2019

Protocol #: 1902177583

Study Title: Getting Serious about Games: A Study of Work and Play through Information Systems - Interview Study

Expiration Date: 03/19/2020

Last Approval Date:

The above-referenced protocol has been approved following expedited review by the IRB Committee that oversees research with human subjects.

If the research involves collaboration with another institution then the research cannot commence until the Committee receives written notification of approval from the collaborating institution’s IRB.

It is the Principal Investigator's responsibility to obtain review and continued approval before the expiration date.

Protocols are approved for a maximum period of one year. You may not continue any research activity beyond the expiration date without Committee approval. Please submit continuation requests early enough to allow sufficient time for review. Failure to receive approval for continuation before the expiration date will result in the automatic suspension of the approval of this protocol. Information collected following suspension is unapproved research and cannot be reported or published as research data. If you do not wish continued approval, please notify the Committee of the study closure.

Adverse Events: Any serious or unexpected adverse event must be reported to the IRB Committee within 48 hours. All other adverse events should be reported within 10 working days.

Amendments: If you wish to change any aspect of this study, such as the procedures, the consent forms, study personnel, or number of participants, please submit an amendment to the IRB. All changes must be approved by the IRB Committee before they can be initiated.

You must maintain a research file for at least 3 years after completion of the study. This file should include all correspondence with the IRB Committee, original signed consent forms, and study data.

cc: Rajiv Sabherwal, Investigator

INTRODUCTION

Play and games are essential components of humanity, pervading culture in ways that are often unrecognized and understudied. Daily life is replete with references, metaphors, and figures of speech that emerge from the domain of play. “The game of life” is a broadly scoped example. The salesperson “struck out” with her first client today, but “hit a home run” in the afternoon and closed a big deal. It is important to have a “level playing field” so no one can “game the system,” but sometimes it is a “numbers’ game.” Moreover, leisure activities comprise a substantial portion of our lives and are central to our well-being. In the hours that we are not working, sleeping, or attending to family and personal needs, we pursue leisure activities such as watching television, reading books, or playing games. For many, these leisure activities are key sources of enjoyment in life. If we could experience similar enjoyment at work, during exercise, or in the doldrums of daily chores, life might be more enjoyable.

The convergence between work and play is accelerating due to advances in technology and the increasing connectedness of a flatter world. Individuals want to be engaged in ways that stimulate and challenge them, and organizations want to increase stakeholder satisfaction and performance. This convergence has been studied through phenomena such as serious games (Abt 1970; Walz and Deterding 2015) and hedonic IS (Lowry et al. 2013). Recent literature has begun to study the related notion of gameification, a term that is still undergoing conceptual development, with definitions that are not fully compatible emerging in different fields (Deterding et al. 2011; Huotari and Hamari 2017; Liu et al. 2017). In IS, this term refers to the incorporation of game design elements into a system such that the system’s instrumental
functions are retained (Liu et al. 2017). In this view, gamification is distinguished by its focus on retaining the instrumental functions of a traditional IS, whereas serious games are full-fledged games designed for an instrumental purpose (Walz and Deterding 2015). However, prior literature tends to treat gamification and serious games interchangeably due to a lack of consensus on definitions.

Several other phenomena related to work and play have been examined in the literature. Examples include mini-games (e.g., Santhanam et al. 2016), design aesthetics (e.g., Lowry et al. 2015), incentive hierarchies (e.g., Goes et al 2016), eSports (e.g., Hamari and Sjöblom 2017), and taskification (Prestopnik and Crowston 2012). As work and play continue to converge and new phenomena emerge, ambiguous terms and lack of conceptual clarity threaten to hinder research. Additionally, the broader domain of gamification (i.e., incorporation of game design into non-game contexts) suffers from inconsistent, mixed, and negative findings (Seaborn and Fels 2015). This lack of conceptual clarity, insufficient differentiation, and inadequate theoretical understanding pose an opportunity to clarify the nature and structure of gameful experiences through IS. There is a need to define the essence of concepts and nature of relationships in this research domain so that future theories can draw on firmly grounded definitions and classifications to adequately describe, predict, and prescribe (Doty and Glick 1994; Iivari 2007). Against the backdrop of increasing convergence of work and play, nascent conceptualizations of relevant phenomena, and inconsistent findings in the literature, our initial research objective is to define and establish a classification of gameful IS to provide a foundation for future research.

Based on a review of literature on the sociology of play and psychology, and drawing on relevant work in serious games and gamification, we develop the broader conceptualization of “gameful IS” and establish a working definition. Building on this definition, we develop a
taxonomy of gameful IS to situate relevant concepts in a theoretically grounded and empirically supported classification. Taxonomies support future theory development by organizing knowledge in a field (Glass and Vessey 1995), bringing order to disorderly concepts (McKnight and Chervany 2001), and shedding light on inconsistent research findings (Sabherwal and King 1995). Following the process recommended by Nickerson et al. (2013), we iterate between conceptual and empirical considerations to develop a taxonomy that is concise, robust, comprehensive, extendible, and explanatory. We first develop an initial theoretical classification of nine categories, and then develop a more refined classification using qualitative data from twenty interviews. We interview working professionals with diverse backgrounds to understand the perspective of the “players” who can shed light on the instrumental and experiential activities and outcomes enabled by gameful IS. We use results from text mining of the interview data to develop a refined classification of gameful IS including five clusters, and discuss these clusters along a work-leisure continuum and in relation to the initial theoretical categories.

THEORETICAL DEVELOPMENT

Defining Gameful IS

While the study of play and games has diverse branches in psychology (Vygotsky 1978), economics (von Neumann and Morgenstern 1974), and philosophy (Nguyen 2017), we draw on foundations from sociology to establish an historical account and working definition of key terms. We choose sociology due to its status as a reference discipline for the study of play and games (Nguyen 2017), and its attention to how play and games manifest in, and shape, culture. As a society, we are at an inflection point in an age of information and digital connectedness, and the lines between work and play fade into areas of grey matter. Thus, we seek to understand the minds of the designer and player in a realm of new experiences that are reshaping culture.
Two sociological perspectives have dominated thinking on play and games for the last several decades (Bateman 2018; Rodriguez 2006; Salen et al. 2006). One is the theory of *homo ludens* (translated as “man who plays,” as opposed to *homo sapiens* or “man who knows”), which suggests that play: is free; is separate and distinct from ordinary life; creates and demands order; and is disconnected from material interests (Huizinga 1949). Furthermore, according to this theory, play is competitive and deeply embedded in our culture in ways that go unnoticed and taken as canon: in religious ceremonies, legal proceedings, war, art, and politics. In short, many of the rituals that define modern culture are rooted in play.

The second sociological perspective extends *homo ludens* by adding characteristics of play as being constructed of imagined realities and having uncertain outcomes (Caillois 1962). This extension also suggests play as a supercategory of games with four “play forms” of which games may be composed: *agon* (competition), *alea* (chance), *mimicry* (role playing), and *ilinx* (vertigo). Departing from *homo ludens*, Caillois (1962) de-emphasizes competition by allocating it to a single category, and emphasizes the role of uncertainty to include games of chance and gambling – a corruption of play according to Huizinga (1949). Caillois (1962) places play along a continuum from *paidia*, characterized by spontaneity and playfulness, to *ludus*, characterized by established norms and firm rules often associated with the concept of games.

These perspectives offer valuable insights into the nature of play and games as activities involving elements of chance, competition, mimicry, and vertigo, and in a contrived domain that is separate from ordinary life. However, these classic works have been the subject of some criticisms (Ehrmann et al. 1968; Malaby 2007; Nagel 1998). Perhaps most importantly, the distinction of a “game” from “play” is unclear. If play is separable, unproductive, and pleasurable, how can games (as domains of play) be integrated into work and instrumental in
nature, yet sometimes be immensely frustrating? Malaby (2007) views games as inherently processual and grounded in human action, and offers a definition of a game as a “semibounded and socially legitimate domain of contrived contingency that generates interpretable outcomes” (p. 96). Another criticism of Huizinga and Caillois is rooted in the treatment of play as a supercategory of games. Malaby rejects this notion, viewing play as a mode of human experience rather than a form of human activity. Consistent with this view, we view play as a mode of human experience – a disposition or attitude “characterized by a readiness to improvise in the face of an ever-changing world that admits of no transcendentally ordered account” (Malaby 2009, p. 206) such that the player is an agent whose actions may affect future events in intended or unintended ways.

Malaby’s (2007; 2009) definitions align with the study of gameful IS for the following reasons. The “contingent” nature of games indicates that they are rooted in disorder. Designers carefully contrive and calibrate contingencies to create games that balance open-endedness with familiarity and reproducibility. Play “reflects an acknowledgement of how events, however seemingly patterned or routinized, can never be cordonned off from contingency entirely” (Malaby 2009, p. 211). Adding elements of games to work routines can foster a sense of play. The “semibounded” nature of games indicates that games can only be somewhat separated from ordinary life. Games mimic everyday experience to some extent, which can make them compelling. The convergence of work and play through gameful experiences reflects the semibounded characteristic of games quite clearly. Gameful experiences are also “socially legitimate” based on either the intention of the designer (incorporation of game design into non-game contexts) or the actions of referent others (enactment of a socially accepted mode of play). Finally, gameful IS share the characteristic of “interpretable outcomes” with games more
generally but extend interpretable outcomes beyond the game domain to include direct or indirect outcomes that are more instrumental in nature (Liu et al. 2017).

The most widely cited definition of gamification is “the use of game design elements in non-game contexts” (Deterding et al. 2011, p. 10). This definition is appealing due to its simplicity and generalizability but has been criticized for a lack of specificity of means and goals (Liu et al. 2017) and the inherently subjective nature of defining a “non-game” context (Huotari and Hamari 2017). In IS literature, gamification is defined as “the incorporation of game design elements into a target system while retaining the target system’s instrumental functions” (Liu et al. 2017, p. 1013). This definition achieves greater specificity by indicating that gamification adds a layer to a new or existing instrumental system and viewing the goals of gamification as retaining the system’s instrumental functions. As such, gamification differs from the related phenomenon of serious games, which are full-fledged games (thus sacrificing any directly instrumental purpose of a target system on which the game is based) intended to serve a non-entertainment purpose such as training, education, or social change (Michael and Chen 2005).

Given our focus on play as a mode of experience, the preceding definitions fall somewhat short in addressing the experience of the player alongside the intent of the designer. Further, in considering games as semi-bounded and socially legitimate domains of contrived contingency with interpretable outcomes, the line between a “gamified system” and a “game” blurs in a haze of subjective interpretation. By adding a game layer to an instrumental system, the semi-bounded domain of a game is affixed to interpretable outcomes that may be both experiential and instrumental. The deliberate incorporation of game design elements implicitly lends social legitimacy to the domain of a gamified system. Even without the sanction of design, legitimacy is socially constructed and construed to the extent that the entirety of life may be experienced as
a game (Berne 1964). This leaves only the idea of “contrived contingency,” but that begs the question, “of whose contrivance?” If designers contrive a “game layer” without compromising instrumental functions, but players contrive and experience the system as a game, then is it a gamified system, or is it a game? Recent literature has begun to explore how user conceptions of the instrumental-hedonic purpose of a system affect use experience (Köse et al. 2019).

Another recent definition views gamification as “a process of enhancing a service with affordances for gameful experiences in order to support users’ overall value creation” (Huotari and Hamari 2017, p. 25). Rooted in ecological psychology (Gibson 1979), *affordances* refer to “properties of the world that are defined with respect to people’s interaction with it” (Gaver 1991, p. 80). A *gameful experience* is a combination of conditions leading to the self-perception that a subject is playing a game, irrespective of the context (McGonigal 2011). By this definition, gamification involves altering an environment to afford opportunities for people to perceive themselves as playing a game, supporting overall value creation. We thus adopt the following definition of a gameful IS:

*An IS that is designed or perceived to afford or support user experiences similar to those associated with play or games.*

By addressing the perspectives and intentions of both the designer and consumer of the gamified experience, this definition offers a suitable starting point for conceptualizing gameful IS. As this definition makes no assumptions of an extant non-game context or instrumentality of the IS, it includes phenomena such as traditional video games (van der Heijden 2004; Wu and Lu 2013) and playful attitudes toward purely instrumental systems (Agarwal and Karahanna 2000; Sicart 2019). It also includes phenomena more commonly studied at the intersection of work and play, such as serious games and gamification.
Level of Theorizing: The IS in Use

In discussing gameful IS, it is prudent to situate such systems in their context of use. The scope of a gameful experience may be as broad as a human life (Berne 1964) or as narrow as a single (and potentially literal\(^3\)) step in an infrequent task. Thus, the scope can extend well beyond the boundaries of any particular use of an IS, or can be limited to a very specific aspect of IS use. The IS becomes a component of a narrative network, defined as a set of interconnected events and actions that embodies a coherent purpose (Pentland and Feldman 2007). In this view, based on structuration theory (Giddens 1984), the IS expands the possible stories through its modular, recombinable, distributive, communicative, and stateful nature. The structure of a system enables and constrains human action, which subsequently “enacts emergent structures through recurrent interaction with the technology” (Orlikowski 2000, p. 407). Designers have specific narratives in mind when constructing an IS, but functional affordances can yield new possible narratives that evolve through symbolic expression and innovative use (Goh et al. 2011). Such narrative networks constitute stories of IS in use.

As mentioned above, affordance refers to a potential for an action by a person in an environment (Gaver 1991). Any environment is a system, and classifying and understanding gameful IS requires positioning the IS as a system, or an aspect of a broader system, that affords or supports gameful user experiences. Thus, the IS is both a part of the broader environment and an environment in itself. Consider, for example, a commercial tactical combat simulation game. To a retail consumer, this IS (the game) in use affords enjoyment as a traditional video game. However, the same simulation game might be embedded in a military training exercise. In these two situations, the IS is embedded in different narrative networks, offering different affordances.

\(^3\) https://www.youtube.com/watch?v=2lXh2n0aPyw (as footnoted in Liu et al. 2017)
Viewing the training exercise as the broader system, the IS in use may afford learning and relationship development in addition to enjoyment as part of gamified training.

Moreover, we recognize that a given IS may have numerous features, and that each use of the IS typically involves only a subset of those features. If a system contains features that support both instrumental and gameful affordances, but a user is unaware of the gameful affordances, the IS in use would not be considered to have a gameful aspect. Thus, we position the “IS in use” as an appropriate conceptual level for gameful IS taxonomy development.

**Needs-Affordances-Features in Gameful IS**

Substantial research in gamification and serious games draws on psychological needs literature (Seaborn and Fels 2015). Contemporary definitions of gamification justifiably focus on the importance of gameful affordances (Huotari and Hamari 2017). While gameful affordances are generally acknowledged as essential for meeting psychological needs, little research has effectively integrated these ideas. A recent framework extends the affordance literature by explicitly tying affordances to both (1) the underlying needs they serve, and (2) the affordance-enabling features of the environment. We draw on the needs-affordances-features (NAF) framework (Karahanna et al. 2018) to integrate affordances and human needs. NAF suggests that needs motivate IS use to the extent that the IS provides affordances which satisfy those needs. That is, features of the IS enable certain affordances, and those affordances fulfill needs, with needs also motivating the use of affordances. Originally developed as a perspective on social media use, NAF drew on core psychological needs from two sources: self-determination theory (Deci and Ryan 2000), which posits three basic psychological needs: competence, autonomy, and relatedness; and psychological ownership, which posits two additional needs: having a place
and self-identity, which is further subdivided into coming to know the self, expressing self-identity, and maintaining continuity of self-identity (Pierce et al. 2003).

We draw upon two additional sources to identify needs in the context of gameful IS. Given the combination of hedonic and instrumental motivations inherent in the convergence of work and play, the core psychological needs remain relevant. In addition, more instrumental physiological and safety needs such as food, water, shelter, and a sense of security, represented by the lowest two layers of Maslow’s (1971) classic hierarchy of needs, should be considered. These represent more basic needs that must be met before higher-level psychological needs can be fulfilled, and are likely to be served most effectively by instrumental affordances. By contrast, gameful experiences are most often associated with enjoyment or happiness. While happiness may be achieved through the fulfillment of other psychological needs, we also include more directly the need for happiness as defined in two ways: hedonia (i.e., pleasure, enjoyment, comfort) and eudaimonia (i.e., seeking to develop the best in oneself) (Waterman 1993). Table 2.1 summarizes the relevant needs.
<table>
<thead>
<tr>
<th>Need</th>
<th>Definition</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physiological</td>
<td>&quot;the lack of chemicals, nutrients, or internal (e.g., exercise/health) or environmental (e.g., temperatures) conditions necessary for the body to survive, such that the extended absence of these things could lead to psychological stress or physical death&quot; (Taormina and Gao 2013, p. 157)</td>
<td>We use only the lowest two layers of Maslow’s hierarchy because the other layers are (1) conceptually compatible with other needs in our framework and (2) less compatible with current affordances and gameful IS research.</td>
</tr>
<tr>
<td>Safety/Security</td>
<td>&quot;the lack of protections such as shelter from environmental dangers and disasters, personal protection from physical harm, financial protection from destitution, legal protection from attacks on one’s rights to a peaceful existence, or a lack of stability in one’s life&quot; (Taormina and Gao 2013, p. 157)</td>
<td></td>
</tr>
<tr>
<td>Competence</td>
<td>&quot;a propensity to have an effect on the environment as well as to attain valued outcomes within it&quot; (Deci and Ryan 2000, p. 231)</td>
<td></td>
</tr>
<tr>
<td>Autonomy</td>
<td>&quot;volition-the organismic desire to self-organize experience and behavior and to have activity be concordant with one’s integrated sense of self&quot; (Deci and Ryan 2000, p. 231)</td>
<td></td>
</tr>
<tr>
<td>Relatedness</td>
<td>&quot;the desire to feel connected to others-to love and care, and to be loved and cared for&quot; (Deci and Ryan 2000, p. 231)</td>
<td></td>
</tr>
<tr>
<td>Having a Place</td>
<td>&quot;the individual's motive to possess a certain territory or space-to have a &quot;home&quot; in which to dwell&quot; (Pierce et al. 2001, p. 300)</td>
<td>Consistent with Karahanna et al. (2018), we combine the need for efficacy or effectance with that of Deci and Ryan’s (2000) competence.</td>
</tr>
<tr>
<td>Self-identity</td>
<td>the need for self-definition and self-knowledge, for communicating one’s identity to others, and for maintaining an emotional connection between self-identity and the past (Pierce et al. 2001)</td>
<td></td>
</tr>
<tr>
<td>Hedonia</td>
<td>&quot;the positive affects that accompany getting or having the material objects and action opportunities one wishes to possess or to experience&quot; (Waterman et al. 2008, p. 42)</td>
<td>Based on Kraut (1979)</td>
</tr>
<tr>
<td>Eudaimonia</td>
<td>&quot;the subjective experiences associated with doing what is worth doing and having what is worth having&quot; (Waterman et al. 2008, p. 42)</td>
<td>Based on Norton (1976) and Telfer (1980)</td>
</tr>
</tbody>
</table>

We construct a list of gameful affordances based on three sources. First, Suh et al. (2017) conducted a literature review to identify four commonly implemented gameful affordances: rewards, status, competition, and self-expression. Second, advances in computing have led to more realistic visual, auditory, and haptic environments delivered through augmented reality
(AR) platforms (Holopainen et al. 2018). We therefore include two key affordances originally studied through virtual worlds: presence and embodiment (Schultze 2010). The concept of embodiment overlaps with that of self-expression, as both involve the ability to customize and control the way that one’s virtual self is presented. We therefore combine the two and adopt the embodiment label. Third, as gameful IS are increasingly social in nature (Hamari and Keronen 2017), we conclude with Karahanna et al.’s (2018) list of social media affordances, based on their extensive literature review, and retain those that are associated with gameful experiences: interactivity, meta-voicing, communication, collaboration, self-presentation, and competition. As with self-expression from Suh et al. (2017), we conceptually integrate self-presentation into the affordance of embodiment.\textsuperscript{4} The affordance of competition is consistent with that of Suh et al. (2017), so we combine them as well. Table 2.2 presents the compiled set of affordances for gameful IS and their definitions.

\textsuperscript{4} We drop the following affordances from Karahanna et al.’s (2018) list as relating primarily to social media and not to gameful experiences: content sharing, presence signaling, relationship formation, group management, browsing others’ content, and sourcing.
Table 2.2. Affordances for Gameful IS

<table>
<thead>
<tr>
<th>Affordance</th>
<th>Definition</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embodiment</td>
<td>the ability to engage in practices of the body (Schultze 2010), which we extend to include the overall presentation of the self, i.e., self-expression in Suh et al. (2017) and self-presentation in Karahanna et al. (2018)</td>
<td>These affordances are essential components of virtual world experiences.</td>
</tr>
<tr>
<td>Presence</td>
<td>the ability to sense that one exists in a given setting</td>
<td></td>
</tr>
<tr>
<td>Rewards</td>
<td>the ability to receive rewards for completing predesigned tasks</td>
<td>These affordances are common components of gameful experiences.</td>
</tr>
<tr>
<td>Status</td>
<td>the ability to improve standing by achieving predesigned goals</td>
<td></td>
</tr>
<tr>
<td>Competition</td>
<td>the opportunity to compare one’s performance with that of others</td>
<td></td>
</tr>
<tr>
<td>Interactivity</td>
<td>the ability to move around and alter the virtual environment</td>
<td></td>
</tr>
<tr>
<td>Meta-voicing</td>
<td>the ability to react online to others’ presence or activities, and see how others react to their own presence and activities</td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>the ability to directly send and receive messages between two or more users</td>
<td></td>
</tr>
<tr>
<td>Collaboration</td>
<td>the ability to work with other users toward shared goals</td>
<td></td>
</tr>
</tbody>
</table>

Following Karahanna et al. (2018), we next map the identified needs to the collection of gameful affordances. We also include a category for instrumental affordances, but leave this classification deliberately broad due to the numerous context-specific affordance possibilities.

Table 2.3 provides a matrix relating needs to gameful affordances in gameful IS. Table 2.4 provides a matrix relating needs to a sample of instrumental affordances in gameful IS. We acknowledge that some affordances (for example, communication and collaboration, included in both tables) may be both gameful and instrumental.

---

5 Instrumental affordances will vary greatly between contexts, and are therefore both too numerous and of relatively less importance in the present context of understanding gameful IS. We offer the instrumental affordance matrix as a representative example of how such affordances may satisfy this set of physiological and psychological needs.
Table 2.3. Needs and Gameful Affordances for Gameful IS

<table>
<thead>
<tr>
<th>Needs</th>
<th>Gameful Affordances</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rewards</td>
</tr>
<tr>
<td>Maslow (1971)</td>
<td></td>
</tr>
<tr>
<td>Physiological</td>
<td></td>
</tr>
<tr>
<td>Safety / Security</td>
<td>X</td>
</tr>
<tr>
<td>Autonomy</td>
<td>X</td>
</tr>
<tr>
<td>Relatedness</td>
<td>X</td>
</tr>
<tr>
<td>Pierce et al. (2001)</td>
<td>Having a Place</td>
</tr>
<tr>
<td>Self-identity</td>
<td>X</td>
</tr>
<tr>
<td>Waterman et al. (2008)</td>
<td>Hedonia</td>
</tr>
<tr>
<td>Eudaimonia</td>
<td>X</td>
</tr>
</tbody>
</table>

Table 2.4. Needs and Instrumental Affordances for Gameful IS

<table>
<thead>
<tr>
<th>Needs</th>
<th>Instrumental Affordances</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Compensation</td>
</tr>
<tr>
<td>Maslow (1971)</td>
<td>Physiological</td>
</tr>
<tr>
<td>Safety / Security</td>
<td>X</td>
</tr>
<tr>
<td>Autonomy</td>
<td>X</td>
</tr>
<tr>
<td>Relatedness</td>
<td>X</td>
</tr>
<tr>
<td>Pierce et al. (2001)</td>
<td>Having a Place</td>
</tr>
<tr>
<td>Self-identity</td>
<td>X</td>
</tr>
<tr>
<td>Waterman et al. (2008)</td>
<td>Hedonia</td>
</tr>
<tr>
<td>Eudaimonia</td>
<td>X</td>
</tr>
</tbody>
</table>

To situate affordances in the context of gameful IS, we combine the NAF framework with the dual outcomes of meaningful engagement from the Liu et al. (2017) gamification framework, positioning experiential and instrumental outcomes (i.e., meaningful engagement) as
mediators between enacted affordances and the needs they aim to serve. While instrumental outcomes are self-explanatory, experiential outcomes refer to aspects of cognitive or emotional engagement such as enjoyment, flow, attention, or arousal (Liu et al. 2017). They are typically associated with gameful experiences, and result from enacting gameful affordances. We refer to this extended NAF framework as the Needs-Affordances-Features-Engagement (NAFE) framework. Figure 2.1 depicts the integrated NAFE framework.

![Figure 2.1. Needs-Affordances-Features-Engagement Framework](image)

We use the NAFE framework to undergird our development of theoretical gameful IS categories, and to support our interpretations of emergent clusters based on empirical analyses.

The NAFE framework effectively integrates the designers’ intentions (features in context to enable certain affordances) with the players’ experiences (enactment of certain affordances motivated by physiological and psychological needs) to achieve a combination of instrumental and experiential outcomes that is central to the concept of gameful IS.

The Liu et al. (2017) framework also incorporates the “gamified system” depicted as a set of gamification design elements (i.e., features) that interact with the target system context of user, task, and technology characteristics. We suggest that this “fit” between design elements and the context is congruent with the concept of affordances. The gamification framework defines
“user-system interactions” as “dynamics resulting from gamification elements coming together with user actions” (Liu et al. 2017, p. 1014), and positions these interactions as antecedents of meaningful engagement. We view the enactment of affordances to parallel the concept of user-system interactions and represent it in Figure 2.1 using the directed arrows from affordances to meaningful engagement. We do not delve into the distinction between types of user-system interactions (i.e., user-to-system, system-to-user, and user-to-user), leaving such work to future research, but we do consider enacted affordances to encompass all three types of interaction.

Terminology around affordances in the human-computer interaction literature remains somewhat inconsistent, with gamification literature referring to both gameful affordances (e.g., Hamari et al. 2014) and motivational affordances (Zhang 2008; Jung et al. 2010). Another stream of research categorizes affordances into cognitive, physical, sensory, and functional (Hartson 2003). In this view, the functional affordance represents a higher-order purposive action, supported by cognitive (to understand the possible action) and physical (to take the possible action) affordances. Sensory affordances support physical and cognitive affordances by providing sensations (e.g., visual, auditory, haptic) that indicate physical and cognitive possibilities (Hartson 2003). Viewed in this light, we consider functional affordances, those which relate to some higher-level goal or purpose, as the primary affordances of interest in gameful IS theorizing.

Karahanna et al. (2018) conduct a review of the social network literature to identify 140 design features across 21 social networking sites that they subsequently map to their list of more abstract affordances. For design features of gameful IS, we draw on a recent comprehensive review of gamification research (Koivisto and Hamari 2019), which categorizes and lists gameful affordances found in 819 studies. This review treats game design elements (e.g., points,
quests, leaderboards) as affordances, but we follow Karahanna et al. (2018) in treating affordances at a higher level of abstraction than specific design features. We therefore draw on this review for insights into design features while clarifying the distinction between design features and affordances to inform the NAFE framework.

The Initial Theoretical Taxonomy

Following the recommendations of Nickerson et al. (2013) for taxonomy development, we first select an appropriate meta-characteristic to serve as the basis for choice of further characteristics. As discussed above, the perspectives of both the designer and player are critical in the study of gameful experiences. Thus, we choose intention as the meta-characteristic. The second step in taxonomy development is to choose appropriate ending conditions. The resulting classification should consist of a mutually exclusive and cumulatively exhaustive set of categories into which phenomena can be classified, and should be concise, robust, comprehensive, extendible, and explanatory. Additionally, to maximize the utility of the classification, we add the suggested objective ending condition that “at least one object is classified under every characteristic of every dimension” (Nickerson et al. 2013, p. 344).

For the initial development iteration, we follow a conceptual-to-empirical approach. Given the meta-characteristic of intention, we need a theoretical framework that can represent both the intentions of the designer in shaping an IS environment to enable or discourage gameful experiences, and of the user in perceiving and taking action in the IS environment to pursue hedonic and/or instrumental goals. Accordingly, and drawing upon the above discussion of affordances and the NAFE framework, we classify gameful IS phenomena based on designed and enacted affordances. Designed affordances are those intended by the creator of the IS, irrespective of the subjective interpretation of its users. Similarly, enacted affordances are those
perceived and acted upon by the users of the IS, irrespective of its “designed” affordances or the intentions of its creators. We suggest two extreme and one intermediate level for each, while recognizing that these levels occur on a spectrum that could be explored in future research.

At one end of the spectrum are affordances that are primarily **gameful**. From the designer’s perspective, these are designed as full-fledged games with no significant instrumental purpose. From the player’s perspective, these are experienced as full-fledged games with no immediate instrumental objective. At the other end of the spectrum are affordances that are primarily **instrumental**. From the designer’s perspective, these are designed as instrumental systems that may support gameful experiences, but are not themselves gameful. From the user’s perspective, these are experienced as instrumental systems to achieve desired outcomes. In between these extremes are **mixed** affordances – a combination of gameful and instrumental. From the designer’s perspective, these systems deliberately integrate aspects of game design and instrumental functions with the goal of improving both instrumental and experiential outcomes (e.g., Liu et al. 2017). From the player’s perspective, these systems offer experiences that are both enjoyable and practical. **Table 2.5** presents the initial classification. The following section briefly discusses modalities of play as they relate to the taxonomy. We then describe each cell in greater detail, including examples of phenomena in each cell, note affordances as designed and enacted that support each example, and discuss boundary conditions for each cell.
Table 2.5. Theoretical Classification of Gameful IS

<table>
<thead>
<tr>
<th>Designed affordances are primarily:</th>
<th>Enacted affordances are primarily:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gameful</td>
<td>Gameful</td>
</tr>
<tr>
<td></td>
<td>Games as entertainment</td>
</tr>
<tr>
<td>Mixed</td>
<td>Mixed</td>
</tr>
<tr>
<td></td>
<td>Serious games</td>
</tr>
<tr>
<td>Instrumental</td>
<td>Instrumental</td>
</tr>
<tr>
<td></td>
<td>Hacking for fun</td>
</tr>
<tr>
<td></td>
<td>Metagames</td>
</tr>
<tr>
<td></td>
<td>Commodified play</td>
</tr>
<tr>
<td></td>
<td>Gamification / Taskification</td>
</tr>
<tr>
<td></td>
<td>Playful design</td>
</tr>
<tr>
<td></td>
<td>Playful attitude</td>
</tr>
<tr>
<td></td>
<td>Utilities</td>
</tr>
</tbody>
</table>

**Gameful IS and Modalities of Play**

Any gameful IS context is a negotiated environment between the intentions of the designer and player. The designer incorporates some affordances to create conditions that promote a playful mode of experience, and other affordances to enable more utilitarian activities. Assuming free will, the player ultimately determines their own mode of experience, deciding which affordances to enact and for what purpose. Sicart (2019) proposes two modalities of play: submission, which involves voluntary compliance to the conditions as designed, and resistance, which involves playing in such a way as to mock or contradict the conditions as designed. Consistent with this view, we suggest that the experience of play occurs on a spectrum between the two poles of resistance and submission.

The “matching” diagonal in the typology of gamified IS (Table 2.5) includes games as entertainment, gamification, and utilities. We suggest that the gameful IS operates in these cases as designed, and the player engages in a submissive modality. In the “mismatched” affordance categories of hacking for fun and commodified play, we suggest that players, in a resistance modality, appropriate the IS for their own purposes. We propose that the players experience the
other four categories (metagames, playful design, playful attitude, and serious games), all involving mixed affordances by design or enactment, through modalities that are neither fully submissive nor fully resistant. In these cases, the gameful IS is a negotiated environment between the intent of the designers and desire of the players.

Gamification / Taskification

At the center of this taxonomy is gamification, a focal topic of current research at the convergence of work and play. We agree with Liu et al. (2017) that any instrumental functions of the target system or service should be retained if we are to call the process “gamification.” From the perspective of the designer, gamification involves intended affordances that are both experiential and instrumental (Liu et al. 2017). Importantly, the instantiation of gamification is contingent on the focal actor. From the perspective of the player, gamification involves the perception and enactment of mixed affordances – that is, having fun while being productive.

Gamification typically incorporates game design elements into an instrumental system. For example, Suh et al. (2017) study a gamified knowledge sharing platform that uses points, levels, badges, and leaderboards to increase continuance intention by improving flow and aesthetic experiences. Using an affordance lens, they find that status and competition affordances positively affect both flow and aesthetic experiences, that self-expression affects aesthetic experience, and that reward affordances affect neither in the study context. While the study’s focus was on gameful affordances and their impacts, the gamified IS clearly affords more instrumental functions such as learning and knowledge contribution.

Starting from the opposite perspective but reaching generally the same end as gamification, taskification involves the incorporation of instrumental aspects into a gameful system (Prestopnik and Crowston 2012). While this term has seen relatively little use, it
effectively describes the new generation of video games involving physical activities, such as exergames (Oh and Yang 2010) and AR games that require walking to achieve in-game goals (Althoff et al. 2016). We combine gamification and taskification into a single category due to their explicit design and enactment of mixed affordances. If a gameful IS involves about half each of gameful and instrumental activities, is it gamification or taskification? In a scenario of truly mixed design and enactment, the distinction becomes pedantic, so we refer to the category using both terms (but refer to the broader category in some instances as gamification for brevity).

Given the unit of theorizing as the “IS in use,” we discuss the boundaries of the gamification cell by providing examples of an IS that may, depending on its use, be considered gamification. When considering a broader process as a system in which the IS plays a role, an IS that is intended for primarily gameful or primarily instrumental purposes may be inserted in order to gamify the process. For example, Santhanam et al. (2016) consider “mini-games” as part of gamified training. These games could stand on their own in the category of “games as entertainment,” but they provide a gameful affordance (i.e., challenge) alongside an instrumental affordance (i.e., learning) as part of the broader system including the IS.

**Serious Games**

From the designers’ perspective, serious games (like gamification) involve mixed affordances. For example, a serious game for IS training may involve higher-level dynamic affordances (Cook and Brown 1999) for learning a new system interface. While the players may or may not be aware of the goals of a serious game, they should not directly perceive such higher-level affordances. Instead, they perceive and enact affordances consistent with the experience of playing a game.
For example, ERPsim (Léger et al. 2007) is a serious game for learning about integrated business processes using SAP enterprise resource planning (ERP) software. In this game, teams of players collaborate to run a virtual firm, and compete against other teams in a shared simulated economy using the ERP system as an integrated decision-making platform. While they play, players are typically concerned only with the game – the strategies, tactics, and execution of plans to maximize their virtual firms’ performance. There is no direct real-world impact of the activities performed in the game, as the experience of the players during the game is primarily that of “playing.” By design, players acquire knowledge of the ERP and integrated business processes (Cronan and Douglas 2012; Deranek et al. 2019) almost as a byproduct of playing the game – the affordances enacted by the players during the game are those of interactivity, collaboration, and competition, rather than something more instrumental such as learning.

The distinction between gamified training and a serious game blurs if a player consciously pursues instrumental affordances (e.g., investigating job-relevant aspects of the system) when experiencing something designed as a serious game. Like mini-games or traditional games, serious games may be viewed as “gamifying” a training course such that the full-fledged game provides instrumental knowledge of a new system – mixed affordances perceived and enacted by the player.

**Playful Design**

The third category through which designers embed mixed affordances is one in which users perceive and enact primarily instrumental affordances – that of playful design. Playful design involves the use of aesthetics such as color, sound, and movement to enhance the user experience while not specifically encouraging the enactment of gameful affordances (e.g.,
Anderson 2011; Cyr et al. 2006). This may also involve the use of novel media, such as mixed reality (MR), to provide a primarily instrumental experience in an engaging way.

For example, Holopainen et al. (2018) consider several MR cases including 360-degree videos, MR shopping, and MR home design. Each case example is primarily instrumental in nature, but the design of the experiences affords embodiment and interactivity that are typically found in immersive games. But this category is not limited to immersive technologies. Another example is incorporating sandbox features to model “what if” scenarios – features that afford greater interactivity with an instrumental (rather than a gameful) goal.

In some cases, an IS incorporating playful design may be used differently than intended. For example, a sandbox feature in an urban planning IS might spur planners to playfully build “urban mazes,” affording competition to navigate each other’s creations. Such an example might be institutionalized as a serious game for training on the IS, or might be more of an informal gamification of day-to-day work processes on the part of the planners. In other cases, the designers’ intentions may be ambiguous or open-ended. For example, Second Life is an immersive “virtual world” environment that users have engaged with as a primarily instrumental tool for teaching (e.g., Wang and Braman 2009), as a purely gameful experience of exploration and creation (e.g., Zhou et al. 2011), or even as a speculative investing opportunity in virtual real estate (e.g., Hendaoui et al. 2008). Each of these uses would place the IS in a different cell in the taxonomy: playful design, games as entertainment, and commodified play, respectively.

**Games as Entertainment**

For systems designed primarily with gameful affordances in mind (i.e., as full-fledged hedonic games), the user’s perceived and enacted affordances belong to three categories. Most simply, “games as entertainment” represent a prominent area of business (for companies making
games) and leisure (for players). Under the supercategory of gameful IS, this category is comprised primarily of video games. The earliest video games emerged in the 1960s, though it was not until the mid-1970s that a catalyst emerged, the game of Pong, that launched what is now a $152Bn USD industry (Myers 1998; NewZoo 2019).

Examples of video games vary across eras, genres, and platforms. From the arcade classic chomper Pac-Man, to the desktop PC urban planner Sim City, to the addictive mobile matcher Candy Crush, video games consume enormous amounts of leisure time. A recent global market study estimates that gamers spend 7.1 hours per week, on average, playing video games (Limelight Networks 2019). In the U.S. alone, an estimated sixty-seven percent, or 211.2 million gamers (NPD Group 2018), spend around 78 billion hours playing video games annually.

Gamers spend these hours enacting gameful affordances in ways that, by and large, the designers intended. Motivations for playing video games can vary greatly between gamers, and we suggest that the types of affordances offered (and consequently the design features of the game) are important determinants of what games people play. For example, a player with a higher need for relatedness may choose a video game with greater affordances for communication and collaboration, while someone seeking a hedonic escape from the real world may prefer an immersive MR game that offers greater opportunities for presence and interactivity.

As described in other categories along the designed-gameful row, a full-fledged video game may be a part in a mixed-affordance use case such as gambling in which an online poker game is both a game and a means to potentially earn real-world financial rewards (a metagame in our taxonomy), or could be fully appropriated for instrumental pursuits (commodified play in our taxonomy). As part of a larger system such as classroom instruction, a traditional video game might also be used as gamification of the learning experience (Squire 2005).
Metagames

Sometimes, games take on a more instrumental purpose while still retaining the elements of gameful experiences for which they were intended. We refer to these as metagames, or games that have taken on a direct instrumental purpose to the player while still providing a gameful experience. This view of metagames, while sharing the core concept of a “game around the game,” differs somewhat from the term’s colloquial use as referring to the players’ use of extra-game knowledge to develop intra-game strategies. Rather, we view a metagame as representing the use of an IS to play games involving other games. The higher-level game may involve instrumental or mixed affordances while preserving the integrity of the lower-level game.

Examples of this category include competitive gaming such as eSports (Hamari and Sjöblom 2017) and online gambling (e.g., Ma et al. 2014). These examples retain the core experience of gameplay, but the salience and enactment of particular gameful affordances may advance to the foreground such as competition (in eSports) and rewards (in online gambling). In the case of eSports, professional players derive both enjoyment and instrumental rewards through game play, but may go through periods of unpleasant (and primarily instrumental) struggle while developing their skills to be competitive (Kim and Thomas 2015).

To the extent that a player is enacting gameful affordances (i.e., “playing” the game), participation in a broader metagame layer affords instrumental objectives such as financial security and recognition without tarnishing the game itself. However, if a player stops enjoying the game (e.g., through burnout) or lower level needs (e.g., paying for shelter) dominate the player’s focus, the IS in use shifts toward commodified play.

---

Commodified Play

In some cases, the core gameful experience embedded in a traditional game is cast aside in favor of the pursuit of instrumental outcomes, a phenomenon called the “commodification of play” (Dibbell 2016). The underlying goals served by this category of gameful IS may be pecuniary or non-pecuniary. A key distinguishing feature of commodified play is the modality of use. Specifically, the user adopts a modality of resistance (Sicart 2019) toward the design features that encourage gameful affordances, instead using those features mainly in an instrumental way.

Commodified play, as a category of gameful IS, is exemplified by the for-profit enterprises of “gold farming” in games, character mills, and similar forms of ludo-capitalism. These are “games as a means to an end.” However, commodified play is not limited to the growing trend of ludo-capitalism. It can also be driven by non-pecuniary instrumental affordances such as network development and job security. Further, participation in a ludo-capitalistic enterprise may not always justify classification as commodified play. In some cases, players of online games want to recoup some costs, or benefit from excess in-game resources. This participation of amateurs in a ludo-capitalist market could be considered a layer atop the core game (Liboriussen 2016), or metagaming based on the proposed gameful IS taxonomy.

To further explicate potential boundary conditions of commodified play, consider a small group of five people who get together to play an online multiplayer video game. To an external observer, such an IS in use may seem to fall into the category of games as entertainment. Now consider the possibility that three of these people work together – one supervises the other two. To the manager, this might seem like a team-building exercise that will enhance team morale in a fun and engaging way, creating a more instrumental layer around the game that classifies as a
metagame. One of her subordinates, however, really doesn’t like the video game and is just “playing along” to maintain good working relationships. In this subordinate’s case, the IS in use is an example of commodified play as the use of the game is primarily instrumental. The other subordinate, meanwhile, relishes any opportunity to play this game and immerses himself in the hedonic experience with no regard for potential instrumental implications. In this case, the IS in use is a game as entertainment with no regard for working relationships, even if repeatedly outperforming work colleagues in the game might result in negative instrumental outcomes.

**Hacking for Fun**

For systems designed with primarily instrumental affordances in mind, the user’s perceived and enacted affordances also belong to three categories. If an instrumental system is perceived and used as a game, this represents “hacking for fun.” While “hacking” has taken on a negatively-valenced and security-focused meaning in contemporary use, it is traditionally defined as an “obsessive commitment to creative and innovative computer programming, especially the re-engineering of systems that pushed the relatively new technology of the computer in interesting directions which were oftentimes not anticipated or recognized by their designers” (Gunkel 2005, p. 595).

Like commodified play, hacking for fun is characterized by a modality of resistance; the user resists the design features that encourage instrumental affordances, instead using those features in a mainly gameful fashion. This could involve hacking or cracking (i.e., attempts to gain unauthorized access to a system) for enjoyment, or simply “messing around” in the system with no instrumental goal, perhaps as a form of workplace loafing. One study describes an interesting example of “creative misuse” of an instrumental surveillance system to enact a full-fledged game (Farman 2014). While such creative misuse is a harmless and likely fun example
of this category, a more common example is non-instrumental security hacking behavior.

Generally regarded as undesirable, such behaviors can serve as a form of social entertainment (Turgeman-Goldschmidt 2005). Hacking, whether in the traditional sense or in the more contemporary security sense, contributes to eudaimonia as hackers hone their skills, even to a point of blissful immersion with a technology (Coleman 2012).

An important boundary condition applies to this category. Hacking for any purpose other than pleasure falls outside the domain of gameful IS. Identity theft, cybercrime, internet fraud, and similar enterprises are instrumental misuses of instrumental systems, not playful misuses or adaptations of instrumental systems.

**Playful Attitude**

“Playful attitude” refers to the situation where a system is designed for instrumental purposes, but is also a source of playful or gameful activity. This may manifest in socially constructed games using the IS, curious exploration, or as an enjoyable intellectual challenge. Play as a mode of human experience involves a readiness to improvise in an ever-changing world (Malaby 2009), and might thus involve improvising aspects of an instrumental task or system by incorporating elements of contrived contingency (i.e., creating a game) into the task, adopting a mindset of exploration, or embracing challenges.

Individuals may be predisposed toward playfulness in general, or when interacting with technology more specifically (Webster and Martocchio 1992). Playfulness might also be catalyzed situationally based on the social or cultural environment (Malaby 2009).

A playful attitude in the use of a system is perhaps more difficult to conceptually and empirically distinguish from normal use, or from the adjacent categories of gamification and hacking for fun. At what point does openness to an instrumental challenge become a playful
embrace? At what point does a socially constructed game become a gamified process? At what point does too much of a playful attitude become hacking for fun? While the prior examples suggest clearly distinguishable phenomena, we suggest that some borderline cases will be more difficult to evaluate.

**Utilities**

Finally, “utilities” represent the situation where an IS is used to support gameful experiences without specifically designed or enacted gameful affordances. Utilities afford gameful experiences at a higher level without distinct features or affordances normally associated with games. For example, a chat tool that is used to enhance communication during multi-player games would be considered a utility. The chat tool affords interactivity between players, but is a separate IS from the game. Tracking and management apps for leisure activities also fall into this category. For example, an IS to track recreational sports league rosters and standings does not afford gameful experiences directly, but supports and enhances the gameful experience of players in the league. This category differs from other categories of gameful IS in that it is a second-order support structure for gameful experiences. As such, most research on gameful design and player experiences would not directly apply to this category of systems, and they represent a potentially understudied type of IS.

The primary boundary condition around utilities relates to whether they support a gameful experience. Many utilities can be used for communication, tracking, and other affordances for supporting instrumental tasks (e.g., spreadsheets, online chat tools). If the IS in use serves as a utility for enhancing a gameful experience, then it falls into the utility category of gameful IS. It is also possible that such utilities themselves may be gamified – for example, the
productivity app EpicWin\(^7\) is a gamified utility app that includes design features such as virtual currency, quests, and chore battles. This app could also be used to manage a list of characters in a video game. To the extent that EpicWin is used for managing this list, it is a gameful IS utility. When the player engages with its gamified features, EpicWin is a gamified IS.

We propose that these theoretical categories represent a mutually exclusive and collectively exhaustive categorization of gameful IS from the perspective of affordances. These categories do not apply to gameful experiences that do not involve an IS, as those are beyond the scope of this work. Further research can generalize this taxonomy and extend it as necessary to the broader convergence of work and play. We next refine this classification system based on qualitative interview data in a conceptual-to-empirical approach.

**EMPIRICAL METHODS**

We continue with the conceptual-to-empirical approach to taxonomy development (Nickerson et al. 2013) by conducting in-depth interviews with working professionals in a variety of organizations and job roles. This study’s goal is phenomenological, describing the focal phenomena (gameful IS) as accurately as possible (Groenewald 2004), in order to understand the "social and psychological phenomena from the perspectives of people involved" (Welman and Kruger 1999, p. 189). In constructing the sample, we took care to be diverse with respect to gender, job role, industry type, and work experience. This is a convenience sample from the target population drawn from a fairly diverse professional and personal network. We describe below the interviews and analytical methods that led to the emergent categories.

---

\(^7\) [http://www.rexbox.co.uk/epicwin/](http://www.rexbox.co.uk/epicwin/)
Interviews

We conducted 20 semi-structured, face-to-face interviews, with 19 interviews involving a single interviewee and one involving a team of 4 interviewees, for a total of 23 interviewees. To the extent possible, we conducted the interviews at the interviewee’s place of employment. When this was not possible, we did the interview at an alternate location suggested by the interviewee. We provide the interview guide in Appendix 2.1. The average interview lasted around 55 minutes, with a minimum of 32 minutes and a maximum of 93 minutes. We provided an overview of discussion topics and basic definitions of the terms game, play, and gameful IS prior to the interview so that interviewees could consider relevant examples of gameful IS from their own experiences. We prompted each interviewee for three specific examples of gameful IS: one used by the interviewee at work, one used by the interviewee outside of work, and one used by a referent other either at or outside of work. In some cases, interviewees provided multiple examples of gameful IS in response to these questions, which we incorporated into the final results. Additionally, we recorded and classified gameful IS that were mentioned during other portions of the interview but not explored in detail. Table 2.6 provides a summary of work and technology experience as well as gender and minority percentages. Table 2.7 provides descriptive information about the interviewees including organization types and job roles.

<table>
<thead>
<tr>
<th>Summary Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years in Role</td>
<td>6.48</td>
</tr>
<tr>
<td>Years Overall</td>
<td>15.82</td>
</tr>
<tr>
<td>Tech Savvy (1=not at all; 5=expert)</td>
<td>3.96</td>
</tr>
<tr>
<td>Interviews with Female</td>
<td>35%</td>
</tr>
<tr>
<td>Interviews with Minority</td>
<td>20%</td>
</tr>
</tbody>
</table>

8 The interview was originally scheduled with one person, but at the time of the interview the interviewee asked if he could include his team in the discussion. We decided to move forward with a small group interview with the idea that we may gain additional insights from group discussion.
<table>
<thead>
<tr>
<th>Role Type</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analyst</td>
<td>5</td>
</tr>
<tr>
<td>Consultant</td>
<td>3</td>
</tr>
<tr>
<td>Director</td>
<td>5</td>
</tr>
<tr>
<td>IT</td>
<td>2</td>
</tr>
<tr>
<td>Manager</td>
<td>7</td>
</tr>
<tr>
<td>Physician</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Industry Type</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banking</td>
<td>1</td>
</tr>
<tr>
<td>Consulting</td>
<td>4</td>
</tr>
<tr>
<td>Education</td>
<td>3</td>
</tr>
<tr>
<td>Healthcare</td>
<td>1</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>5</td>
</tr>
<tr>
<td>Public Service</td>
<td>1</td>
</tr>
<tr>
<td>Real Estate</td>
<td>1</td>
</tr>
<tr>
<td>Retail</td>
<td>4</td>
</tr>
<tr>
<td>Technology</td>
<td>1</td>
</tr>
<tr>
<td>Transportation</td>
<td>2</td>
</tr>
</tbody>
</table>

**Theoretical Coding**

During each interview, we asked the interviewee to identify gameful IS that she uses at work, that she uses outside of work, and that someone else uses. Responses to these and other questions during the 20 interviews led to the identification of 168 examples of gameful IS. Of these 168, 66 were identified directly in response to the questions on specific examples. For these 66, we captured the interviewees’ ratings by asking a single question to measure each type of outcome: (Enjoyment) on a scale of 1 to 5, where 1 is not at all and 5 is very highly, to what extent does <this IS> provide a sense of fun and enjoyment? (Utility) on a scale of 1 to 5, where 1 is not at all and 5 is very highly, to what extent does <this IS> help you achieve practical outcomes? We varied the order of questions based on whether the described IS was used outside the workplace (Enjoyment first) or inside the workplace (Utility first).
We included 102 other gameful IS discussed by interviewees during each interview in response to questions outside of the aforementioned question sets in the overall total of 168. All 102 non-rated examples were described in sufficient depth to indicate the nature of the IS in use. Because non-rated systems were described with variable depth and inconsistent context, we do not include them in subsequent empirical analyses. By contrast, the subset of 66 rated examples provides a consistent set of responses to interview questions on the needs, affordances, and features related to instrumentality and enjoyment for each system. I coded the rated examples following each interview, and reviewed all transcripts to extract and code the remaining 102 gameful IS following the completion of the final interview. To validate coding accuracy, a second rater, familiar with the theoretical categories, coded a random subset of 15 examples. This produced good interrater agreement (Landis and Koch 1977) based on weighted category proximity (Cohen’s Kappa = 0.72)\(^9\) (Cohen 1960).

**RESULTS**

Table 2.8 summarizes the complete set of 168 examples based on their theoretical classifications. Table 2.9 provides a more detailed view of the 66 gameful IS discussed in greater depth during the interviews.

---

\(^9\) We based category weights on stepwise distance between categories in the original 3x3 theoretical classification matrix (e.g., gamification and serious games are 1 step apart, but utilities and games as entertainment are 4 steps apart). We used similarity weights of 0.0, 0.25, 0.5, and 0.75 for 4, 3, 2, and 1 step apart, respectively).
Table 2.8. Theoretical Classification of Gameful IS Mentioned in Interviews

<table>
<thead>
<tr>
<th>Classification</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Games as entertainment</td>
<td>44</td>
</tr>
<tr>
<td>Gamification / Taskification</td>
<td>28</td>
</tr>
<tr>
<td>Hacking for fun</td>
<td>1</td>
</tr>
<tr>
<td>Metagame</td>
<td>6</td>
</tr>
<tr>
<td>Playful attitude</td>
<td>28</td>
</tr>
<tr>
<td>Playful design</td>
<td>12</td>
</tr>
<tr>
<td>Serious game</td>
<td>6</td>
</tr>
<tr>
<td>Utility</td>
<td>43</td>
</tr>
<tr>
<td>Grand Total</td>
<td>168</td>
</tr>
</tbody>
</table>

Table 2.9. Enjoyment and Utility Ratings for Gameful IS

<table>
<thead>
<tr>
<th>Classification</th>
<th>Enjoyment (E)</th>
<th>E-Rank</th>
<th>Utility (U)</th>
<th>U-Rank</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Games as Entertainment</td>
<td>4.56</td>
<td>1</td>
<td>3.41</td>
<td>7</td>
<td>17</td>
</tr>
<tr>
<td>Gamification / Taskification</td>
<td>3.88</td>
<td>6</td>
<td>3.81</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>Metagame</td>
<td>4.50</td>
<td>2</td>
<td>3.50</td>
<td>T-5</td>
<td>2</td>
</tr>
<tr>
<td>Playful attitude</td>
<td>4.11</td>
<td>5</td>
<td>4.67</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Playful design</td>
<td>3.75</td>
<td>7</td>
<td>3.63</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Serious Game</td>
<td>4.30</td>
<td>3</td>
<td>3.50</td>
<td>T-5</td>
<td>5</td>
</tr>
<tr>
<td>Utility</td>
<td>4.17</td>
<td>4</td>
<td>3.96</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>Grand Total</td>
<td>4.18</td>
<td></td>
<td>3.81</td>
<td></td>
<td>66</td>
</tr>
</tbody>
</table>

The ratings are consistent with the theoretical categories, with games as entertainment achieving the highest enjoyment and lowest utility scores. Metagames are similar at second overall in enjoyment but tied for fifth in utility. Serious games are also seen as fun, but lower in utility, consistent with the indirect instrumentality of serious games. Gamification/Taskification achieves similar scores (but varying ranks), consistent with their focus on both instrumental and gameful affordances. Playful attitude ranks first in utility, consistent with its instrumental design focus. Playful design ranks lowest in enjoyment, consistent with the non-gameful focus of the IS in use, and suggesting that instrumental systems can only be enhanced so much through aesthetics and gameful design. Finally, utilities rank high for practical outcomes, and are also
enjoyable, which is somewhat surprising given utilities’ primarily instrumental design, but this may relate to the nature of some utilities in supporting enjoyable activities.

**Toward a Refined Taxonomy**

To refine the taxonomy based on the interviews, we first constructed a corpus of interview responses related to the 66 detailed examples of gameful IS. We constructed this corpus by compiling each interviewee’s responses to questions III.b.v, III.c, and III.d in Appendix 2.1. Interviewer questions were removed but relevant clarifying questions were incorporated using [bracketed explanatory text]. Interviewees sometimes diverged from the main question on their path to answering, discussed alternate points of view within the question, referred to another’s use of a system in relation to their own, etc. We considered dropping sentences involving non-focal enactors and alternate uses, but took a conservative approach to retain maximum meaning and reduce the risk of losing important context. This increases the likelihood that emergent clusters are not as clean but retains the full meaning and characteristics salient to the interviewee for each response.

This corpus consists of 43,842 words with an average of 664.3 words (minimum = 118, maximum = 2,406) per gameful IS. We perform text mining and clustering using SAS Text Miner, a component of SAS Enterprise Miner 15.1. We use the expectation-maximization algorithm to form clusters based on a Gaussian distribution using a weighted frequency of terms in the text. Given our focus on affordances, or what the user is able to do using the system, we limit the text mining algorithm to only consider verbs (actions) and nouns (objects). We use default rules for multi-word terms and text stemming, and add company and organization entities to the default ignore list. We began with the default “stop words” list (a list of words to ignore during parsing). We modified the stop words list to remove terms that are salient in a gameful IS
context, and iteratively added words that showed up in a list of common terms, but are not meaningful in this study (e.g., specifically, yeah, thing).\textsuperscript{10} We use single value decomposition for dimension reduction with low resolution and a maximum of 100 reduced dimensions (the default settings). Given the empirical focus of this analysis, we varied the number of clusters between three and seven (the number of distinct theoretical categories among the 66 systems) to find a solution that is both parsimonious and interpretable (Hair et al. 2006). The selected model contains five clusters, which we describe in greater detail below. For each cluster, we provide a general description, discuss how it relates to the theoretical dimensions, present a relevant example, and describe cross-validation results to highlight the salient attributes of each cluster.

**Cluster Summary**

We present the top ten terms associated with each cluster in Table 2.10. In the broader context of the convergence of work and play, we name and discuss the clusters in relative order from most closely associated with work to most closely associated with play. We named clusters based on commonly occurring words, alignment with the theoretical classifications, patterns in contextual factors, and insights from a second text mining technique that we discuss below. The first two clusters focus on adaptation and discovery, both important activities in the workplace, and how they are augmented by play. The third cluster, productive play strikes a balance between work and play, and could just as easily be called playful productivity. The last two clusters focus on games and recreation, activities more clearly associated with non-work contexts, and how instrumentality emerges from or enhances them.

\textsuperscript{10} We will provide a complete list of stop words used for this study upon request.
Table 2.10. Emergent Clusters: Top Ten Terms

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Descriptive Terms</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gameful Adaptation</td>
<td>picture ‘social media platform’ sense book app use day information goal computer</td>
<td>9</td>
<td>14%</td>
</tr>
<tr>
<td>Enjoyable Discovery</td>
<td>bi 'business application' power tool data answer allow figure experience system</td>
<td>13</td>
<td>20%</td>
</tr>
<tr>
<td>Productive Play</td>
<td>competition engage sort point build track back app job show</td>
<td>20</td>
<td>30%</td>
</tr>
<tr>
<td>Generative Games</td>
<td>‘video game’ game video kid watch play interest time friend connect</td>
<td>17</td>
<td>26%</td>
</tr>
<tr>
<td>Intensified Recreation</td>
<td>sport night player focus reason play connect watch phone day</td>
<td>7</td>
<td>11%</td>
</tr>
</tbody>
</table>

The following tables provide cross-tabulations of the emergent clusters as compared to the theoretical classifications (Table 2.11), their focus by design (Table 2.12), and their focus by experience (Table 2.13). Table 2.14 presents average enjoyment and utility ratings by cluster.

Table 2.11. Emergent Clusters: Comparison to Theoretical Classifications

<table>
<thead>
<tr>
<th>Theoretical Category</th>
<th>Gameful Adaptation</th>
<th>Enjoyable Discovery</th>
<th>Productive Play</th>
<th>Generative Games</th>
<th>Intensified Recreation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Games as Entertainment</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>11</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Gamification / Taskification</td>
<td>2</td>
<td>2</td>
<td>13</td>
<td>0</td>
<td>0</td>
<td>17</td>
</tr>
<tr>
<td>Metagame</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Playful Attitude</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>Playful Design</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Serious Game</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Utility</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>9</strong></td>
<td><strong>13</strong></td>
<td><strong>20</strong></td>
<td><strong>17</strong></td>
<td><strong>7</strong></td>
<td><strong>66</strong></td>
</tr>
</tbody>
</table>

Notes. $\chi^2(24) = 78.53$, $p < 0.01$

Table 2.12. Emergent Clusters: By Design

<table>
<thead>
<tr>
<th>Design</th>
<th>Gameful Adaptation</th>
<th>Enjoyable Discovery</th>
<th>Productive Play</th>
<th>Generative Games</th>
<th>Intensified Recreation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Gameful</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>11</td>
<td>3</td>
<td>19</td>
</tr>
<tr>
<td>Gameful + Instrumental</td>
<td>4</td>
<td>8</td>
<td>13</td>
<td>1</td>
<td>0</td>
<td>26</td>
</tr>
<tr>
<td>All Instrumental</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>21</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>9</strong></td>
<td><strong>13</strong></td>
<td><strong>20</strong></td>
<td><strong>17</strong></td>
<td><strong>7</strong></td>
<td><strong>66</strong></td>
</tr>
</tbody>
</table>

Notes. $\chi^2(8) = 30.66$, $p < 0.01$
Table 2.13. Emergent Clusters: By Experience

<table>
<thead>
<tr>
<th>Experience</th>
<th>Gameful Adaptation</th>
<th>Enjoyable Discovery</th>
<th>Productive Play</th>
<th>Generative Games</th>
<th>Intensified Recreation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Gameful</td>
<td>0</td>
<td>6</td>
<td>3</td>
<td>11</td>
<td>2</td>
<td>22</td>
</tr>
<tr>
<td>Gameful + Instrumental</td>
<td>3</td>
<td>5</td>
<td>16</td>
<td>3</td>
<td>1</td>
<td>28</td>
</tr>
<tr>
<td>All Instrumental</td>
<td>6</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>9</strong></td>
<td><strong>13</strong></td>
<td><strong>20</strong></td>
<td><strong>17</strong></td>
<td><strong>7</strong></td>
<td><strong>66</strong></td>
</tr>
</tbody>
</table>

Notes. $\chi^2(8) = 34.96$, $p < 0.01$

Table 2.14. Emergent Clusters: Enjoyment and Utility Ratings

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Enjoyment (E)</th>
<th>E-Rank</th>
<th>Utility (U)</th>
<th>U-Rank</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gameful Adaptation</td>
<td>3.78</td>
<td>5</td>
<td>3.61</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Enjoyable Discovery</td>
<td>4.08</td>
<td>4</td>
<td>3.96</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>Productive Play</td>
<td>4.23</td>
<td>2</td>
<td>4.16</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>Generative Games</td>
<td>4.21</td>
<td>3</td>
<td>3.76</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>Intensified Recreation</td>
<td>4.71</td>
<td>1</td>
<td>2.86</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td><strong>4.18</strong></td>
<td><strong>3.81</strong></td>
<td></td>
<td></td>
<td><strong>66</strong></td>
</tr>
</tbody>
</table>

We relate these clusters to the initial theoretical classifications (Table 2.11) and the NAFE framework based on their designed (Table 2.12) and enacted (Table 2.13) affordances. We consider both experiential and instrumental (Table 2.14) outcomes. We conduct post hoc analyses to identify salient elements of context, and to gain insights into fulfilled needs through additional text analyses, described below.

The following tables provide post hoc analyses using cross-tabulation for categorical variables, including work vs. non-work context (Table 2.15), role types (Table 2.16), and education (Table 2.17). Chi-square difference tests for gender and ethnicity were non-significant.
<table>
<thead>
<tr>
<th>Table 2.15. Emergent Clusters: Work vs. Non-Work Context</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cluster</strong></td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td><strong>Use Context</strong></td>
</tr>
<tr>
<td>At Work</td>
</tr>
<tr>
<td>Outside of Work</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
<tr>
<td>Notes. $\chi^2(4) = 24.01, p &lt; 0.01$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2.16. Emergent Clusters: Role Types</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cluster</strong></td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td><strong>Role Type</strong></td>
</tr>
<tr>
<td>Analyst</td>
</tr>
<tr>
<td>Consultant</td>
</tr>
<tr>
<td>Director</td>
</tr>
<tr>
<td>IT</td>
</tr>
<tr>
<td>Manager</td>
</tr>
<tr>
<td>Physician</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
<tr>
<td>Notes. $\chi^2(20) = 36.70, p &lt; 0.01$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2.17. Emergent Clusters: Education Level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cluster</strong></td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td><strong>Education Level</strong></td>
</tr>
<tr>
<td>High School</td>
</tr>
<tr>
<td>Bachelors</td>
</tr>
<tr>
<td>Post-Graduate</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
<tr>
<td>Notes. $\chi^2(8) = 19.82, p &lt; 0.01$</td>
</tr>
</tbody>
</table>
Table 2.18. Emergent Clusters: Technology Context

<table>
<thead>
<tr>
<th>Technology Context</th>
<th>Gameful Adaptation</th>
<th>Enjoyable Discovery</th>
<th>Productive Play</th>
<th>Generative Games</th>
<th>Intensified Recreation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business Application</td>
<td>4</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>Device</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Event</td>
<td>0</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>Mobile App</td>
<td>3</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Mobile Platform</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Social Media Platform</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Video Game</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>7</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>Video Game Platform</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Website</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>9</td>
<td>13</td>
<td>20</td>
<td>17</td>
<td>7</td>
<td>66</td>
</tr>
</tbody>
</table>

Notes. $\chi^2(32) = 75.07, p < 0.01$

The following table provides post hoc analyses to support emergent classifications and triangulate results between two text-mining techniques. We use the Linguistic Inventory and Word Count (LIWC) software to analyze the corpus of 66 gameful IS descriptions. LIWC is a “transparent text analysis program that counts words in psychologically meaningful categories” (Tausczik and Pennebaker 2010, p. 24), and is commonly used in IS literature to analyze text communication (e.g., Huang et al. 2019; Yin et al. 2016). LIWC identifies words that highlight contextual aspects of gameful IS. LIWC provides summary information for each analyzed unit of text including measures of complexity, parts of speech, and classifications of word types (e.g., cognitive processes, social references). LIWC reports word types as the percentage of words of that type within a unit of text on a scale of 0 to 100. We conduct one-way ANOVA tests for continuous variables of interest and report significant results in the tables below. Notable non-significant differences include positive emotion words, negative emotion words, and achievement references. We find significant differences in the following types of words: social,
insight, perception, health, and leisure. Table 2.19 presents the results. We use Bonferroni multiple comparison tests to determine significant pairwise differences and discuss the results.\(^{11}\)

**Table 2.19. Emergent Clusters: LIWC Categories (One-way ANOVA)**

<table>
<thead>
<tr>
<th>LIWC Category</th>
<th>F-values</th>
<th>Gameful Adaptation</th>
<th>Enjoyable Discovery</th>
<th>Productive Play</th>
<th>Generative Games</th>
<th>Intensified Recreation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social</td>
<td>3.28*</td>
<td>13.26 H</td>
<td>8.36 L</td>
<td>10.62</td>
<td>11.82 h</td>
<td>9.78</td>
</tr>
<tr>
<td>Insight</td>
<td>7.90**</td>
<td>3.64 h</td>
<td>4.27 H</td>
<td>2.90 L</td>
<td>2.61 L</td>
<td>2.59 L</td>
</tr>
<tr>
<td>Perception</td>
<td>17.55**</td>
<td>3.19 H</td>
<td>1.46 L</td>
<td>1.87 L</td>
<td>2.43</td>
<td>2.48</td>
</tr>
<tr>
<td>Health</td>
<td>2.94**</td>
<td>0.10</td>
<td>0.08 L</td>
<td>0.55 H</td>
<td>0.29</td>
<td>0.29</td>
</tr>
<tr>
<td>Leisure</td>
<td>10.18**</td>
<td>2.44 L</td>
<td>1.36 L</td>
<td>1.92 L</td>
<td>4.49 H</td>
<td>3.65 h</td>
</tr>
</tbody>
</table>

Notes. * \(p < 0.05\), ** \(p < 0.01\); H, h, L, and l indicate that the cluster was higher (H: \(p < 0.05\); h: \(p < 0.10\)) or lower (L: \(p < 0.05\); l: \(p < 0.10\)) than at least one other cluster based on Bonferroni multiple comparison tests of pairwise differences.

**Cluster A: Gameful Adaptation**

We label gameful IS in Cluster A as “gameful adaptation” (GA). Based on the frequently occurring words in Table 2.10, GA involves utility-focused (use, information, goal) applications (app, computer) at work (day), sometimes with a social media aspect (social media platforms, picture), that are gamefully adapted to serve goals (sense) of fun, teamwork, status, and obligation.\(^{12}\) Examples of GA systems in our sample include a playfully designed library checkout system, a social media platform for workplace recognition, workplace communication systems containing playful or recreational channels, and the use of editing software to enhance aesthetic appeal of photographs.

All 9 GA systems in this sample are designed with instrumental affordances and are used instrumentally. Of these, 6 systems are not experienced gamefully, the highest proportion of any category, suggesting that these systems mainly serve instrumental purposes but have been

---

\(^{11}\) Results using Sidak and Scheffe tests were consistent with those using Bonferroni.

\(^{12}\) The remaining word, book, is a shared contextual element across three examples: a librarian describing a self-checkout system, a real-estate agent learning to play the guitar, and a data analyst managing his personal library.
adapted to enhance experiential outcomes. Of these 6, 4 are utilities and 2 are playful design
based on the theoretical categories. Of the remaining 3 (of 9), one is a playful attitude toward an
instrumental system, and 2 are classified as gamification (both involving social media). Relative
to other clusters, GA systems are the least enjoyable, which is consistent with the instrumental
focus of these systems. While they are beneficial (3.61 on a 5-point scale), the GA systems in
this study trailed three of five other clusters in average utility ratings. One interviewee described
a gamified social media system as a method for “engagement and morale enhancement,” but he
personally uses it “out of a sense of obligation… [as] part of [his] responsibility.” When he
receives recognition, he considers it “nice” but “not necessarily fun.”

GA systems are essentially utility- (typically workplace-) focused systems, “spruced up”
to enhance the experiential aspects through aesthetics or other minor but effective gameful
elements. A relevant example of a GA system is the playful use of Microsoft Teams, a workplace
collaboration platform offering voice and video chat, persistent conversation channels, and
document/file sharing capabilities. The interviewee thus described her use of Teams:

Now, we’re using Teams… [for] chatting, we’re having meetings out of there, we also
are storing documents in there… I don’t keep anything on my personal device. I mean, I
could run it over right now and it wouldn’t be a material impact. Because [we use] …
OneDrive and Teams to store all of the documentation and making people aware of it… I
can post a document out there. Then I can tag… just like you do in social media. You can
@ somebody and it’ll send them a message…

The interviewee also described running conversations in Teams that include little jokes,
playful use of emojis, and amusing memes. She described a specific example in which a business
manager playfully softened a negative message:

I had a business manager reaching out to me last week on the status of something and I
was giving him bad news… he gave me a little funny meme in response that made me
know that he got it. He wasn’t, you know, he wasn’t frustrated with me, he just knew
that… it was what it was. It wasn’t me.
GA systems serve a variety of needs, including relatedness, having a place, and eudaimonic (but not hedonic) enjoyment. Social and communication media platforms are common (5 of 9) in this cluster, underscoring the focus on connecting and interacting with others through technology. One consultant described her workplace use of Facebook as a way to connect with clients: “Because people put interests in Facebook… for example, that someone is interested in rock bands… That's a point of conversation that you can have.” Social media also serves as an online “home” for both individuals and businesses, helping them to establish and project their place in the virtual world. Enjoyment stemming from GA systems is eudaimonic in nature. For example, one IT analyst uses a playfully designed personal database app on his phone to track his library of books and network of personal contacts, satisfying two of his personal priorities for self-development (books) and sustaining great relationships (contacts).

GA systems offer a variety of affordances, including communication, meta-voicing, and rewards. As noted above, social and communication media platforms afford interpersonal and group communications, and provide meta-voicing capabilities such as the meme described in the Microsoft Teams quote above. Rewards are also fairly common in this cluster, such as in a social media recognition system offering a feature to give “points” to co-workers for a job well done, which they can then redeem for gift cards or other items: “You can just go in and tag somebody, and recognize them for doing something great.”

Post hoc analyses indicate that GA systems differ from other clusters in several ways consistent with its interpretation based on theoretical considerations and commonly occurring terms. These examples were discussed primarily (7 of 9) in a work context using business applications (4 of 9). Of the 2 non-work examples, one involved learning a new skill and the other involved organizing personal databases – both functional applications. Based on LIWC
analyses and consistent with prior descriptions, GA systems are more likely to focus on social (media) aspects that may serve underlying needs for relatedness. Several GA system examples focused on adaptations to enhance perceptual or aesthetic aspects, which is supported by significant differences in perceptual words. GA systems are also less leisure-focused than more traditional games, consistent with the business focus of this cluster.

Based on these observations, GA systems exhibit characteristics of playful design (Anderson 2011) by enhancing aesthetics. They also exhibit characteristics of playful attitudes, as individuals engage in instrumental pursuits in a lighthearted manner and a readiness to improvise (Malaby 2009) in pursuit of enjoyment. Finally, they share conceptual space with gamification (Liu et al. 2017), at least for minor adaptations of existing types of systems as illustrated in this sample (e.g., adding a reward or recognition feature to a social media platform).

**Cluster B: Enjoyable Discovery**

We label gameful IS in Cluster B as “Enjoyable Discovery” (ED). Based on frequently occurring words in Table 2.10, ED involves the use of data (data, bi, power) and systems as tools (system, tool) at work (business application) for training and insight (allow, figure, answer) with a focus on positive experience (experience). Examples of ED systems in our sample include a Tableau Hackathon, playful use of Microsoft Power BI and other analytics tools, and a traditional game that inspired one interviewee to develop cloud computing skills.

Like GA, ED systems are designed with instrumental affordances (12 of 13). In contrast to GA systems which afford primarily instrumental experiences, ED systems typically afford gameful experiences (11 of 13). While GA systems are enjoyable (4.08/5.00), they balance enjoyment with high utility (3.96/5.00). This cluster includes all (5) of the serious games based on the theoretical categories. This is consistent with common uses of serious games to introduce
new concepts in a fun and engaging way (Susi et al. 2007). Of the remaining 8 examples, 3 are classified as exhibiting playful attitudes toward instrumental systems, two as gamification/taskification, and one each as games as entertainment, playful design, and utility. In all cases, the context involves learning a new technology in a fun and engaging way. For example, one interviewee described a game on which he has logged more than 500 hours of playing time in relation to his history with video games: “I would say that my entire IT career has been built around learning something related to video games… [for this game] learning how to set up a system based in the cloud that I can then… teach myself containerization.”

ED is characterized by “playing with new toys” – enjoying the novelty, exploring and learning something that is new and different. This serves underlying needs for autonomy, competence, and eudaimonia through exploration and self-training on ITs that are worth exploring. Most (11 of 13) of these examples involve analytics and visualization tools (i.e., Tableau, Power BI, Alteryx, Excel), reflecting a current hot topic in IS research and practice (Chen et al. 2012). Although lacking empirical evidence to support this claim, we believe that ED should be generalizable to other new ITs and represents an enduring pattern of exploratory learning. One consultant described her use of Microsoft Power BI as follows:

I’d say I’ve used every possible feature in Power BI, everything from power query in the back end… [p]ulling in and transforming data…, DAX for calculations and building measures and … custom visualizations as well… for one client they wanted to replicate their financial statements in Power BI, and so they had been very manually preparing this report for their board members, and they wanted to automate that by using Power BI to where it’s just “click refresh and here we go.”

In discussing aspects that the interviewee considered enjoyable, she replied:

“… there’s some intrinsic benefit there where it’s cool to help people be better at their jobs and there’s also extrinsic. I get rated well when I’m using these. I think building visualizations is a lot of fun. I’m really fascinated by how people look at data and… are able to then better understand trends… I also think a lot of the data wrangling is actually pretty fun, too. I get a lot of satisfaction when I’m able to figure out a measure that works
and finally get to the right answer. That … pure problem-solving aspect is really fun to me.

ED systems relate clearly to the need for eudaimonic enjoyment, as illustrated by the above quote describing the satisfaction of a job well done. They also serve intrinsic needs for competence and autonomy. Developing competence with Microsoft Power BI inspired a playful approach for one interviewee: “For Power BI it was picking it up and using trial and error to do something. I came up with something… that I wanted to do, and I had to figure out how to get from no knowledge to intermediate level and accomplish something.” As part of a Tableau (visualization tool) hackathon, one participant indicated that he treated the synthetic data like it was his “own… store” and that it was fun to “[d]evelop your own story of what this data means,” serving his need for autonomy in creating a personal narrative using the data.

ED systems tend to focus on affordances of competition (e.g., the hackathon mentioned above), embodiment, and interactivity. These systems promote embodiment not in the immersive virtual world sense, but in the expression of the self through personal narratives and personalized design. One IT analyst described interesting visualizations in Power BI including a football field and a fish tank to personalize the way that data is presented to stakeholders. The modern analytics tools characterizing this cluster are highly interactive, adapting smoothly through trial and error to render visual depictions of data: “just the active, going through that and learning and figuring out what is working and what's not working, I think that's fun.”

Post hoc analyses indicate that ED occurs primarily in a workplace context (12 of 13), consistent with the descriptive analysis of the cluster as being related to business applications and events. This was the most common cluster described by interviewees in an analyst role (6 of 11). In contrast to other clusters (Table 2.17), ED is spread across education levels in our sample. ED is less socially focused than GA (p < 0.05) and Generative Games (p < 0.10). However, ED
stands out among all clusters as the most focused on cognitive processes, particularly insight (Table 2.19), which is consistent with the present context of analytics-focused ED and suggests a focus on serving an underlying need for eudaimonic enjoyment.

Based on these observations, ED is aligned with serious games that are intended to enhance knowledge and skills in new domains (Susi et al. 2007). The process and rules of discovery, however, do not need to be externally contrived. Users develop playful attitudes toward new technologies that can result in ED (Webster and Martocchio 1992), and the design of new technologies may incorporate playful aspects or more deliberately gamified elements. As noted above, even a full-fledged game can catalyze inspiration for learning a new IT.

**Cluster C: Productive Play**

We label gameful IS in Cluster C as “Productive Play” (PP). Based on frequently occurring words in Table 2.10, PP systems are designed to engage (engage) through apps (app) and competitions (competition) to achieve instrumental objectives (build, job), and often incorporate visual aspects (show, point, sort) and interactive (track, back) features. Examples of PP systems in our sample include a virtual reality language learning system, Codecademy (a gamified technology learning platform), a gamified app for truck drivers, and gamified fitness.

PP systems are most closely associated with the modern concept of gamification. Of the 20 examples in this cluster, we classified 13 into the theoretical category of “gamification / taskification” (13 of the 17 receiving this classification, with the remaining 4 divided evenly between GA and ED). The dual-purpose nature of PP systems is evident in the combination of gameful (85%) and instrumental (80%) design, and gameful (95%) and instrumental (85%) enactment. The deliberate dual-purpose design and enactment of PP systems result in high rankings for both utility (4.16/5.00, the highest scoring cluster) and enjoyment (4.23/5.00, the
second-highest scoring cluster). Of the 7 PP systems not classified as gamification/taskification, 3 were classified as games as entertainment, 2 as playful attitude, and 1 each as metagame and utility. Of the three classified as games, two are word games that interviewees described as useful tools for stretching their vocabulary, and one was the use of an Xbox gaming system to foster social connections, develop mastery, and earn rewards – all focused on a combination of experiential and instrumental outcomes.

PP systems involve a deliberately designed and consciously experienced combination of instrumental and gameful objectives. They do not sacrifice instrumentality or enjoyment at the expense of the other. One interviewee, an IT professional, described his use of Pokémon Go as a way to “drive myself to get outside to get more exercise, and stay acclimated to the weather… I spend a lot of time indoors in air conditioning in a chair, and it’s not good for my health.” Meanwhile, he thoroughly enjoys aspects of the game such as badges, social interactions, and achievement-centric narratives. In another example of a PP system, a director described her company’s hackathons as:

… something that we’ve seen a lot of success with and engagement with our employees… [w]e actually had one earlier this year and there was so much excitement from our business leadership on the things that they were seeing, that they asked us to do it again right before budget time.

… we have the one going on this week and we… give some kind of broad definition of what we’re looking for… We have a platform that we are trying to get all of our applications on because as you can imagine, a company of this size [multi-billion USD annual revenue]… this probably should have been thought of… so, we’ve really left the hackathon just at, how can we solve a problem using the platform?

In the spirit of fun and hacking – traditionally, referring to expert technologists coming up with innovative ideas through exploration and use of systems in oft-unintended ways (Yar 2005) – she explained:
Cheating is encouraged, no rules, just something that you can solve a problem with that works in some regard… then, they would present their ideas to executive leadership… [rules are flexible] and we roll with them… so, it’s kind of fun to be able to be a coding criminal for a little while…

We have sponsors come in, and food, and music, and all that kind of stuff to keep the spirits high… cash rewards at the end… [T]his is the first year that we’re crowdsourcing the judging, which is kind of cool… we’ll go through a round of judging and I’ll be a part of that and… we’ll help scale that down to the top ten-ish ideas, and those are the ones that will go before the group… and it’ll be live streamed, everybody in the company can watch… They’ll present their idea and their business case and show the tech, and then everybody will get to vote on who the winner is.

As the category most integrative of instrumental and gameful experiences, PP systems serve a wide variety of needs, including physiological and security, all three intrinsic needs (Deci and Ryan 2000), and both hedonic and eudaimonic enjoyment. This cluster includes several gamified fitness devices and apps to meet physiological needs, such as an Apple Watch to track steps and heart rate, the Strava app to track runs and bike rides, and the game Pokémon Go to motivate more exercise. PP systems can also fulfill needs for competence and autonomy, as illustrated by a gamified innovation competition designed for “empowering and enabling innovators and entrepreneurs” by integrating “talent, access to capital, building entrepreneurial culture, and… community engagement.” While some traditional games offering hedonic enjoyment fall into this category, many examples in this cluster are more eudaimonic in nature such as the fitness and innovation systems described above.

PP systems serve the above needs through a wide variety of affordances. Competition, status, and rewards are central to the gamified innovation competition described above. As a mixed reality game, Pokémon Go affords presence and embodiment that bridge the virtual and real worlds. Gamified fitness apps often offer meta-voicing capabilities through features to give “kudos” or “likes.” One example of a traditional game platform illustrates the social interactivity and communication affordances: “he's playing a whole host of different types of [games], and
he's got communities online that enjoy playing those particular games with him in that environment. And it's a way for him to stay connected.”

*Post hoc* analyses indicate that PP systems are evenly distributed between work (11) and non-work (9) contexts. PP is also spread across technology contexts with the notable exception of platforms (1 of 20 were construed at the platform level). PP is the only category to exhibit such a balance, which is consistent with the dual-purpose design and experience of these systems. PP systems were described more often than other categories by manager-level and director-level interviewees (8 of 15 and 9 of 22 systems described, respectively). Nearly all (95%) PP systems were discussed by interviewees with a post-graduate degree. Taken together, this suggests that gamification is on the mind of thought leaders and business leaders. Analyses of LIWC categories suggest that PP systems tend more than some other categories to be health focused, consistent with recent trends in gamified health apps (Johnson et al. 2016) in serving physiological needs.

PP systems are most closely related to gamification (Liu et al. 2017) and taskification (Prestopnik and Crowston 2012). Some research labels such systems as dual-purpose (e.g., Köse et al. 2019), such that users can simultaneously pursue extrinsic (e.g., job performance, rewards) and intrinsic (e.g., competence, autonomy) needs. More traditional games appearing in this cluster tend to highlight instrumental benefits or focus on practically relevant skills (e.g., vocabulary), evoking comparisons to the gamification of learning and edutainment software (e.g., Alemi 2010).

**Cluster D: Generative Games**

We label gameful IS in Cluster D as “Generative Games” (GG). Based on frequently occurring words in Table 2.10, GG systems are clearly associated with traditional video games
(video game, video, game), either playing (play) or watching (watch) with interest (interest). They are often social/family (connect, friend, kid) in nature and sometimes consume large amounts of time (time). Examples of GG systems in our sample include playing Xbox with friends and family, playing games such as World of Warcraft and The Sims, and children’s use of tablets to play games and watch videos.

GG systems are most closely associated with video games and the theoretical category of “games as entertainment” (11 of 17 systems in the cluster, and 11 of 17 systems in the theoretical category). As such, they are rated highly for enjoyment (4.21/5.00). Of the remaining 6, 3 are classified as playful attitude, 2 as utility, and 1 as playful design. Most (12 of 17) are designed as gameful, and relatively fewer (6 of 17) are designed as instrumental. Congruent with their design, most GG systems are experienced as gameful (14 of 17), and relatively fewer as instrumental (6 of 17). Somewhat surprisingly, GG systems were also rated highly for utility (3.76/5.00). Despite their relatively low direct instrumental use, interviewees described practical benefits of GG system use in every case, suggesting indirect instrumentality. Even for a game as simple as the popular mobile game “Angry Birds,” one interviewee plays it for “[j]ust smashing things… blowing things up… [as] something to get my mind off of other things,” but also notes based on his prior military experience in developing coursework for counter-sniper operations that the game is “pretty accurate on gravity and arc and speed and the weight of the birds… so it’s sort of practical if you want to learn a little bit about trajectories.”

GG systems involve the use of video games and technology for (primarily) leisure purposes, but the use generates tangible instrumental benefits as an indirect result. One interviewee said, regarding her three-year old daughter’s use of a tablet to play games and watch videos, that “the endless library…, the evolution of technology” enables her to “see the art of the
possible through multiple videos, created by people from all walks of life, from all parts of the world, using different languages.” This example highlights the power of technology-enabled play for pre-reading exploratory learning.

Two examples illustrate the indirect benefits of games for technology skill development. One interviewee describes his step-daughter as “not a techy person,” but in playing The Sims, she has “downloaded some emulator and [has the game] running as a server… and she’s gotten all into… modifications to where she can do things that the game didn’t have to start with.” Another interviewee described his teenage son’s experience with World of Warcraft and its impact on his career path:

He was always on his computer playing games [online with friends]. He loved playing World of Warcraft… All those kids, … like five of them that were on the games all the time, had their headphones on talking and playing, they’ve all gone on [professionally] to do something with computers… cybersecurity…, programming or data analysis.

Comprised mostly of video games, GG systems serve the need for hedonic enjoyment and intrinsic factors of competence, autonomy, and relatedness. In discussing the playful “front office” experience he offers his clients, a physician explained: “If people leave our office feeling comfortable, entertained, delighted, that is my goal, just to constantly be delighting people in different ways, in creative ways.” This highlights the goal of hedonic enjoyment, but he also noted that “[i]f I have a kid that I know is uneasy about being here, and I see him on the Xbox doing something, sometimes I'll just plop down in the chair next to him… and start playing, and connect with him,” fulfilling a need for relatedness.

GG systems fulfill these needs through gameful affordances such as competition, presence, communication, and collaboration. One interviewee discussed how his family connects through Xbox games: “we're now a three Xbox home. [T]hey'll be in their rooms and we'll put our headsets on and we'll play a game together, which is kind of silly. But we can cooperate in a
game, and laugh and have fun and make fun of me. And it works out well.” Consistent with the wide variety of video games, GG systems may offer affordances for competition (e.g., one interviewee competes with her spouse in Mario Kart regularly), or for presence and embodiment such as in The Sims: “She's basically building out a replication of the family, her friends, their houses, their neighborhoods. She's replicating stuff, which in a way, it's sort of creepy, but still. And it's not like an objective-based game. It's just an immersive situational thing.”

Post hoc analyses indicate that GG systems are mostly used outside of work (13 of 17). Interestingly, no director-level interviewees offered examples of GG systems, but 13 of 17 examples were provided by interviewees with post-graduate degrees. Unsurprisingly, most (9 of 17) systems in this cluster are in a game-related technology context. Based on LIWC analyses, GG systems are characterized by a greater focus on leisure words, which is consistent with the idea that these systems are primarily used outside of work for leisure purposes and serve a need for hedonic enjoyment.

Despite the clear association with traditional video games, seen by some as colossal time wasters, GG systems are characterized by generativity. While counter to some contemporary perspectives, this is consistent with the view of games and play as evolutionary mechanisms for simulating reality (Harteveld 2011) and training for the unexpected (Spinka et al. 2001). While research has made significant progress in understanding hedonic IS (e.g., Lowry et al. 2013), future work should consider generativity in context as an important factor in adoption, continued use, and effectiveness of hedonic IS.

Cluster E: Intensified Recreation

We label gameful IS in Cluster E as “Intensified Recreation” (IR). Based on frequently occurring words in Table 2.10, IR systems are characterized by a focus on enabling (reason)
recreational activities (sports, player, play) and connections to others (connect, phone), but also promote leisurely distraction via cognitive engagement (focus). Examples of IR systems in our sample include mobile apps to track and remotely monitor personal and family sporting events, fantasy football, and “mindless” games (e.g., Candy Crush) to unwind.

IR systems represent the smallest cluster in our sample, including only 7 of the 66 classified systems. Of those 7, most (4) aligned with the theorized utility category, and 3 of those 4 were utilities to enhance enjoyment of sports. Of the remaining 3, 1 is classified as a metagame (fantasy football), and 2 are games as entertainment (Candy Crush as a way to deeply disengage). While the 4 IR systems classified as utilities are not directly gameful by design, they are all designed to support non-work / leisure experiences – taking this into account, IR systems are arguably the least “work focused.” Consistent with their recreational focus, IR systems are rated highest for enjoyment and lowest for utility.

IR systems help people enjoy what they enjoy, to an even greater extent. They intensify the recreational experiences that people inherently find gratifying. For example, one interviewee enjoys fantasy football for the “competition. I enjoy it also because I like sports, so it adds a level to that. It’s not just watching the sports, but it’s actually having your own kind of selfish needs what a team needs to do.” Though lowest in utility ratings, IR systems are not without benefits. For the football fan, it also helps her stay in touch with family: “it gives me a sense of checking in with them and even if I’m calling to let them know that I beat them in fantasy football, you know we get to catch up on other stuff.” Another interviewee described his use of podcasts to keep up with his favorite college football team:

I listen to a lot of podcasts and follow the University of Iowa. Even though I went to Iowa State, I grew up this Iowa Hawkeye fan. So, I just enjoy reading and listening about that school and the athletic programs… [including] analysis of recruits… When the
Saturday game is over, there’s analysis around the game, … around the stats, people, the tackles they had, how many yards they have, how the defense played…

Podcasts enable this interviewee to extend the boundaries of his enjoyment beyond the scope of any given game, and also offer a channel for engagement or escape:

I think I listen to a lot of these when I’m… traveling, so it makes the time go by faster. But when I listen to these podcasts, I’m thinking about nothing else. I’m not worried about work. I’m not worried about anything on the home front. I don’t know if you’d call it my escape, but it just takes my mind off of everything else but that…. I’ll also say it has… a crazy way of helping me fall asleep… because my mind isn’t wandering about 18 different things.

Like GG systems, IR systems help to fulfill the need for hedonic enjoyment, and also serve psychological ownership needs (self-identity and having a place) as well as relatedness and autonomy. Autonomy is perhaps at the heart of “leisure time” when people may freely choose their activities, whether that choice is to immerse oneself in a game of Candy Crush or a football podcast, or to manage sporting activities in either a real or fantasy sense. The fantasy football example mentioned previously fulfills a need for relatedness to family, while two other apps in this category fulfill a similar need managing real athletic activities. In one case, a tennis app helps to establish a place and team identity to “build a team…, find a tournament, … register for that tournament as a captain, … then communicate out to my other players… they register and boom. Then a team is filled and then I can now place that team wherever I need to.” Another interviewee described an app that she uses to track her daughters’ softball leagues:

[P]arents or fans of the team, family… they're able to watch the game online. We have someone that's entering the different plays as the kids are up to bat. And so, they see real-time, every ball and strike in a little condensed [format]... it's a hoot, my mom will call me and say, "Did that really go as far as it looks like it went?" Yes mom, that really was a good hit. Or, "Should she have caught that ball? What happened?" It sounds a little bit crazy but it's a neat way to collect stats and let people be there if they aren't.
This example highlights an online “home” for the softball teams and their fans to have a place, experience hedonic enjoyment by virtually “being there” through technology, and relate to their friends and family by experiencing the game together while physically apart.

IR systems offer gameful affordances to meet the above needs primarily through presence and competition. The examples above suggest that presence, whether through immersion in a single-player experience or a space that is shared by others, is a key ingredient for more intense recreational experiences. Similarly, most of the examples in this category highlight competition as a central element, either as a primary element (competition against the game in Candy Crush) or as a second-order focus (using technology to enhance competitive experiences such as fantasy football and real-world sports). With the softball app described above, “you can also [watch other teams]… there's a team that we don't especially like and we wanted them to lose, if we're being honest. So, we'll watch other teams and root for whoever we want to… It's the coach, it's not… the kids.”

Post hoc analyses indicate that IR systems in our sample are used exclusively outside of work (7 of 7), consistent with the primary analyses and examples. Six of the 7 examples in this category were provided by interviewees in a manager or director role. Further, most of these (4 of 7) are in a mobile app context, consistent with their supporting role in other enjoyable activities. Based on LIWC analyses, IR systems are associated more strongly with leisure, and less strongly with insight, than ED systems, suggesting a focus on hedonic enjoyment needs.

IR systems present an emergent category that is not clearly tied to prior gameful IS literature. Through their focus on enhancing the broader gameful experience of the user, this category of systems goes beyond (but does include) video games that serve purely hedonic purposes. The differences between IR systems and other clusters suggest that additional research
is needed to understand how to design and evaluate such systems. IS literature seldom focuses on primarily hedonic systems, but IS such as IR systems may offer the greatest potential for human enjoyment. In an age of technological distractions, systems that intensify our focus on what’s important to us are certainly worthy of deeper study.

Above, we have described examples of salient needs and affordances in each cluster. To further show the intersection of the clusters with the NAFE framework, Table 2.20 and Table 2.21 highlight the commonly fulfilled needs, and the commonly observed affordances, respectively, in each cluster. These tables are based on the general descriptions of the IS in use in each cluster and the definition of each need and affordance.

**Table 2.20. Emergent Clusters and Needs**

<table>
<thead>
<tr>
<th>Needs</th>
<th>Emergent Clusters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gameplay Adaptation</td>
</tr>
<tr>
<td>Physiological</td>
<td>X</td>
</tr>
<tr>
<td>Safety / Security</td>
<td>X</td>
</tr>
<tr>
<td>Competence</td>
<td>X</td>
</tr>
<tr>
<td>Autonomy</td>
<td>X</td>
</tr>
<tr>
<td>Relatedness</td>
<td>X</td>
</tr>
<tr>
<td>Having a Place</td>
<td>X</td>
</tr>
<tr>
<td>Self-identity</td>
<td>X</td>
</tr>
<tr>
<td>Hedonism</td>
<td></td>
</tr>
<tr>
<td>Eudaimonia</td>
<td>X</td>
</tr>
</tbody>
</table>
Table 2.21. Emergent Clusters and Gameful Affordances

<table>
<thead>
<tr>
<th>Affordances</th>
<th>Emergent Clusters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gameful Adaptation</td>
</tr>
<tr>
<td>Rewards</td>
<td>X</td>
</tr>
<tr>
<td>Status</td>
<td></td>
</tr>
<tr>
<td>Competition</td>
<td>X</td>
</tr>
<tr>
<td>Presence</td>
<td>X</td>
</tr>
<tr>
<td>Embodiment</td>
<td></td>
</tr>
<tr>
<td>Interactivity</td>
<td></td>
</tr>
<tr>
<td>Meta-voicing</td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td></td>
</tr>
<tr>
<td>Collaboration</td>
<td></td>
</tr>
</tbody>
</table>

DISCUSSION AND RESEARCH AGENDA

We discuss the emergent gameful IS categories along two spectra: the work-play context and the submissive modality diagonal of the theoretical model. We situate the emergent clusters in IS literature and propose a research agenda.

**Figure 2.2** depicts the emergent gameful IS clusters, flowing from left to right based on the extent to which they occur in a work (left) vs. non-work (right) context. Focusing primarily on instrumental outcomes, gameful adaptations represent the most work-focused cluster. As work shifts to incorporate additional elements of play and games through enjoyable discovery, both enjoyment and utility of gameful IS increase. Enjoyment and utility continue to rise in parallel as play and work converge in a balance of fun and utility through productive play. We note an interesting divergence as gameful IS shift toward non-work recreational contexts. As enjoyment continues upward on a generally linear trajectory, utility scores begin to drop quickly.
While neither of these trends are surprising individually, their juxtaposition offers several insights that can inspire future research.

**Figure 2.2. Emergent Clusters: Enjoyment and Utility**

First, consistent with prior literature, incorporating fun and enjoyment into instrumental systems can improve both instrumental and experiential outcomes up to a point. While this “tipping point” undoubtedly varies by context (e.g., system, task, user), our findings suggest that the convergence of work and play is, broadly speaking, a positive phenomenon. Second, our findings suggest a “sweet spot” – a peak at which enjoyment and utility have increased to a point that further enjoyment does not detract from instrumentality. This peak represents a gold standard for gamification research and practice: maximum productivity supported by fun. Third, we observe continued and increased enjoyment as gameful IS move away from the work context, paired with a downturn in the utility curve. IS literature has not taken games very seriously.
Petter (2017) and has scarcely considered systems in the intensified recreation space. Games are generative (Petter et al. 2018), and the time, passion, and money that people invest in recreation justify a deeper investigation of how gameful IS can help support the experiences in life that most of us work to achieve.

In relation to the theoretical model, the emergent clusters largely follow the diagonal representing a modality of submission (Sicart 2019). Based on the personal nature of interviews and reluctance to discuss socially undesirable behaviors, the rated and clustered examples contained no examples of “hacking for fun” or “commodified play” – two theoretical categories characterized by a modality of resistance. Future research should consider these theoretical categories and employ methods that are conducive to studying socially undesirable behaviors. We overlay the clusters on the theoretical categories in Figure 2.3. As per the original theory, the intentions of designers and enactments of players occur on a spectrum of instrumental and gameful affordances. We begin discussion in the bottom right (instrumental design and enactment) and move up the diagonal toward the top left (gameful design and enactment). In primarily instrumental scenarios, gameful adaptation incorporates utilities, playful design, and playful attitudes to enhance a workplace experience with elements of fun and games. This cluster is consistent with prior research incorporating hedonic aspects of systems – enjoyment that is helpful, but not essential, to the proper functioning of systems and processes.
Moving upward along the diagonal, we encounter two clusters that incorporate significant mixed or instrumental aspects. Enjoyable discovery shares significant overlap in our sample with the theoretical category of serious games. Serious games have been used for years to teach new concepts and technologies (e.g., Susi et al. 2007), but may also be used in more traditional scenarios (e.g., flight simulators). Enjoyable discovery shifts the focus away from the system itself to how people playfully engage with new opportunities (systems, environments, concepts).

While we did not observe any instances in the analyzed examples, we suggest that enjoyable discovery may share common ground with “hacking for fun” as people try to stretch their abilities, attempt to circumvent controls, and resist authority in the spirit of fun. Productive play is most consistent with the contemporary and theoretical view of gamification as a combination of instrumental and gameful affordances by design and experience. Not all examples in this
cluster fell cleanly into the theoretical gamification / taskification classification, but those that did not tended to exhibit mixed affordances in practice, nonetheless.

In the top left corner of the theoretical model, two clusters share the field. Of the two, generative games are more instrumental (and are occasionally used at work, e.g., video game breaks). Games have not received sufficient attention in IS literature, and given their understudied generative nature we suggest that these systems should comprise a prominent subdomain of IS research. The final cluster, intensified recreation, departs somewhat from the theoretical model in its relative abundance of utilities. Because the utilities in this category support purely (or nearly purely) gameful experiences – by design and enactment – we shift the cluster to the most gameful position. This suggests the need to study gameful IS utilities as two separate classes of IS: one that consist of utilities supporting gameful workplace activities, and the other used to support non-work recreational activities.

Through the interview data collection and analysis process, we made several observations about the nature of the collected data. First, as anticipated during initial theory development, the concept of the IS in use was salient throughout the process. Of the 168 gameful IS identified during the interview process, we noted 138 distinct IS. Of these, 11 were classified in at least two different categories based on their context of use. Future research can develop and enrich theory around gameful IS in use, considering both the focal stakeholder and context-specific goals.

Second, we noticed a variety of construal levels among interviewees when describing systems. As an example, one interviewee discussed “playing Xbox with friends” at a platform level, while another discussed Minecraft as a specific game played on the Xbox. Both are clearly games as entertainment, but the level of construal in each case could lead to additional noise in the data. Other interviewees discussed “video game breaks” or “video game discussions” at an
even higher level than the platform. When observed, we did not attempt to constrain their views
to a specific level, choosing instead a more receptive and conservative approach to capture their
examples in the terms that were most familiar and comfortable. This allowed us to gain insights
into aspects we were interested in during this study, but future research can consider and be
sensitive to the multiple levels of construal of IS in general, and gameful IS specifically.

Third, we were struck by salient differences in focal perspectives as interviewees
described their experiences with gameful IS. A physician described his planned Nintendo Switch
café as a way to “inspire delight” in his clients. As an example of an IS he uses at work, this
positions him as the designer of a playful workplace using technology. During a small group
interview, the team manager described his experience as an observer of a Tableau Hackathon,
highlighting the value of developing talent and evaluating a new tool. His team members
alternately described their positive and negative experiences as players in the competition. When
studying gameful IS in use, researchers should be sensitive to salient focal perspectives. The
same “game” can be seen by different stakeholders in very different ways.

More broadly, we identify a need to investigate these emergent clusters through context-
sensitive theorizing and rigorous empirical research. The emergent clusters represent dynamic
and recurrent experiences rather than more static "designs" (e.g., gamification) or psychological
states (e.g., playful attitude). As such, we should investigate them through a process lens,
thorizing about the recurrent cycles and the roles of instrumentality (i.e., cognition) and
enjoyment (i.e., emotion) in those cycles. In the following essays, we begin this line of inquiry
by studying online competitions as a form of “productive play” in Essay 2, and emotions,
cognitions, and coordination in a team-based business simulation game as a form of “enjoyable
discovery” in Essay 3.
Contributions

This paper makes several contributions to IS research and practice. First, we bring clarity to concepts at the convergence of work and play by developing a theoretically grounded classification of gameful IS, while introducing the concept of gameful IS as an umbrella term to capture the variety of IS related to gameful experiences. In doing so, we adapt and extend the NAF framework (Karahanna et al. 2018) to the context of gameful IS. We incorporate additional classes of needs that are salient in gameful IS, and we integrate NAF with the gamification framework proposed by Liu et al. (2017). By considering the perspectives of both the designer and player using an affordances lens, the proposed categories bring conceptual clarity to a nascent research domain and offer insights for how different types of gameful IS can be studied and evaluated.

Second, we empirically evaluate and refine the proposed classification system using text mining techniques and examples from qualitative interview data. The resulting categories suggest points of alignment with extant literature as well as areas of divergence that offer opportunities for further study. The 5 emergent categories are compatible with the initial theory, but offer a more nuanced and grounded view of IS in use. We suggest that both the theoretical and emergent classifications can inform future conceptual and empirical work on gameful IS.

Within our classifications, we identify several types of gameful IS that warrant further study. Based on the 5 emergent categories, enjoyable discovery and intensified recreation represent two types of gameful IS that can significantly improve work and leisure experiences, respectively. Based on the 9 theoretical categories, we suggest future research at the “corners of resistance” (commodified play and hacking for fun) that, for the most part, did not show up in during our interview process (one example described kids circumventing parental controls on
publicly accessible tablets in order to access adult content – hacking the control software for fun). These more extreme cases are of interest beyond gameful IS, as commodified play is more aligned with traditional business objectives and hacking for fun is quite relevant to theory and practice in deviant behavior and cybersecurity domains.

Third, we highlight the generativity of play through technology based on in-depth qualitative data gathered from working professionals, most of whom are business leaders (12 of 23 in a director or manager role) or highly educated thought leaders (15 of 23 holding post-graduate degrees). The data send a message that play and games are worth studying, not only because humans expend significant resources to enable and engage in leisure activities, but because play and games create value through their inherent instrumentality. This underscores our call to action for increased research of gameful IS.

Fourth, we draw attention to a juxtaposition of the enjoyment and utility functions in gameful IS as they shift from a workplace focus to a leisure focus. Up to a point, both enjoyment and utility improve as gameful and instrumental components are combined. We do not suggest that a single objective “peak” exists across systems, but do propose that this peak should be a design goal for practitioners, an experiential goal for players, and a focal area of contextualized research for scholars. After reaching this peak, the downturn in utility is not inherently negative – it is a phenomenon that warrants additional study in its own right, as we seek to more deeply understand the generative nature of gameful IS and answer questions related to how we can retain or enhance generative aspects of such experiences.

Finally, we offer a modest methodological contribution through our use of two text mining approaches (expectation-maximization using SAS and linguistic inventory using LIWC) to triangulate empirically derived clusters with theoretical classifications. Our approach
combines traditional theory development with the richness of qualitative data to highlight areas of convergence and divergence between theory and practice, triangulated using multiple empirical approaches to unpack the qualitative data using modern text analysis methods.

Overall, we believe this study advances future research in gameful IS by offering theoretical and empirical classifications to enhance the clarity of current terms, support further conceptual development, explain prior inconsistent findings, and increase the practical utility of gameful IS through improved theory.
REFERENCES


Léger, P.M., Robert, J., Babin, G., Pellerin, R. and Wagner, B. 2007, ERPsim, ERPsim Lab, HEC Montréal, Montréal, QC.


APPENDIX 2.1. SEMI-STRUCTURED INTERVIEW GUIDE

I. Introduction of myself

II. Description of the research and objectives … mention: (a) confidentiality … and (b) recording, and that I will send the interview transcript for approval/correction.

III. Interview questions

a. Based on your LinkedIn profile, it looks like you work for <x>, and your position is <y>. It looks like you have <z> IT-related experience. Is there anything else that you would like to add or clarify?

b. Thinking about your work at <company>…

<alternate between a-b and c-d below to ask first, to avoid potential priming or recency bias in subsequent questions>

i. I will define a game broadly as an event with recognizable boundaries and a set of contrived rules that players agree to, and it has some sort of outcome. Does that make sense?

ii. Do you engage in any “games” related to your work, such as friendly competitions, challenges, etc.? These may be part of a normal or official work process, or something unofficial that you and/or your co-workers came up with on your own.

iii. I will define play as a mode of human experience characterized by a readiness to improvise in an ever-changing world, which could be either within or outside the domain of a game. Does that make sense?

iv. Are there times when you feel “playful” at work? This could be as part of a sanctioned activity that was intended to encourage playfulness, or as an aspect of your work that you just find intrinsically or aesthetically appealing.

v. Please provide a specific example of an information system or technology that you have used at work that relates to play or games (it can be one that you have already mentioned if appropriate). What is it? How do you use it?

1. Can you please describe some of your job-related activities with which this system helps you? How? Which features of the system? In what situations? How do these activities enable you to meet your own goals?

2. Overall, on a scale of 1 to 5, where 1 is not at all and 5 is very highly, to what extent does this system help you achieve practical outcomes?

3. Can you please describe some of your activities related to enjoyment or fun at work with which this system helps you? How? Which features of the system? In what situations? How do these activities enable you to meet your own goals?
4. Overall, on a scale of 1 to 5, where 1 is not at all and 5 is very highly, to what extent does this system provide a sense of fun and enjoyment?

c. Outside of work…

i. Please provide a specific example of an information system or technology that you have used outside of work that relates to play or games (it can be one that you have already mentioned if appropriate). What is it? How do you use it?

1. Can you please describe some of your activities related to enjoyment or fun with which this system helps you? How? Which features of the system? In what situations? How do these activities enable you to meet your own goals?

2. Overall, on a scale of 1 to 5, where 1 is not at all and 5 is very highly, to what extent does this system provide a sense of fun and enjoyment?

3. Can you please describe some of your activities related to practical outcomes with which this system helps you? How? Which features of the system? In what situations? How do these activities enable you to meet your own goals?

4. Overall, on a scale of 1 to 5, where 1 is not at all and 5 is very highly, to what extent does this system help you achieve practical outcomes?

d. Now I’ll ask you to think about a specific example of an information system or technology that *someone else* has used at work or outside of work that relates to play or games. What is it? How did they use it?

1. To the best of your knowledge, can you describe some of their activities related to enjoyment or fun with which this system helps? How? Which features of the system? In what situations? How do these activities enable them to meet their goals?

2. Overall, on a scale of 1 to 5, where 1 is not at all and 5 is very highly, to what extent does this system provide them a sense of fun and enjoyment?

3. To the best of your knowledge, can you describe some of their activities related to practical outcomes with which this system helps? How? Which features of the system? In what situations? How do these activities enable them to meet their own goals?

4. Overall, on a scale of 1 to 5, where 1 is not at all and 5 is very highly, to what extent does this system help them achieve practical outcomes?

e. Thinking more generally about yourself and your motivations…

i. What aspects of your work do you consider to be “fun”?

ii. What makes these work activities fun?

iii. What kind of activities do you do outside of work for fun? Why?

iv. With whom do you engage in these activities, and why?
1. Do you consider yourself a “playful” person? Why or why not?
2. Do you consider yourself a “gamer”? Why or why not?
   v. Do you use any (additional) apps or tools in these activities?
   1. What aspects of these tools do you most like?
   f. Is there anything else you would like to share?

IV. Conclusion
   a. Thank you! May I contact you for clarifications or follow-up questions?
   b. In light of our conversation, is there anyone else, especially within your organization, whom you would recommend that I talk to about this topic?

INTRODUCTION

Competition is vital to human progress. We compete for resources (Wernerfelt 1984) and mates (Buss 1988). Seeking to improve, we often measure our worth through comparison with others (Festinger 1954; Gerber et al. 2018). Competition is central to the workplace at both macro (Hunt and Morgan 1995) and micro (Fletcher et al. 2008) levels, as well as to our recreational activities outside of work (Caillois 1962). What makes us want to participate, and to continue in a competition? And how does competition help to drive us forward?

Given the ubiquitous competition in life, research on these questions spans across nearly every domain, including economics (Nash 1951), business (Porter 1985), sociology (Podolny 1993), and psychology (Garcia et al. 2013). Assuming free will, bounded rationality, and complex cognitive-emotional processes that drive decision making, we adopt a psychological perspective to investigate these questions. Competitive behavior is closely linked with social comparison (Festinger 1954), but social comparison literature has focused more on the process of self-evaluation than on the resulting competitive behavior (Garcia et al. 2013). The desire to pursue or sustain a superior relative position stems from a combination of individual and situational factors and results in competitive behavior (Garcia et al. 2013).

Competition typically goes beyond a singular event, whether it is a season of sports with multiple games, a game with several periods, a tournament with numerous rounds, or a video game with infinite replays. Competitive experiences, like many human experiences, consist of cycles of observation, planning, and action. We receive input, process that input to discern its meaning and evaluate our options for action, and generate output in the form of decisions regarding whether and how to move forward. This represents a classic input-process-output (I-P-
O) cycle, with the output of each cycle creating a feedback loop as we evaluate our prior performance as an input to the current cycle. This cyclical process is more accurately portrayed as an input-mediator-output-input (IMOI) model, where mediators\(^{13}\) consist of affective, cognitive, and behavioral mechanisms that transform input into output (Ilgen et al. 2005).

Competitions typically involve players who decide on whether and how to compete based on emotions (affective) and cognitions (cognitive), exert effort (behavioral) to attain desired outcomes, and obtain feedback (input) on their own performance (output) in both absolute and relative terms.\(^{14}\) Feedback is a key factor in competitions, and research emphasizes feedback’s complex effects in motivating behavior and influencing performance (Kluger and DeNisi 1996). Similar challenges exist in understanding the performance impacts of effort (Christen et al. 2006) and emotions (Pessoa 2008). Thus, the nature of the relationships between inputs (individual and situational factors including performance feedback), key mediators related to competition (affective, cognitive, and behavioral), and outputs (i.e., participation and performance) is unclear.

The nature of competition is changing significantly due to the increasing convergence of work and play (Petelczyc et al. 2018) and the rapid progress of information technology. This has led to the emergence of online competitions within and beyond organizational boundaries. Online competitions are used within organizations to engage stakeholders (Leimeister et al. 2009), hold great promise beyond organizations to address “wicked problems,”\(^{15}\) and are also gaining prominence in books and movies (e.g., Ready Player One, The Circle).

\(^{13}\) We use the term mediator throughout the paper in the conceptual sense, consistent with the IOMI model, rather than in the statistical sense.

\(^{14}\) In the present study, we do not hypothesize cognitive effects (but we do measure and control for them) because the study’s context of analytics creates substantial interference in distinguishing the cognitive processes of the players from the analytical nature of the domain. We also consider accumulated effort to be a valuable concept in studying competitions and treat it as an exogenous factor in our model, as elaborated later in the paper.

\(^{15}\) https://fortune.com/2019/09/17/xprize-ceo-anousheh-ansari-mpw-international/
The social comparison perspective of competition suggests six salient situational factors that influence competitive desire and behavior: proximity to a standard, incentive structures, number of competitors, social category fault lines, audience, and uncertainty (Garcia et al. 2013). Online competitions differ from traditional competitions in each of these factors, suggesting salient factors in the omnibus context of online competitions that warrant further study (Johns 2006). We briefly describe each situational factor in Table 3.1 and provide an illustrative difference between traditional and online competitions related to each factor. More generally, effort and participation in traditional competitions are bound by geographical and time constraints, whereas online competitions are broader in terms of when and from where diversely skilled individuals compete. Further, online competitions vary widely in availability and scope, addressing a broad spectrum of challenges, and can involve fluid participation of many competitors (Faraj et al. 2011) at different skill levels (Liu et al. 2013) for higher-profile events.

Table 3.1. Situational Factors in Traditional and Online Competitions

<table>
<thead>
<tr>
<th>Situational Factor</th>
<th>Description</th>
<th>Traditional</th>
<th>Online</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proximity to a standard</td>
<td>Comparison of feedback to a goal state, with proximity increasing competitiveness</td>
<td>Periodic feedback, sometimes subjective and low fidelity</td>
<td>Capability for real-time, high-fidelity objective feedback</td>
</tr>
<tr>
<td>Incentive structures</td>
<td>Extrinsic rewards or meeting intrinsic needs, with value increasing competitiveness</td>
<td>Quasi-voluntary participation</td>
<td>Anonymous and volitional &quot;fluid&quot; participation</td>
</tr>
<tr>
<td>Number of competitors</td>
<td>Lower numbers of competitors increase competitiveness</td>
<td>Low to moderate</td>
<td>Moderate to very high</td>
</tr>
<tr>
<td>Social category fault lines</td>
<td>Differences in social category (e.g., gender, organization) increase competitiveness</td>
<td>More salient</td>
<td>Less salient due to anonymity</td>
</tr>
<tr>
<td>Audience</td>
<td>Larger audiences increase competitiveness</td>
<td>Known volume and identity</td>
<td>Unknown volume or identity</td>
</tr>
<tr>
<td>Uncertainty</td>
<td>Uncertainty about aspects of the environment can increase competitiveness</td>
<td>Less uncertainty in identifying audience and social category fault lines</td>
<td>Less uncertainty in feedback and number of competitors</td>
</tr>
</tbody>
</table>

16 This theory also suggests individual factors including personal and relational factors. We acknowledge the importance of these factors, which have received substantial attention in the literature, while focusing on situational factors and mediating mechanisms most relevant to the IMOI cycle in this study. We empirically control for individual factors using multi-level analytical methods.
Several questions emerge in the light of these differences. For example, regarding proximity to a standard, what components of feedback cycles are key in online competitions? Given the anonymous and fluid participation in such competitions, what mechanisms influence players’ decisions to continue? As prior literature shows, competitive desire drops as the number of competitors rises (Garcia and Tor 2009), so how can very large online competitions succeed?

As discussed earlier: (a) the relationships among feedback, emotions, effort, and performance are unclear in traditional competitions; and (b) the emergent online competitions are quite different in terms of these aspects and their interrelationships. Thus, and recognizing the increasing importance of online competitions within and beyond organizations, this essay seeks to develop a process theory of online competitions (PTOC). The proposed theory is intended to help understand and manage factors that influence participation and performance in online competitions involving fluid participation by autonomous actors.

We develop PTOC primarily at the individual level of analysis by integrating the social comparison model of competition (Garcia et al. 2013) with the IMOI process model (Ilgen et al. 2005). Accordingly, we draw on feedback and social comparison literature (e.g., Festinger 1954; Kluger and DeNisi 1996), and use complementary perspectives in psychological ownership (e.g., Karahanna et al. 2015) and cognitive neuroscience (e.g., Pessoa 2008) literature to develop hypotheses related to the behavioral and affective mediators of effort and emotion, respectively.

Online competitions vary widely in their focus, but often involve “knowledge work” products such as ideas (Schweitzer et al. 2012), innovations (Bullinger et al. 2010), software (Lakhani et al. 2010), and analytics (Martinez and Walton 2014). We focus our empirical study in one context, online analytics competitions, given their practical relevance (Leonardi and Contractor 2018; Ransbotham and Kiron 2018) and research interest (Chiang et al. 2018; Huselid...
2018; Singhal et al. 2018). Although big data and analytics promise to transform organizations and benefit society (Baesens et al. 2016; Chen et al. 2012), the supply of available talent falls short of the demand (PricewaterhouseCoopers 2017). Organizations are therefore seeking innovative ways to leverage collective resources, especially through crowdsourcing (Kittur et al. 2011). Online communities provide an effective medium for crowdsourcing complex problems, and several communities have emerged with the goal of bringing to bear collective human capital to solve problems through big data and analytics. Examples of such communities include DrivenData, CrowdAI, Analytics Vidhya, and Kaggle.\footnote{https://www.drivendata.org/; https://www.crowdai.org/; https://analyticsvidhya.com/; https://www.kaggle.com} To promote greater engagement, these data analytics communities often host competitions as a form of gamified crowdsourcing.

Our empirical context involves discussions, actions, and outcomes in a gamified analytics community. Kaggle is an analytics community hosting numerous competitions, data sets, discussion forums, and learning resources focused on analytics. One of the data sets they offer, Meta Kaggle, focuses on Kaggle’s own operations: data on competitions, participants and teams, submissions, competition forums, and performance data. We provide a partial test of our theory using feedback (input) based on score and leaderboard rank in a competition, positive and negative emotions (affective mediators) in forum posts, accumulated effort (behavioral mediator), and continued participation and performance (outputs). We consider continued participation (via competition submissions) and absolute performance (via score) as desirable outcomes. We consider emotions as mediators of interest, but do not suggest that positive (negative) emotions are desirable (undesirable) \textit{per se}. Instead, we view a combination of positive and negative emotions as essential for regulating the theorized feedback loop and providing a gameful competitive experience to participants (Mullins and Sabherwal 2020).
A Process Theory of Online Competitions (PTOC)

The social comparison model of competition (Garcia et al. 2013) provides an integrative theoretical foundation for examining competitive motivations from a psychological perspective more broadly, and a social comparison (Festinger 1954) perspective more specifically. The premise of this theory is that situational and individual factors influence the degree of comparison concerns, defined as “the desire to achieve or maintain a superior relative position” (Garcia et al. 2013, p. 635). Comparison concerns subsequently influence competitive behavior. Individual factors have dominated social comparison literature, but recent literature has begun to explore situational factors. This theory positions individual factors between an actor and target (i.e., similarity and closeness) and between an actor and a dimension (i.e., individual differences and relevance) as being encompassed or encircled by situational factors. Four situational factors figure prominently in prior research: number of competitors, incentive structures, social category fault lines, and proximity to a standard. Garcia et al. (2013) illustrate prior empirical support for these four factors and propose two additional situational factors that warrant further study: audience and uncertainty.

While this theory offers an excellent starting point for understanding motivations to participate in online competitions and suggests a logical path through which salient factors influence motivation and behavior, it does not address the recurrent process of competing. The proposed path aligns with the classic “input-process-output” (I-P-O) model (e.g., McGrath 1984). Additionally, its focus on social comparison provides key insights into psychological mechanisms, but does not delve deeply into affective, behavioral, and cognitive mediating processes embedded in comparison concerns. Finally, the terminal condition in the social development...
comparison model of competition is competitive behavior (e.g., participation), but we wish to go one step further and consider the resulting performance. We thus turn to IMOI, which integrates a feedback loop from output back to input, and explicitly considers the affective, behavioral, and cognitive mediators that transform inputs into outputs (Ilgen et al. 2005).

The IMOI model was originally developed to describe recurrent team behaviors within organizations during formation, function, and finishing phases (Ilgen et al. 2005). Though developed with the team as a focal unit, many of the proposed processes, including planning, structuring, adapting, and learning, apply to individuals as well as organizations. In addition to the essential nature of feedback in achieving desired outcomes, IMOI unpacks the “process” phase of I-P-O into affective, behavioral, and cognitive mediators, and loosens traditional I-P-O assumptions of linear progression of main effects from one stage to the next (Ilgen et al. 2005). IMOI has been used to explain adaptive performance in teams (Christian et al. 2017), with calls for similar work to study individual adaptive performance (Jundt et al. 2015).

We present the integrated model in Figure 3.1. Dashed-line boxes represent the Garcia et al. (2013) social comparison model of competition and correspond to labels along the bottom of the figure. Solid-line boxes represent the Ilgen et al. (2005) IMOI model stages and feedback loop and correspond to labels along the top of the figure. In the following sections, we develop specific hypotheses to test the model subject to the limitations of our empirical context of online analytics competitions.
We situate PTOC in the specific context of online analytics competitions by narrowing the broader conceptual framework into measurable constructs subject to the limitations of our empirical context. We consider the primary input of interest to be performance feedback that is provided in both an absolute (points) and relative (leaderboard rank) sense, allowing players to assess the situational factor of proximity to a standard. We empirically address the situational factors of the number of competitors and incentive structures via statistical control variables. We suggest that social category fault lines are not salient in large-scale anonymous online competitions, and therefore do not address them in this study. The remaining situational factors (audience and uncertainty) are salient features of the omnibus context and may serve as explanatory mechanisms for observed findings, but are not empirically accessible in our data. We address individual factors, which have been thoroughly studied in the social comparison literature, by adopting a multi-level analytical approach in which effects associated with individual players are controlled for so that we can more deeply consider the role of affective and behavioral mediators in the processing of input into the production of output.
We consider positive and negative emotions as affective mediators, highlighting the important role of emotions in regulating behavior and performance. Because our empirical context involves analytics, we expect confounding effects of cognitive measures (as compared to non-analytics competition contexts) based on forum messages. We therefore do not hypothesize, but do statistically control for, cognitive expression as a mediator. We consider accumulated effort, which we define as the player’s total investment of effort in a competition at a given point in time, as a behavioral mediator.

Finally, we investigate two outcomes of paramount importance in competitions: participation and performance. We consider continued submissions to an online competition to adequately represent participation. We use the same conception of absolute performance (score) as above to represent performance in a competition.

**Theoretical Model**

Feedback influences behavior and performance in complex and nuanced ways (Kluger and DeNisi 1998). Feedback about performance does not consistently have a positive effect on subsequent behavior and performance, and may lead to negative outcomes (Kluger and DeNisi 1996). Similarly, the literature on effort does not universally indicate that greater effort results in increased performance (e.g., Dissanayake et al. 2019). Accordingly, we consider the mechanisms through which feedback and effort influence emotion, participation, and performance.

**Performance Feedback**

In online competitions, positive feedback results in higher positive emotions because it provides a sense of competence, a key intrinsic motivator (Deci and Ryan 2000). This holds for absolute feedback (i.e., score) as well as relative feedback (i.e., rank). Relative feedback
additionally appeals to the intrinsic need for relatedness (Deci and Ryan 2000) in a world where social comparison pushes us to aspire toward higher strata peer groups (Festinger 1954).

Negative feedback, on the other hand, results in higher negative emotions because it provides a signal of lower competence (Deci and Ryan 2000). Absolute feedback gives a more objective assessment of factors under the player’s control than does relative feedback. Negative relative feedback also indicates greater distance to a desired extrinsic (i.e., reward) goal state, and difficulties, interruptions, and frustrations in attaining goal states result in negative affect (Carver and Scheier 1990; Kluger and DeNisi 1996).

More generally, the direction of feedback consistently aligns with the valence of affect, with positive and negative feedback generating positive and negative affect, respectively (Kluger et al. 1994; Venables and Fairclough 2009). Gamified online competitions commonly have two design elements providing salient sources of feedback. Leaderboard rank offers feedback information relative to other players, and competition score offers feedback information on an absolute scale. We propose that positive or negative feedback through either of these mechanisms results in higher positive or negative emotion, respectively.

\[ H1a: \text{Positive relative feedback (higher leaderboard rank) leads to higher positive emotions.} \]

\[ H1b: \text{Positive absolute feedback (higher competition score) leads to higher positive emotions.} \]

\[ H1c: \text{Negative relative feedback (lower leaderboard rank) leads to higher negative emotions.} \]

\[ H1d: \text{Negative absolute feedback (lower competition score) leads to higher negative emotions.} \]

Positive feedback results in continued participation beyond the effects of intrinsic factors (which we propose operate through positive emotions). Positive feedback indicates progress toward desired extrinsic rewards, which may be pecuniary (i.e., monetary rewards for top
performers) or non-pecuniary (e.g., status via community recognition, profile badges, etc.). Progress toward such goals should result in persistence in pursuing the goals. Online community research shows that participants contribute to the community to reach a goal state in the community hierarchy, though contributions may decrease thereafter (Goes et al. 2016). We expect similar mechanisms to operate in more explicit online competitions.

Negative feedback, by contrast, signals a lack of progress toward extrinsic goals, and will therefore be more likely to result in withdrawal from the competition. Beyond the negative effects of emotion, which we also suggest will contribute to withdrawal, negative feedback indicates a lower likelihood of meeting goals for rewards in or through a particular competition. Logically, a player’s time would be better spent pursuing a more attainable goal, or an existing goal through more achievable means. In other contexts, negative feedback leads to goal changes or abandonment (e.g., Hu et al. 2017; Ilies and Judge 2005; Tolli and Schmidt 2008).

While score provides an absolute measure of performance, rank is especially salient as rewards in online competitions are typically tied to a player’s relative position rather than absolute performance.

**H2a: Positive relative feedback (higher leaderboard rank) increases likelihood of continued participation.**

**H2b: Positive absolute feedback (higher competition score) increases likelihood of continued participation.**

**Accumulated Effort**

Accumulated effort represents the player’s total investment of effort in a competition at a given point in time. Prior literature has considered effort at a broader aggregate level via post-competition measures (e.g., Liang et al. 2018) or in a more episodic context (e.g., Dissanayake et al. 2019). While post-competition measures are convenient and can provide broader insights, they lack sufficient detail to help predict behavior within a competition. By contrast, episodic
effort can capture shorter-term effects, but falls short in capturing potential longer-term effects within a competition such as escalation of commitment (e.g., Newman and Sabherwal 1996) and sunk behavioral costs (Cunha and Caldieraro 2009).

Accumulated effort enhances positive emotions because people (players in this case) develop attachment to and affinity for work in which they have invested. As players invest time into a competition, they develop a sense of psychological ownership in their work (Pierce et al. 2001). Similar attachment is seen in consumer products (Fuchs et al. 2010), software development (Barki et al. 2008), and social media (Karahanna et al. 2015). Psychological ownership serves an underlying need to maintain a positive emotional connection between one’s self-identity and the meaningful prior investment of effort (Karahanna et al. 2015; Shu and Peck 2011). This is also consistent with the cognitive bias of the “mere ownership” effect, which posits that people evaluate an object more favorably merely because they own it (Beggan 1992).

**H3a: Accumulated effort results in higher positive emotions.**

We expect similar mechanisms to operate in reducing negative emotions. Effort results in lower negative emotions because players are less likely to see negative aspects in their own work due to positivity bias (Allport 1937; Mezulis et al. 2004). When engaged in a task, momentary effort is shown to predict positive emotions (mediated by performance), and to inversely relate to negative emotions (Fisher and Noble 2004). We suggest that these effort effects are cumulative such that those who are more invested in a gamified online competition are likely to exhibit higher levels of positive emotions and lower levels of negative emotions.

**H3b: Accumulated effort results in lower negative emotions.**

Accumulated effort results in higher likelihood of continued participation because players have a perceived commitment to the competition and to their “product.” This commitment motivates players to engage in behaviors to satisfy their needs for effectance, self-identity, and
having a place, such that players “will be more likely to invest their time, effort, and self into the target of ownership, exercise control over the target of ownership, and come to know the target of ownership more intimately” (Karahanna et al. 2015, p. 188). Psychological ownership is shown to affect commitment (e.g., Dawkins et al. 2017; Van Dyne and Pierce 2004). This is also consistent with the interrelated notions of escalating commitment (e.g., Newman and Sabherwal 1996) and “sunk cost,” which occur across a variety of decision-making contexts (Roth et al. 2015; Sleesman et al. 2012) and imply that decision makers’ investment in a path drives them to continue that trajectory irrespective of performance (Arkes and Blumer 1985; Thaler 1980).

*H4: Accumulated effort results in higher likelihood of continued participation.*

We also suggest that accumulated effort results in higher performance based on the age-old concept of “practice makes perfect.” Prior literature generally shows a positive association between effort and performance (Van Eerde and Thierry 1996). While early efforts in a task may not yield better performance, accumulated effort through practice increases the strength of the effort-performance relationship (Yeo and Neal 2004). Using a similar context to the present study, Dissanayake et al. (2018) consider the reciprocal impact of performance feedback on effort, showing that positive performance feedback results in greater subsequent effort, and that higher performing teams exert greater effort in the later stages of an online competition.

*H5: Accumulated effort results in higher performance.*

**Emotion**

We continue to do the things that we enjoy and avoid the things that we don’t enjoy. Current neuroscience literature suggests that emotional regulation is tied to affective biases in cognitive attention (Todd et al. 2012), such that we attend to positive affective stimuli and avoid negative affective stimuli. Players experiencing positive emotions, because they are enjoying the competition, are more likely to continue participating. Expression of positive emotions may stem
either from positive feedback or from other aspects of the competition (e.g., responses to others’ posts). In one study, better emotional support was associated with higher commitment in discussion forums (Wang et al. 2012). By contrast, in another study emotional tone embedded in newsgroup forums showed no significant effects on continued participation, whether from the original poster or a responder (Joyce and Kraut 2006). Enjoyment in the closely related context of crowdsourcing is shown to increase participation (Ye and Kankanhalli 2017), as well as continuance intention in video games (Hsiao and Chiou 2012) and e-learning (Lee 2010).

**H6a: Positive emotions result in higher likelihood of continued participation.**

Conversely, we expect players experiencing negative emotions to have a lower likelihood of continued participation because they have better things to do than spend time on a task that causes negative emotions such as anxiety or frustration. In the related context of crowdsourcing, decreased enjoyment and increased frustration can result in decisions to disengage with the contest (Kaikkonen 2019). Consistent with flow theory (Csikszentmihalyi 1990), video game players may also disengage when experiencing negative emotions such as frustration or boredom (Sharek and Wiebe 2014).

**H6b: Negative emotions result in lower likelihood of continued participation.**

Positive emotions will result in lower performance in online competitions because these emotions can reflect a sense of confidence and associated complacency. Neuroscience literature indicates complex interdependencies between cognitive and emotional processes (Pessoa 2008). One review indicates that positive mood impairs aspects of cognitive updating, planning and switching processes (Mitchell and Phillips 2007). Positive emotions can also reflect a sense of confidence that may result in “tunnel vision” (Gray 2001) as future efforts continue using a similar approach rather than seeking alternate solutions for better performance. Additionally,
while positive emotions may improve performance in verbal reasoning, they can impede performance on non-verbal reasoning tasks (Bartolic et al. 1999).

**H7a: Positive emotions result in lower performance.**

Conversely, we suggest that negative emotions will result in better performance for those who continue to participate because these players persist with the goal of correcting their mistakes and overcoming their negative experiences. While it is possible or even likely that negative performance feedback and negative emotions decrease the likelihood of continued participation (discussed above), negative emotions do not necessarily impair performance (Eysenck et al. 2007). Consistent with the axiom that we learn more from our mistakes than from our successes, frustration experienced from poor performance can lead to cognitive reappraisal and new approaches to solving a problem (Granic et al. 2014; Mullins and Sabherwal 2020). While reappraisal has been shown to improve performance following negative feedback, suppression (inhibited emotional expression) seems to prevent such gains (Raftery and Bizer 2009). The expression of negative emotions in a public forum signals frustration to the community, which is not suggestive of suppression. The act of posting a message signals continued cognitive engagement in the competition. Additionally, while negative emotions may reduce performance in verbal reasoning, they can improve performance on non-verbal reasoning tasks (Bartolic et al. 1999).

**H7b: Negative emotions result in higher performance.**

**Figure 3.2** presents the research model with hypotheses noted for each depicted relationship. Dotted lines indicate assumed paths.
Figure 3.2. PTOC Model

METHODS

Study Context

Kaggle is an online community for data analytics focused on promoting the learning and practice of analytics through educational resources, publicly shared data sets, and competitions. Kaggle has more than 2.25 million registered users. Kaggle’s competitions are one of its most popular features. Users can browse competitions, review rules, explore competition notebooks, read competition discussions, and choose to participate in one or more competitions as an individual or by forming a team. This study is based on the Meta Kaggle dataset, which contains Kaggle data including competitions, submissions to competitions, team composition, and competition discussion forums. The longitudinal nature of this data permits investigation of temporal aspects of engagement and performance in online crowdsourced competitions. We combine panel data on behaviors and performance feedback with text mining of competition forum discussions to test our model.

18 Kaggle notebooks may contain code (e.g., Python, R) as well as analyses and write-ups related to a competition or data set available through Kaggle.
Data

At the time of download, the raw data for Meta Kaggle included 1,226 competitions, 1.38 million teams (many of which have a single member), 1.41 million team membership records, 3.98 million submissions, 2.46 million users, 18.5 thousand forums, 60 thousand forum topics, and 384 thousand forum messages. We refine the data by focusing on a three-year window of competitions which started on or after January 1, 2016 and finished on or before December 31, 2018. We further refine the data to teams who submitted solutions to at least one competition, and only consider forums directly pertaining to competitions. The refined data set consists of 719 competitions, 156,200 teams, and 2,327,690 submissions (aggregated into 847,313 submission cycles as described below).

We further trim the data set to remove “merged” teams. Kaggle allows teams to merge during a competition, subject to the condition that the total number of merged team submissions does not exceed the total allowable submissions since the beginning of the competition. When Kaggle records team mergers, the Meta Kaggle data set reflects team performance as if the merged team had always worked together (e.g., the best individual performance on a day prior to merging becomes the merged team’s best performance for that day retroactively). To avoid potential confounds introduced by merged team data, we consider only teams that did not merge during the competition.

Unit of Analysis: The Player Submission Cycle

The unit of analysis is the player submission cycle, which we define as the activities occurring since the player’s prior submission or since the beginning of a competition (whichever is most recent), culminating in either a submission or the end of the competition. For example, “Player A” makes three submissions to a competition, which comprise four player submission
cycles: activities prior to the first submission, second submission, and third submission, as well as any activities after the third submission but prior to the end of the competition. Because Kaggle provides some data relevant to our analyses only at the date level, it is not feasible to analyze individual submissions. Additionally, most Kaggle competitions implement a rule for the maximum number of submissions that a player can make each day, suggesting a day as a natural unit of work. We therefore aggregate all submissions in a day and consider that day to mark the end of a current submission cycle.¹⁹

**Figure 3.3** depicts an example of four player submission cycles over the course of a seven-day competition. In this example, the player makes her first submission on Day 2, but has not posted any messages to the forum. This cycle contains no text-based data, and the single submission represents her performance for the first cycle. She then works through day 3 with no submissions but posts a message to the competition discussion forum. On day 4, she posts another message and submits a solution. She adjusts some parameters in her algorithm and submits again before the end of day 4. During the second submission cycle, her messages are aggregated into a single unit for analysis, and the best of the two submissions represents her performance for that cycle. On day 5, she posts again to the forum and makes four submissions to the contest. This third submission cycle contains the forum post and her best performance for that cycle. Because another exciting competition just started, she makes no further submissions after day 5, represented by the fourth submission cycle containing no posts and no submissions.²⁰

---

¹⁹ To achieve this aggregation, and to re-create a daily leaderboard snapshot data based on submission history, we loaded the Meta Kaggle data set into a relational database and used SQL for data manipulation. We will provide additional details about this process upon request.

²⁰ Irrespective of a player’s continued participation, their best submission remains part of the competition and may represent a prize-winning solution at the competition’s end.
Submission data consist of the user, team, submission date, and the public score displayed on the leaderboard. Because players may submit multiple times in the same day, we aggregate data to the day level for two reasons. First, any submission represents that the player was working on the problem that day. Multiple submissions are likely to be part of that work process, seeking incremental feedback for ongoing work. We suggest that the best result from that day is an accurate reflection of the player’s performance for that submission cycle.

Additionally, the data for submission is only available at the date level, so while we can infer the relative ordering of submissions within a day, we are unable to ascertain the time at which any submission was made. Forum message data consist of the competition, date and time, user, topic or thread, and text content of the message in HTML format. Prior to text mining, we remove HTML tags and quoted text (from prior messages) from discussion forum messages to analyze only the distinct content of each message. We then aggregate all forum messages for each player submission cycle into a single string for text analyses.

**Figure 3.3. Submission Cycle Example**
Because it is not feasible to determine when a specific forum message was posted in relation to same-day submissions, we operationalize the submission cycle in two different ways. To test hypotheses involving text-related factors (e.g., emotion) as the dependent variable (DV), we include all forum message text from the day after the previous submission up through the day of the current submission. We then use a one-cycle lag for performance measures, guaranteeing that the previous cycle’s work ends before the current cycle’s messages are posted. Conversely, to test hypotheses involving text-related factors as independent variables (IVs), we include forum message text from the day of the previous submission up through the day prior to the current submission. We then use a one-cycle lag for text-related measures, guaranteeing that the previous cycle’s messages are completed before the current cycle’s work begins.

To summarize, the unit of the analysis is the player submission cycle, which represents a natural unit of activity that spans from the day following prior submission (or competition start) until the day of the next submission (or competition end). Given this study’s process focus, we consider DVs at all stages of the process, including continued participation, emotions expressed in discussions, and submission performance.

Performance and Performance Feedback

We operationalize performance feedback in two ways: score and leaderboard rank. Due to differences in evaluation metrics between competitions, lower scores may be better in some competitions (e.g., where the metric is root mean square error) while higher scores may be better in other competitions (e.g., where the metric is classification accuracy). Additionally, the range and scale of scores may vary widely even between competitions with identical evaluation metrics. To account for this, we standardize scores by competition and multiply the resulting score by -1 for competitions where lower scores are better (thereby ensuring that “better” scores...
are always positive). As noted previously, we consider only the player’s best score for each submission cycle. For the analysis of performance as a DV, we only consider the score. While correlated ($r = 0.46$ in our sample), rank is not a suitable DV because it is (1) more dependent on the performance of others in the competition, and (2) based on the player’s best score to date rather than their best score for the submission cycle (and therefore may result from activities during previous submission cycles). As a measure of performance feedback, we calculate the leaderboard rank as $1 - ((\text{RawRank} - 1) / (\text{CurrentTeamCount} - 1))$ to represent the proportion of competitors that are behind the focal player, where RawRank is the leaderboard position and CurrentTeamCount is the number of players currently in the competition (e.g., a player ranked 3 of 150 = 0.987, indicating that 98.7% of competitors are ranked lower than the focal player).

**Text Mining for Emotions and Cognition**

We use text mining to analyze communication on competition discussion forums using the Linguistic Inquiry and Word Count (LIWC) text analysis software,\(^{21}\) which is a “transparent text analysis program that counts words in psychologically meaningful categories” (Tausczik and Pennebaker 2010, p. 24). This software is commonly used in IS literature to analyze text communication (e.g., Yin et al. 2016), and is capable of distinguishing words that characterize common emotions (e.g., anxiety, anger, and sadness) and cognitions (e.g., insight, cause, certainty). Specifically, we use the parent categories of positive emotions (posemo), negative emotions (negemo) and cognitive processes (cogproc) reported by LIWC in our analyses.

We aggregate all messages posted to the competition discussion forum by a player during each submission cycle into a single field for text analyses, thus capturing competition-relevant public communication by the player during that period. LIWC provides proportions for each

\(^{21}\) http://liwc.wpengine.com/.
category (e.g., a posemo value of 10 indicates that 10 percent of the words in the text relate to positive emotion), which we use to represent the player’s relative emphasis on positive emotions, negative emotions, and cognitions in forum posts. We inspected histograms and Q-Q plots of the three variables and noted substantial right skewness in the data. To adjust for this, we use a natural log conversion of each variable for subsequent analyses.

**Continued Participation and Accumulated Effort**

We operationalize continued participation in two ways: as a binary variable for each submission cycle indicating whether a submission was made, and as the time between submissions. To measure the related concept of accumulated effort, we use the number of submissions to date (at the beginning of a cycle), representing the total effort that a player has invested in the competition thus far. We consider the total number of submissions to date to adequately represent accumulated effort in the competition, as it reflects persistence by including elements of both duration (due to the maximum daily submission limit) and the number of submissions on active days in aggregate. We do not consider effort at the submission cycle level as a suitable DV due to the nature of the competitions and data. To illustrate, consider a player who submits one solution in a day that was the culmination of three days of work. Another player submits five solutions in a day, with each solution being a minor change to model parameters from the prior day’s submission. Clearly, the first player exerted greater effort, but the data do not reflect this.

---

22 When analyzing text measures as IVs, to avoid losing records if any of three text measures was not detected in a message, we first add a nominal value of 0.001 to each variable. When analyzing text measures as DVs, we are interested in the extent of emotions expressed in a message. Because we are interested in the extent of expressed emotions as a DV rather than its presence, and because panel regression is unsuitable for a DV with a zero-inflated distribution, we do not add a nominal value to each variable prior to natural log transformation.
Controls

More than 90% of teams contain a single member, irrespective of merge status. Even so, team size may influence participation, performance, and emotional expression, so we include it in all analyses as a control variable, and suggest that it represents a salient “individual difference” factor. We include number of competitors and a binary indicator of monetary rewards (presence = 1) as situational controls. We also include cognitive word proportion as a control, representing the cognitive mediator in the IMOI model.\(^\text{23}\) We present the constructs for the model, their conceptual counterparts, and empirical measures in Table 3.2.

Table 3.2. Concepts, Constructs, and Measures

<table>
<thead>
<tr>
<th>Concept</th>
<th>Construct</th>
<th>Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotions / Cognition</td>
<td>Positive emotions</td>
<td>In of positive emotions word proportion</td>
</tr>
<tr>
<td></td>
<td>Negative emotions</td>
<td>In of negative emotions word proportion</td>
</tr>
<tr>
<td></td>
<td>Cognition (control)</td>
<td>In of cognitive word proportion</td>
</tr>
<tr>
<td>Continued participation</td>
<td>Submission cycle survival</td>
<td>Competition submission (binary)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Time to submission (days)</td>
</tr>
<tr>
<td>Performance feedback</td>
<td>Leaderboard rank</td>
<td>Percentage of competitors trailing the focal player based on public leaderboard</td>
</tr>
<tr>
<td>/ Performance</td>
<td>Score</td>
<td>Best score during the current submission cycle (standardized by competition)</td>
</tr>
<tr>
<td>Effort</td>
<td>Accumulated effort</td>
<td>Submissions to date as of the start of each submission cycle</td>
</tr>
<tr>
<td>Number of competitors</td>
<td>Total competitors</td>
<td>Number of teams/players in the competition</td>
</tr>
<tr>
<td>Incentive structures</td>
<td>Monetary rewards</td>
<td>Boolean value indicating presence (1) or absence (0) of monetary rewards</td>
</tr>
<tr>
<td>Team size</td>
<td>Team Size (control)</td>
<td>Number of team members</td>
</tr>
</tbody>
</table>

We report descriptive statistics and correlations based on the adjusted data set as described above. The largest reduction in size resulted from retaining only player submission cycles during which the player posted a message to the discussion forum (29,623 in the initial data set), followed by the reduction for merged teams (affecting 7,185 submissions). We also

\(^{23}\) We do not include cognitive processes as a control for analyses where emotions are the DVs because the two are measured using the exact same text.
eliminate records for submissions that are more than five standard deviations below the mean for performance because results that distal from a meaningful standard of performance indicate significant departures from “competitive” assumptions (affecting 40 submissions). After also eliminating records without a submission (a submission cycle is recorded for each player if her final submission was not on the same day as the competition’s end), and those that recorded submissions before the competition start date, we base summary statistics and subsequent analyses on the remaining 17,771 records.\textsuperscript{25} Table 3.3 provides the summary statistics.

<table>
<thead>
<tr>
<th>Construct</th>
<th>Mean</th>
<th>S.D.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Score</td>
<td>0.19</td>
<td>0.56</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Rank</td>
<td>0.81</td>
<td>0.22</td>
<td>0.455</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Submissions to Date</td>
<td>38.77</td>
<td>46.47</td>
<td>0.160</td>
<td>0.381</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 ln(Positive Emotion)</td>
<td>-1.33</td>
<td>4.75</td>
<td>-0.015</td>
<td>-0.004</td>
<td>0.020</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 ln(Negative Emotion)</td>
<td>-4.95</td>
<td>4.91</td>
<td>0.019</td>
<td>-0.001</td>
<td>0.011</td>
<td>0.165</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 ln(Cognitive Process)</td>
<td>1.62</td>
<td>3.32</td>
<td>-0.011</td>
<td>-0.009</td>
<td>0.003</td>
<td>0.162</td>
<td>0.225</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 Competitors</td>
<td>2886.24</td>
<td>1667.79</td>
<td>0.028</td>
<td>0.035</td>
<td>0.194</td>
<td>0.064</td>
<td>0.001</td>
<td>0.019</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 Monetary Rewards</td>
<td>0.91</td>
<td>0.28</td>
<td>0.032</td>
<td>-0.062</td>
<td>-0.056</td>
<td>-0.022</td>
<td>-0.013</td>
<td>-0.010</td>
<td>0.126</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>9 Team Size</td>
<td>1.13</td>
<td>0.75</td>
<td>0.039</td>
<td>0.064</td>
<td>0.085</td>
<td>-0.006</td>
<td>0.005</td>
<td>-0.005</td>
<td>0.005</td>
<td>0.038</td>
<td>1</td>
</tr>
<tr>
<td>Max</td>
<td>3.587</td>
<td>1.000</td>
<td>555</td>
<td>4.605</td>
<td>4.605</td>
<td>4.605</td>
<td>7198</td>
<td>1</td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min</td>
<td>-4.993</td>
<td>0.000</td>
<td>1</td>
<td>-9.210</td>
<td>-9.210</td>
<td>-9.210</td>
<td>5</td>
<td>0</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes. N = 17,771 with listwise deletion; p < 0.05 for all correlations > |0.015|.

Each competition may vary in its scale, incentive structure, and subject matter. Each player\textsuperscript{26} may vary in background, skill level, and motivation. We therefore employ multi-level analytical techniques to account for differences across competitions and players in panel analyses, which we describe in the next section.

\textsuperscript{24} These records are not included in the correlation matrix because they do not contain performance data (N = 20,222 for survival analyses incorporating these records, 17,771 of which included a submission).

\textsuperscript{25} This sample size is for the largest analysis with continued participation as the DV. Analyses predicting performance are smaller due to lag variables, and analyses predicting emotions are smaller due to lag variables and the condition that emotional content appears in the discussion activity during the player submission cycle.

\textsuperscript{26} We use the term “player” to refer to a competitive unit engaged in a competition. Kaggle uses the term “team,” though as previously noted more than 90% of teams consist of a single member.
**Analyses and Results**

To test H1 and H3 (predicting emotions), we use mixed-effects panel regression. The submission cycle measures are all at the player level in this study. In panel-data analyses, observations (submission cycles) are level 1 variables, nested within players over time. We calculate the intra-class correlation (ICC) using an intercept-only model (using the *mixed* command in Stata) to estimate the similarity of performance between the player’s submissions within each competition (Bliese 2000). Additionally, each submission cycle occurs within the context of a particular competition. We therefore consider two levels of potential nesting within this data: the player within the competition and the player over time. We calculate ICCs using intercept-only models and compare two- and three-level models using likelihood ratio tests.

For positive emotion, the ICC between submission cycles of the same player is 0.22. The three-level model indicates a competition ICC of 0.03. While below the suggested level of 0.05 (Hayes 2006), a likelihood ratio test suggests a significantly better fit for the 3-level model ($\chi^2 = 204.78$).

For negative emotion, the ICC between submission cycles of the same player is 0.21. The three-level model indicates a competition ICC of 0.02. Similarly, despite the relatively low ICC at the competition level, a likelihood ratio test suggests a significantly better fit for the 3-level model ($\chi^2 = 75.04$). We therefore estimate emotions outcomes using a three-level mixed-effects panel regression model with restricted maximum likelihood in Stata. Though most players in this context are individuals, some are embedded within teams. In addition to specifying player-level fixed effects using multilevel panel regression, we further account for potential team effects by controlling for team size in all analyses. **Table 3.4** presents the results.
Table 3.4. Predicting Emotions

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Positive Emotion</th>
<th>Negative Emotion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent Variable</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance Feedback</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Score (-1)</td>
<td>-0.0072 (.0202)</td>
<td>-0.0502* (.0257)</td>
</tr>
<tr>
<td>Rank (-1)</td>
<td>0.1035* (.0560)</td>
<td>0.0988 (.0711)</td>
</tr>
<tr>
<td>Accumulated Effort</td>
<td>0.0003 (.0002)</td>
<td>-0.0007** (.0003)</td>
</tr>
<tr>
<td>Competitors</td>
<td>0.0000** (.0000)</td>
<td>0.0000 (.0000)</td>
</tr>
<tr>
<td>Monetary Rewards</td>
<td>-0.0499 (.0692)</td>
<td>-0.0038 (.0729)</td>
</tr>
<tr>
<td>Team Size</td>
<td>0.0018 (.0139)</td>
<td>0.0438 (.0313)</td>
</tr>
<tr>
<td>Log restricted-likelihood</td>
<td>-10,113.95</td>
<td>-5,678.28</td>
</tr>
<tr>
<td>Wald $\chi^2$ (6)</td>
<td>23.5**</td>
<td>12.91*</td>
</tr>
<tr>
<td>$N_{\text{obs}}$</td>
<td>8,225</td>
<td>4,718</td>
</tr>
<tr>
<td>$N_{\text{comp}}$</td>
<td>98</td>
<td>91</td>
</tr>
<tr>
<td>$N_{\text{players}}$</td>
<td>3,769</td>
<td>2,512</td>
</tr>
</tbody>
</table>

Notes. * $p < 0.05$, ** $p < 0.01$ for hypothesized effects using 1-tailed $t$-tests; standard errors in parentheses.

Higher rank on the leaderboard during the prior submission cycle is associated with higher expression of positive emotion, supporting H1a, but higher score during the prior submission cycle is not. Thus, H1b is not supported. Conversely, higher score in the prior submission cycle is associated with lower expression of negative emotion, supporting H1d, while higher ranking shows no effect on negative emotion, not supporting H1c. This interesting pattern suggests salience of different gamified design elements for different outcomes. Accumulated effort is associated with lower levels of negative emotion, supporting H3b. However, we did not find support for H3a that greater effort is associated with higher levels of positive emotion. Among the control variables, the number of competitors is associated with greater positive emotion, potentially indicating a general tendency toward positivity with larger audiences.

To test H5 and H7 (predicting performance), we use a similar analytical approach to account for nested structures within the data. By standardizing by competition prior to analyses,
we account for performance differences at the competition level. However, repeated submission cycles for a player within a competition are expected, so we account for unobserved heterogeneity between players by adopting a multi-level analytical approach. Based on a 2-level intercept-only model, the resulting ICC value of 0.93 clearly indicates a nested structure. To predict performance, we therefore use 2-level mixed effects panel regression with restricted maximum likelihood in Stata. We lag emotions and cognition measures by one period to ensure temporal antecedence. As with H1 and H3, we account for team size as a control. Table 3.5 presents the results of this analysis.

<table>
<thead>
<tr>
<th>Table 3.5. Predicting Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent Variable</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td><strong>Predictor</strong></td>
</tr>
<tr>
<td>Accumulated Effort</td>
</tr>
<tr>
<td>Prior Submission Language</td>
</tr>
<tr>
<td>Positive Emotion_{t-1}</td>
</tr>
<tr>
<td>Negative Emotion_{t-1}</td>
</tr>
<tr>
<td>Cognitive Process_{t-1}</td>
</tr>
<tr>
<td>Competitors</td>
</tr>
<tr>
<td>Monetary Rewards</td>
</tr>
<tr>
<td>Team Size</td>
</tr>
<tr>
<td>Log restricted-likelihood</td>
</tr>
<tr>
<td>Wald χ² (7)</td>
</tr>
</tbody>
</table>

\[\text{Notes.} \quad ^* p < 0.05, \quad ^{**} p < 0.01 \text{ for hypothesized effects using 1-tailed t-tests; standard errors in parentheses.}\]

The results indicate that positive emotions during one submission cycle are associated with lower performance in the subsequent cycle, supporting H7a. Conversely, negative emotions during one submission cycle are associated with higher performance in the subsequent cycle, supporting H7b. This finding supports an essential component of the proposed self-correcting feedback loop as negative emotions improve performance while positive emotions reduce it. The
feedback subsequently generates congruent emotional responses to maintain competitive balance. Accumulated effort, reflecting the trial-and-error learning since the start of the competition, is also associated with higher performance for a submission cycle, supporting H5.

Among the control variables, the presence of monetary rewards does appear to motivate better performance, consistent with the goals of sponsored analytics competitions. The number of competitors negatively influences performance, suggesting that larger competitions attract highly skilled competitors in the top ranks, leading to lower standardized performance for most players. Cognitive expression in discussions also shows a negative association with performance, perhaps indicating that players who request for help about analytical details, especially in online competitions focusing on analytics, may be struggling to perform well.

We test H2, H4, and H6 (predicting continued participation) using survival analysis, a technique to analyze the time to occurrence of an event based on survival and hazard functions with non-linear distributions (Cleves et al. 2008). Survival analysis permits estimation of both the occurrence of some future event and the amount of time elapsed before that event occurs (Kleinbaum and Klein 2010). Traditional methods, such as logistic regression, are limited as they do not account for the duration of activity periods or right censoring of data, both of which are important when assessing the likelihood of continued participation in online competitions that sometimes span long periods of time. For survival analysis, we use the Cox (1972) proportional hazards model as it is robust to a variety of conditions and distributional assumptions.

Survival analysis accounts for the duration of activity periods in addition to proposed IVs to predict the probability of survival at each observation point. The activity periods of interest in this study are player submission cycles. Whereas many survival analyses focus on the probability of a terminal event such as market exit (e.g., Kanat et al. 2018) or customer defection (e.g.,
Scherer et al. 2015), our interest is in predicting a desirable recurring event, i.e., continued participation in an analytics competition via solution submission. To account for multiple events, we use a conditional risk set model (Prentice et al. 1981) in which events are identical (Andersen and Gill 1982) and the data are stratified by event order based on the assumption that a subject is not “at risk” for a second event until the previous event (submission) has occurred.

We prepare the data as a set of ordered events (submission cycles), with each event indicating via a flag whether the player made a submission. If a player did not make a submission on the final day of the competition, the flag is set to 0 for that record. For all other submission cycles, the flag is set to 1. This represents a time-varying set of submission cycles that are right censored by the end of a competition, with failure to submit on the final day marked as 0. We are, in effect, evaluating the probability that a player will submit another attempt to a competition on a given day based on the IVs. We specify the competition end date as the exit time, and the competition start date as the origin time. To account for ordered events, we create a variable to represent the sequence of submission and specify this as the basis for stratification. To account for delayed entry into a competition, we specify the entry time as the player’s (team’s) registration date for that competition. We analyze this data using the stcox command in Stata with Efron (1977) approximation for ties and present the results in Table 3.6.
Table 3.6. Predicting Continued Participation (Survival)

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Coefficient</th>
<th>SE</th>
<th>Hazard Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accumulated Effort</td>
<td>0.0125**</td>
<td>.0013</td>
<td>1.0125</td>
</tr>
<tr>
<td>Performance Feedback Score</td>
<td>0.0826**</td>
<td>.0216</td>
<td>1.0862</td>
</tr>
<tr>
<td>Performance Feedback Rank</td>
<td>0.3395**</td>
<td>.0712</td>
<td>1.4042</td>
</tr>
<tr>
<td>Submission Cycle Language Positive Emotion</td>
<td>-0.0084**</td>
<td>.0032</td>
<td>0.9917</td>
</tr>
<tr>
<td>Submission Cycle Language Negative Emotion</td>
<td>-0.0165**</td>
<td>.0031</td>
<td>0.9837</td>
</tr>
<tr>
<td>Submission Cycle Language Cognitive Process</td>
<td>-0.0009</td>
<td>.0045</td>
<td>0.9991</td>
</tr>
<tr>
<td>Competitors</td>
<td>0.0000*</td>
<td>.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>Monetary Rewards</td>
<td>-0.0404</td>
<td>.0544</td>
<td>0.9604</td>
</tr>
<tr>
<td>Team Size</td>
<td>0.0106</td>
<td>.0181</td>
<td>1.0106</td>
</tr>
</tbody>
</table>

Log pseudo-likelihood: -61,637.27
Wald $\chi^2$ (9): 221.25**

**Notes.** * p < 0.05, ** p < 0.01 for hypothesized effects using 1-tailed t-tests; standard errors in parentheses.

Increases in both positive and negative emotions are associated with a lower likelihood of continued submission. While this supports H6b, the findings are in opposition to H6a. As expected, greater prior effort is associated with a higher likelihood of continued participation, supporting H4 and indicating a level of dedication to the competition. Performance in the prior submission cycle, both in terms of leaderboard rank and score, is positively associated with continued submission, supporting H2a and H2b.

Among the control variables, the number of competitors is positively associated with continued participation, in contrast to a large body of psychology literature (Garcia et al. 2013). This illustrates an important difference between traditional competitions and online competitions, as it appears that participants in larger-scale, mostly anonymous, and highly
volitional online competitions tend to persist in competitions, at least in part, as a result of the crowd. This may relate to the blurring distinction between producers (competitors) and consumers (audience) in online channels (Bird 2011). Table 3.7 summarizes the results.

<table>
<thead>
<tr>
<th>Relationship</th>
<th>Result</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1 Performance feedback → Emotion</td>
<td>Partial</td>
<td>A deterioration in absolute performance feedback (score) increases negative emotions but does not affect positive emotions. An improvement in relative feedback (leaderboard rank) increases positive emotions but does not affect negative emotions.</td>
</tr>
<tr>
<td>H2 Performance feedback → Participation</td>
<td>Supported</td>
<td>Improvements in both absolute performance feedback (score) and relative performance feedback (rank) increase likelihood of continued participation.</td>
</tr>
<tr>
<td>H3 Effort → Emotions</td>
<td>Partial</td>
<td>Accumulated effort reduces negative emotions but shows no effect on positive emotions.</td>
</tr>
<tr>
<td>H4 Effort → Participation</td>
<td>Supported</td>
<td>Accumulated effort increases likelihood of continued participation.</td>
</tr>
<tr>
<td>H5 Effort → Performance</td>
<td>Supported</td>
<td>Accumulated effort improves performance.</td>
</tr>
<tr>
<td>H6 Emotions → Participation</td>
<td>Mixed</td>
<td>Negative emotions and positive emotions both decrease the likelihood of continued participation, counter to the expectation that positive emotions would have a positive effect.</td>
</tr>
<tr>
<td>H7 Emotions → Performance</td>
<td>Supported</td>
<td>Negative emotions improve performance, while positive emotions reduce performance.</td>
</tr>
</tbody>
</table>

The hypothesized effects might differ depending on the temporal stage of a competition (e.g., early, middle, late). Therefore, we conducted robustness tests for each analysis by including dummy variables for early-stage submissions (earliest one-third of the competition time frame) and late-stage submissions (latest one-third of the competition). Consistent with the idea that learning occurs as players advance in the competition, early-stage and late-stage submissions result in lower and higher scores (as compared to the default category of middle-stage), respectively. Early-stage and late-stage submissions result in higher and lower likelihood of continued participation (as compared to middle-stage), consistent with a waning of competition interest over time. We find no significant effects of early- or late-stage submissions.
on positive or negative emotions. Overall, we do not find a significant difference in these results compared to the main results in terms of the hypothesized effects.\footnote{Of 14 hypotheses, results for 0.7 hypothesis would change due to chance alone (p = 0.05). We found that the result of 1 hypothesis changed from significant to non-significant (none changed on the reverse direction). A chi-square test indicates that results are consistent with the main analyses (p = 0.001). In the robustness test, H2a (rank $\rightarrow$ participation) becomes non-significant, with the overall implication that H2 would be partially, rather than fully, supported.}

**DISCUSSION**

Taken together, the results suggest a self-correcting cycle of feedback, emotion, and action that can inform research and practice about the processes through which players participate in online competitions.

First, we unpacked the effects of two types of performance feedback and emotions on continued participation in online competitions, in addition to observing a positive effect of accumulated effort. Consistent with our predictions, positive feedback is positively associated with continued participation (H2). Those who are performing better, in both an absolute (score) and relative (rank) sense, are more likely to keep playing. This is generally unsurprising, and inherent in any competitive enterprise. It is also generally desirable, as better performers continue to innovate and increase the likelihood of a winning solution – an excellent outcome for the competition sponsor as well as the winning players.

As expected, negative emotions are associated with a lower likelihood of continued participation (H6b). Contrary to our prediction, positive emotions are associated with a lower likelihood of continued participation (H6a). This may indicate that players expressing positive emotions at this stage have adopted a more complacent focus and “quit while they are ahead.”

Moreover, we examined the effects of two types of performance feedback on emotions (H1) and found mixed support for our expectations. Absolute performance feedback only affects
negative emotions (specifically, deterioration in absolute feedback increases negative emotion), whereas relative performance feedback only affects positive emotions (specifically, improvement in relative feedback increases positive emotion). While lower relative performance (rank) may signal lower chances of attaining desired extrinsic rewards, it reflects less directly on the player’s competence and can even trigger feelings of admiration for those who are performing better (Smith 2000), thus offsetting negative feelings. By contrast, higher relative performance increases expressions of positive emotions in discussion forums (and lower ranks conversely decrease them), while competition score shows no effect on positive emotion. This could be due to the more social nature of discussion forums and an associated likelihood that social comparison will more likely manifest in positive emotions in a social setting. Competition score, on the other hand, may not be cause for public celebration, particularly if the score did not accompany a commensurate improvement in performance relative to other competitors. Future research can test these potential explanations and bring greater clarity to the conditions under which different design features elicit positive and negative emotional responses.

We also hypothesize and find support for contrasting (and somewhat counterintuitive) effects of positive and negative emotions on performance (H7). For those who persist, negative emotions improve performance, consistent with the view that critical evaluation and creative solutions associated with cognitive reappraisal and growth are congruent with negative feedback and emotions (Van Dijk and Kluger 2011). Consistent with this argument, positive emotions show a negative effect on performance, reinforcing the idea that feedback, emotion, and performance have a complex relationship. In this case, positive emotions suggest the confidence and competence associated with impaired cognition or “tunnel vision” and a quiescence to the status quo or incremental progress. Thus, negative emotions can be generative, and positive
emotions can be detrimental. Combined with our findings that positive and negative feedback increase positive and negative emotions, respectively, this suggests that online competitions involve self-correcting feedback loops that tend toward equilibrium (Robertson 1991).

As expected, greater effort results in greater performance (H5). To the extent that communities can encourage participation, they are likely to generate better solutions to challenging problems such as those posed in the worldwide analytics competitions on Kaggle, and the effect of accumulated effort on continued participation suggests that effort results in continued commitment to a competition (H4). Accumulated effort is also associated with fewer negative emotions (H3), which could result in lower performance (H7). This represents bit of a conundrum, as organizations and communities want to maximize participation and the effort itself exhibits a positive direct effect on performance. We present the emergent model in Figure 3.4. Solid lines indicate positive effects, and dashed lines indicate negative effects that we observed in this study.

![Figure 3.4. Emergent Model](image)
In comparing our results to predictions from the social comparison model of competition, our findings are congruent with the prediction that positive performance feedback increases competitive effort (i.e., continued participation). However, the results indicate that the presence of monetary rewards is associated with higher performance but does not significantly affect competitive effort. As noted previously, contrary to prior social comparison research, we find a positive impact of the number of competitors on competitive effort, which may relate to the blurring distinction online between other players and audience members.

**Limitations**

The results of this study should be viewed in light of its limitations. By integrating the social comparison model of competition with the IMOI model, we present PTOC, a theory highlighting the self-correcting feedback loop of participation and performance in online competitions. Due to the limitations of our empirical context, we are unable to test some aspects of the full theory. Specifically, future research should investigate untested aspects of this theory, including the role of cognitive mediators, the antecedents of effort, and the impact of other salient individual and situational factors in online competitions. Moreover, further research is needed to examine whether our findings within the Kaggle context generalize to online competitions within organizational settings.

We include two situational aspects as controls in the present study: number of competitors and monetary incentives. Monetary incentives influence performance but had no direct effect on emotions or continued participation in our study. Based on our results, larger competitions (i.e., more total competitors) tend to increase the likelihood of continued participation. This result departs from prior research indicating that competitive desire and behavior decrease based on the number of competitors. Future research can delve more deeply
into this topic to replicate these findings and seek explanatory mechanisms for this apparent
effect of the omnibus online competition context.

The discrete context of this study, Kaggle analytics competitions, offers a suitable and
relevant (theoretically and practically) setting for an initial test of PTOC. However, some
limitations of the context limit our ability to fully test the model (e.g., conflation of cognitive
processes in analytics discussions). Future research should consider other online competition
contexts such as online idea and innovation competitions, crowdsourced coding competitions,
and even online gaming environments such as eSports (Hamari and Sjöblom 2017).

Implications for Research

This paper makes several contributions to theory. First, we present a process theory of
online competitions (PTOC), at the heart of which is a self-correcting feedback loop in which
feedback, emotions, and performance contribute to a state of relative equilibrium. Accumulated
effort influences negative emotions, performance, and continued participation as a natural
regulator that can reinforce or disrupt the equilibrium. The online nature of these competitions is
differentiated from traditional competitions by high fidelity and often instantaneous feedback,
potential for greater scale, and fluid participation of autonomous actors. As such, organizations
and players must account for these factors, and modern technology offers promising avenues for
optimizing the instrumental and experiential outcomes of online competitions. Future research
can more deeply investigate the effects of effort in this feedback loop and should also consider
more specific contextual factors such as player characteristics (e.g., goal orientation, self-
efficacy) that were not observable in this study. Additional research can also investigate the
unexpected negative effect of positive emotions on continued participation, and the differential
effects of performance feedback types on emotions.
Second, we find interesting differences between absolute and relative performance feedback in online competitions in terms of their effects on emotions. Whereas absolute performance feedback affects negative emotions, relative performance feedback affects positive emotions, although the effects are consistent in nature; negative absolute feedback increases negative emotions whereas positive relative feedback increases positive emotions. The two types of performance feedback have similar effects on participation, with positive feedback of either kind improving participation.

Third, we make a methodological contribution to the IS literature by illustrating how survival analysis can help predict repeated desirable outcomes such as continued use. To our knowledge, this is the first IS study to use multiple event conditional risk set analysis to predict desirable events. Future work can incorporate similar techniques in other areas of IS research where the probability of desirable outcomes and duration of episodes are of interest. By pairing text mining with survival analysis and multi-level mixed-effects panel regression, we were able to test our process model of online competition. Future research should continue to employ mixed methods to present the most complete and accurate assessment of theory.

Finally, we draw attention to nuance in the level of analysis in studying naturally episodic IS use behaviors. Nearly all IS use is episodic, but it is uncommon for research to conceptualize and measure IS use based on naturally occurring episodes. In the context of online competitions, we situate the level of analysis as the player submission cycle, which represents a natural unit of focused effort during a competition. We suggest that future research can be more sensitive to the context of episodic use by conceptualizing, measuring, and analyzing data in ways that are congruent with natural IS use patterns. As the availability of data continues to increase, we must find increasingly better ways to model the reality that our theories are intended to represent.
Implications for Practice

From a practical standpoint, the study has potential implications regarding the design elements and feedback mechanisms to keep players engaged in online competitions.

The Conundrum of Negative Feedback

Negative feedback increases negative emotion, which can in turn improve performance, and that improved performance would subsequently lead to positive feedback and positive emotions that would reduce performance, which would lead to negative feedback, and so on. This apparent self-sustaining cycle is interrupted due to both positive and negative emotions increasing the likelihood of withdrawal. Some individuals who focus on the task at hand and express less emotions – positive and negative – may continue to participate. But how can organizations maximize desirable outcomes for others while avoiding the detrimental impacts of counterproductive emotions? One approach may be to incorporate additional interventions or gamified design elements to foster healthy emotional balance. This could be achieved by adding a formal channel through which lower performing players can request and receive critical feedback from higher performing players, serving the dual purpose of fostering critical thinking for both positive and negative feedback conditions. Higher performers might also be given extra-game “stretch goals” that are intended to challenge them to the point of frustration, serving the dual purpose of solving additional problems and simultaneously discouraging a quiescent approach to the original problem by triggering creative cognitive processes.

Retaining the Best, and the Rest

Our results indicate that better performers are generally more likely to continue engaging in a competition due to both absolute and relative feedback, and express greater positive emotions and lesser negative emotions. Whereas the greater positive emotions can precede
withdrawal from a competition, the lesser negative emotions can offset this by facilitating
continuation. If positive emotions reflect a sense of quiescence rather than pleasure (Van Dijk
and Kluger 2004), it is possible that its expression will precede withdrawal from an online
competition. We suggest: (a) emphasizing absolute performance feedback for such individuals,
as that would reduce negative emotions, and thereby enable continuation; but (b) de-emphasizing
relative feedback, as that would improve positive emotions, and thereby inhibit continuation. We
also suggest a potential intervention to discourage defection among players who are otherwise
enjoying the competition: offer a text-mining tool that scours the competition message forum and
any relevant notebooks to illustrate the main topics of discussion among higher performing
teams such as data preparation techniques and algorithms. Such a tool may inspire creative ideas
to keep otherwise-successful players engaged in a competition.

On the other end of the spectrum, keeping lower performers engaged is also important –
not to the point of wasting their time in competitions that they have little chance of winning, but
if lower performers do not have the opportunity to advance, and are at risk of defecting, who
then will be left to compete? Communities must find effective ways to retain current players. Our
results suggest that one possible way to do so is to emphasize relative rather than absolute
performance for such individuals, because the negative relative feedback would reduce positive
emotions, and thereby increase the likelihood of continuation. Absolute feedback should be de-
emphasized for such individuals because negative absolute feedback would increase negative
emotions, which would reduce the likelihood of continuation. In addition, a potential design
enhancement could involve a recommendation agent that considers a player’s history and
recommends other competitions that are better suited to current skills and offer desirable skill
development. This could also create opportunities for resource-constrained organizations such as small and medium enterprises and non-profits to sponsor competitions with lower stakes.

In conclusion, we advance a theory of online competitions to help scholars and practitioners understand the converging domains of work and play as individuals compete for fun and rewards in pursuing goals that bring value to sponsor and host organizations. We use data from Kaggle, a leading online analytics community, and integrate text analysis, survival analysis, and multi-level panel regressions to test our theory. Results generally support our model and highlight ways to further advance our knowledge of online competitions.
REFERENCES


INTRODUCTION

As information systems (IS) become more sophisticated and better integrated, organizing work around and through IS becomes more important. The coordination of work in teams is a topic of great interest in management, as efficient and effective work processes are key to the success of modern organizations (Jeston 2014). These recurrent work processes are characterized by a continual flow of emotion and cognition within teams (Healey et al. 2015).

To support digitized work processes, organizations increasingly coordinate through enterprise IS (EIS) (Claggett and Karahanna 2018), which help organizations to modernize infrastructure and reengineer processes to align with best practices (Grover and Markus 2008). EIS such as enterprise resource planning systems provide 80 percent of firms with a transactional backbone to support integrated business processes across business units, but they are costly, complex to implement, and suffer from significant risks in adoption and benefit realization (Computer Economics 2019). It is therefore important to promote greater understanding of EIS through training, and to study emotions, cognitions, and coordination of processes through them.

One modern avenue for studying coordination of work in teams is through the use of serious games, particularly business simulation games (e.g., Boies et al. 2011; Owens and Hekman 2016; Quigley et al. 2007). Business simulation games’ practical objective is to provide training that can develop team process coordination, cognitive growth, and emotional engagement. In many ways, business simulations parallel modern multiplayer video games, where success depends on effective specialization and process efficiency (Freeman and Wohn 2018; Kim et al. 2017). Further illustrating these parallels, literature highlights the importance of
prosocial behavior (Granic et al. 2014), communication (e.g., Leavitt et al. 2016), problem solving, innovation, and creativity (Sourmelis et al. 2017) in multiplayer video games.

Gamification refers the incorporation of game design elements into non-game contexts (Deterding et al. 2011), bridging a gap between work and play. We situate this paper in the context of gamified EIS training involving a team-based competitive business simulation game.

The parallels are remarkable, but unsurprising in retrospect. A key evolutionary role of games is to offer safe spaces in which to simulate some aspect or semblance of reality (Harteveld 2011). We can learn much from the study of how humans interact and coordinate in a simulated environment (e.g., Toups et al. 2011), but little literature has deeply explored the parallels in the coordination of tasks in work and play. We thus pose the following research questions:

**RQ1**: How do teams coordinate ‘work’ in games, and how do emotions, cognitions, and coordination support recurrent team processes?

**RQ2**: How do performance outcomes from business simulation-based training influence emotions, cognitions, and coordination in individuals and teams?

To address these questions, we draw on literature in task coordination (Crowston 1997; Knoblich and Jordan 2003; Kraut and Streeter 1995; Sabherwal 2003) and team processes (Marks et al. 2001) to develop a theory of emotion, cognition, and coordination (TECC) in the context of EIS training. We conduct field studies based on two versions of an accelerated real-time business simulation using a contemporary EIS in a team-based competitive environment. Teams are responsible for self-organizing and coordinating activities to manage business operations. We investigate: (1) how task coordination changes within teams during the execution of simulated business processes; (2) how emotion, cognition, task coordination, and performance influence one another over time; and (3) how training performance affects emotions, cognitions, and coordination in individuals and teams. To test our theory across two studies, we employ a
combination of process and variance methodologies including text content analysis, panel regression, binomial logit regression, structural equation modeling, and mixed-effects regression.

This paper contributes to the literature in two broad areas. First, it contributes to the literature on emergent team processes. We answer calls to incorporate temporal issues in team evolution and dynamics to study team processes and emergent states (Mathieu et al. 2017) by developing TECC. We hope that a theory of emotions and cognitions in process coordination can offer insights about how team processes evolve and teams adapt, and practical value in improving the effectiveness of training interventions. Given the nature of games as simulations of reality, we also suggest that these insights can apply to practice beyond the scope of a game. Simulation is defined broadly as the “use, for research purposes, of any artifact (i.e., model, method, instantiation) that imitates the behavior of the system under investigation” (Za et al. 2018, p. 269). Simulations offer excellent mechanisms to develop new theory (e.g., Cohen et al. 1972; March 1991) and unpack the complexities of human behavior when human agents interact via role-playing with a simulated world, such as a business simulation game (Za et al. 2018).

Second, this paper draws attention to the multiple levels of temporal aggregation (Athanasopoulos et al. 2017; George and Jones 2000; Kourentzes et al. 2017) within recurrent processes in general, and in game play more specifically, by theorizing and empirically analyzing phenomena at three different aggregation levels related to process cycles: the macro cycle of a single instance of a game, the meso cycle of rounds within the game, and sequence of phases within each meso cycle. Thus, processes recur at a variety of temporal levels, e.g., the recurrent actions within a game are situated within a “level” or “stage” of a game, with levels subsequently situated within the game itself, and the instance of playing a game is situated within the lifecycle of the game to its player. Accordingly, we suggest that theory should
be sensitive to such cycles, and go beyond more static multi-level techniques to investigate processual multi-level phenomena.

Next, we develop the foundation for TECC. We then discuss the study contexts, data collection, and measures, followed by the analytical approach and results. We conclude with a discussion of findings, limitations, and contributions to literature and practice.

THEORETICAL DEVELOPMENT

We define coordination as managing interdependent activities among multiple actors to achieve common goals (Crowston 1997; Malone and Crowston 1994). Prior literature classifies coordination in numerous ways, including: task and resource coordination (Crowston 1997); formal and informal coordination (Kraut and Streeter 1995); and coordination through standards, plans, and mutual adjustment (Kumar and van Dissel 1996; Sabherwal 2003). Kraut and Streeter (1995, p. 69) suggest that “different people working on a common project … must coordinate their work so that it gets done and fits together, so that it isn’t done redundantly, and so that components of the work are handed off expeditiously.” Consistent with the view that different actors in complementary roles must coordinate aspects of work to avoid redundancy and achieve goals, we draw on literature in cognitive and experimental psychology on action coordination in teams to propose two types of coordination strategies: anticipatory and compensatory (Knoblich and Jordan 2003). Just as individuals must coordinate their actions by anticipating and compensating for environmental factors, teams exhibit similar patterns of coordination as they work together to achieve common goals (e.g., Schmitz et al. 2018; Vesper et al. 2016).

Anticipatory coordination strategies (ACS) involve establishing a priori standards and plans for how to approach a problem and how to react to environmental cues (Knoblich and Jordan 2003). ACS involve standards and plans as discussed in coordination literature (e.g.,
Sabherwal 2003). Compensatory coordination strategies (CCS) are more emergent and implicit in nature, focusing on the selection and timing of actions based on immediate environmental cues (Knoblich and Jordan 2003). They involve informal coordination and mutual adjustment mechanisms (Kraut and Streeter 1995; Sabherwal 2003). Thus, ACS are proactive while CCS are reactive. CCS provide valuable feedback for enhancing coordination beyond what is arranged through ACS, and teams must employ a mixture of both to achieve proximal and longer-term goals, respectively (Knoblich and Jordan 2003).

To investigate coordination of tasks within teams, we draw on a temporal phase model of team processes (Marks et al. 2001). This model positions phases of team activity as a series of related input-process-output episodes, with task accomplishment consisting of a series of transition and action phases. Transition phases involve mission analysis, goal specification, and strategy formulation and planning. We suggest that ACS develop primarily during transition phases. Action phases involve monitoring progress toward goals, systems monitoring, team monitoring and backup, and coordination. We suggest that CCS emerge primarily during action phases. Marks et al. (2001) further provide a taxonomy of team processes including transition, action, and interpersonal processes. Transition and action processes occur primarily in the respective transition and action phases but may overlap, while interpersonal processes occur during both transaction and action phases. In both studies, we consider the first two of these phases, transition and action, as important factors in team effectiveness as they “have the greatest potential to impact the rate and caliber of task-work” (Marks et al. 2001, p. 370). In Study 1, we also examine interpersonal processes that occur during transition and action phases by considering emotion and cognition in dyadic communication. In Study 2, we examine outcomes of these processes that relate to emotion, cognition, and coordination in individuals and teams.
Given gamification’s focus on enhancing experiential outcomes while retaining instrumental functions (Liu et al. 2017), we propose an “experiential loop” of recurring processes that characterizes the gameful experience, and suggest that this loop can operate simultaneously at multiple levels, such as macro, meso, and micro levels. The macro loop comprises a gameful experience, marked by a generally recognizable start and end – between instances of playing a game. The meso loop includes phases marked by discrete start and end points within a gameful experience, for example, between phases (rounds or levels) within a game. The micro loop includes more frequent cycles of motivation, action, and interpretation within a meso loop, such as patterns of action and situational adaptation within a phase. While proposing these three levels, and acknowledging potential other levels (e.g., the cycle of adoption through discontinuing a game), we focus only on the first two (macro and meso) loops in this paper.

In the meso loop, interactions between the user and system are broadly represented by action phases in which teams use the system to achieve goals. Following each action phase, performance feedback is available for evaluation. Transition phases involve cognitive and emotional evaluation of performance feedback. Cognitively, teams reevaluate their mission, goals, and strategy based on performance feedback to establish or refine ACS. Emotional factors also play a role in this stage through phenomena such as emotional contagion (Hatfield et al. 1993), groupthink (Janis 1972), team entrepreneurial passion (Cardon et al. 2017), and emotional dynamics (Liu and Maitlis 2014). Based on performance feedback, teams determine if they need to adjust their processes and enact any needed changes in the subsequent action phase.

Within action phases, meanwhile, a micro loop operates as teams actively engage in the game to continuously assess and interpret feedback, triggering cognitions and emotions that drive motivation for subsequent action. Action phases are informed by ACS developed during
transition phases, and incorporate CCS deployed in response to contextual conditions. These CCS may subsequently influence ACS in the next transition phase.

We suggest that experiences within the meso loop more broadly influence experiential and instrumental outcomes at a macro level, affecting team factors such as shared identity, knowledge effectiveness, and coordination. We also recognize the importance of studying emotions, cognitions, and coordination within the meso experiential loop as teams enact transition, action, and interpersonal processes throughout the gameful IS experience. Study 1 and Study 2 focus on the emotional and cognitive aspects of team processes during, and the team emotional and cognitive outcomes of, gameful IS experience, respectively. Figure 4.1 presents a high-level view of the proposed model. In the following sections, we develop a theory of emotion, cognition, and coordination (TECC) in the context of gamified training.

![Figure 4.1. TECC High-Level Model](image)

**Performance and Transition in Coordination of Action**

As shown in Figure 4.1, an action phase influences subsequent team performance, which in turn, influences the transition phase. When teams enter a transition phase after receiving
performance feedback, they have an opportunity to adjust task coordination. If teams receive positive feedback, they are more likely to “stay the course” and continue to exploit their existing routines because those routines were effective, and they tend to avoid making changes and taking risks (Håkonsson et al. 2016). However, teams receiving negative feedback are more likely to explore new routines than exploit existing ones because they will be more inclined to take risks and innovate to improve performance (Kahneman and Tversky 1979; Greve 2003).

H1a: Teams with lower (higher) performance are more (less) likely to reorganize task coordination.

During transition phases, teams learn from their successes or mistakes and adjust accordingly. In a series of experiments, teams were able to more effectively implement ACS by way of external cues about other team members’ actions (Knoblich and Jordan 2003). As teams receive feedback about their performance, process cues about other team members’ actions, and have an opportunity to develop or refine their ACS during transition phases, reorganization of task coordination is likely to lead to performance improvements.

H1b: Reorganization of task coordination leads to improved performance.

We further suggest that this effect is most salient for teams with poorer performance because they have more mistakes from which to learn. Mistakes are critical determinants of learning in general (Chialvo and Bak 1999), and in organizations (Madsen and Desai 2010) and cooperative teams specifically (Tjosvold et al. 2004), supporting the adage that “we learn more from failure than from success.” In a cooperative team context, mistakes within the team result in learning and problem solving that can result in improved performance (Tjosvold et al. 2004).

H1c. Reorganization of task coordination interacts with performance such that teams with lower performance experience the highest improved performance.

In this paper, we consider two types of performance: absolute performance (round profit) and relative performance (leaderboard rank). The actions of individuals and teams, including task
coordination, directly affect, and depend on, absolute performance. Therefore, to conceptualize the reciprocal effects of performance and task coordination proposed in H1, we consider absolute performance as the appropriate construct. By contrast, relative performance, which depends on absolute performance based on how other teams perform, would affect – and be influenced by – perceptions rather than objective measures of coordination, as posited in some later hypotheses.

**Emotions and Cognitions in Team Processes**

Emotions are complex adaptive structures, and are commonly studied using two dimensions: valence (positive or negative) and arousal (low to high) (e.g., Barrett 1998). More elaborate definitions include additional components such as subjective feeling states and motor expressions (e.g., Scherer 2005). We take a traditional approach in considering valence (positive or negative) and the intensity (i.e., arousal) of emotion relative to other concerns.

Performance feedback will result in both cognitive and emotional responses. We propose offsetting influences of positive performance feedback on cognitions and emotions. First, positive performance feedback is likely to lead to greater positive emotions. We experience joy in victory, and pride as we attribute success to our own actions (Steunebrink et al. 2009). Conversely, we experience frustration or shame when performance is not meeting our expectations and we think that we could have done better.

*H2a: Higher performance results in higher positive emotion in the transition phase.*

*H2b: Lower performance results in higher negative emotion in the transition phase.*

We consider two types of cognitions that may be salient in team processes, particularly in learning-focused contexts such as gamified training. Both are involved in the broader process of sense making, including how team members adapt their views by seeking information and revising cognitive schema to account for new information (Weick 1995). We use the term sense giving to represent task-relevant information that is intended to help shape the sense making
process (Gioia and Chittipeddi 1991; Weick 1995), and the term sense seeking to represent task-relevant knowledge seeking behavior at a particular point in time and space (Dervin 1998).

We suggest that lower performance will trigger cognitive reappraisal and problem-solving strategies (Granic et al. 2014) during the transition phase, increasing task-focused cognitions. Conversely, higher performance may trigger “tunnel vision” (Gray 2001) as positive emotions and confidence in the current approach lead to lower levels of task-focused cognitions during the transition phase. This should apply equally to sense giving and sense seeking, as low performance can increase sense giving through reflection (Weick 1995) and sense seeking through collecting additional integrative information (Maitlis et al. 2013).

**H3a:** Higher (lower) performance results in lower (higher) sense giving in the transition phase.

**H3b:** Higher (lower) performance results in lower (higher) sense seeking in the transition phase.

Given the competitive context of our studies, how a team performs relative to others – rather than the team’s absolute performance – would influence team members’ perceptions. This is consistent with prior arguments regarding the salience of social comparison and the desire to achieve or maintain a superior relative position in a competition (Garcia et al. 2013). Therefore, when examining the effects of performance, we focus on the effects of relative performance and expect the relationships hypothesized in H2 and H3 (as well as H6 to H8 posited later; H4 and H5 do not involve performance) to manifest as a result of relative performance, rather than absolute performance.

Emotional contagion theory (Hatfield et al. 1993) suggests that emotions expressed among members of a team may be transferred and influence subsequent cooperation and performance (e.g. Barsade 2002). We therefore propose that the valence of emotions during a transition phase will influence the valence of emotions during the subsequent action phase.
*H4a:* Positive emotions during a transition phase lead to positive emotions during the subsequent action phase.

*H4b:* Negative emotions during a transition phase lead to negative emotions during the subsequent action phase.

We propose that sense giving among members of a team during a transition phase relates primarily to standards and planning, improving ACS and resulting in a reduced need for sense giving in the subsequent action phase. As teams coordinate knowledge more effectively, cognition-based trust increases and task-focused communication becomes less important (Kanawattanachai and Yoo 2007). Conversely, teams that do not actively plan for the subsequent action phase via sense giving are more likely to resort to CCS and express greater task-focused communication, particularly sense seeking, therein.

*H5a:* Higher (lower) sense giving during a transition phase results in lower (higher) sense giving during the subsequent action phase.

We also suggest that sense seeking during a transition phase will persist into the subsequent action phase because higher levels of sense seeking indicate a more persistent need for cognition in teams. Need for cognition is a stable trait that should predict active information search behaviors irrespective of phase (e.g., Curşeu 2011), and will carry over between phases.

*H5b:* Higher (lower) sense seeking during a transition phase results in higher (lower) sense seeking during the subsequent action phase.

**Emotional, Cognitive and Coordination Outcomes of a Gameful IS Experience**

We broaden our inquiry to the outcomes of the macro-level experiential loop (i.e., the completion of the gamified training) to consider emotions, cognitions, and coordination. We investigate individual- and team-level emotions and cognitions, and team-level coordination.

Given that an overarching goal of games is to provide an enjoyable experience to the player, we consider enjoyment at the individual level as an emotional outcome of interest. Enjoyment, defined as the extent to which using an IS brings pleasure and fulfillment
irrespective of its performance consequences, has a long history in the IS literature (e.g., Agarwal and Karahanna 2000; Davis et al. 1992; Lowry et al. 2013). Enjoyment is often equated with intrinsic motivation (Deci and Ryan 2000). We suggest that members of higher performing teams will experience higher levels of perceived enjoyment because superior performance serves the underlying intrinsic need to demonstrate competence (Deci and Ryan 2000). Conversely, lower performing teams will experience lower levels of enjoyment because inferior performance signals low competence (Deci and Ryan 2000) and negative social comparisons (Festinger 1954). In general, research has shown a positive relationship between the direction of feedback and the valence of affect (Kluger et al. 1994; Venables and Fairclough 2009).

**H6a: Higher performance is associated with higher levels of enjoyment.**

Goals of team-based training can vary, but a consistently desirable outcome of such training is to improve the affective aspects of teamwork (Salas et al. 2008). We consider shared identity as a desirable team-level emotional outcome that improves communication (Greenaway et al. 2015), enhances members’ ability to cope with stress (van Dick et al. 2018), and can directly impact effort and performance (Stevens et al. 2019). Shared identity within a group (i.e., team in this case) is grounded in emotional, rather than cognitive, connections (Thompson and Fine 1999), and provides a common interpretive framework and platform for shared cognition and coordination (Postmes 2003). We suggest that higher performance will result in a stronger sense of shared identity within a team because positive performance sends a signal of team competence as well as enhancing members’ sense of relatedness to the team. Both relatedness and competence are important intrinsic motivators (Deci and Ryan 2000).

**H6b: Higher performance is associated with higher levels of shared identity.**

Just as player enjoyment is an overarching goal of games, the cognitive experience of immersion is often associated with enjoyable gaming experiences. Cognitive absorption, defined
as a “state of deep involvement with software” (Agarwal and Karahanna 2000, p. 665) includes both heightened enjoyment and focused immersion as second-order dimensions. While enjoyment represents affective aspects of absorption, focused immersion is defined as “the experience of total engagement where other attentional demands are, in essence, ignored” (Agarwal and Karahanna, p. 673). Focused immersion is rooted in cognitive processes of concentration and attention, and is therefore a salient individual-level cognitive outcome in gamified IS training. Consistent with flow theory (Csikszentmihalyi 1990), individuals get immersed in intrinsically interesting tasks that provide “optimal challenge” by being neither too easy nor too hard. As with enjoyment, we expect performance feedback to signal competence, increasing intrinsic motivation, and we expect individuals (within teams) using a new system in a competitive environment to experience appropriate levels of challenge among similarly equipped peers, particularly for teams with the additional challenge of sustaining superior performance.

H7a: Higher performance is associated with higher levels of focused immersion.

We suggest that a salient team-level cognition in gamified training is the team’s ability to effectively use knowledge from the system to perform tasks, given that individuals and teams are participating in training to gain valuable knowledge (in this case, about EIS). Effective management of knowledge results in improved organizational outcomes (Mao et al. 2016) and job performance (Zhang 2017). Teams (and individuals on those teams) will be more satisfied with their ability to effectively manage knowledge to the extent that they perform at higher levels during training. In addition to feelings of competence, higher-performing teams experience a heightened sense of autonomy, an intrinsic motivator (Deci and Ryan 2000) which has been shown to increase cooperative learning and satisfaction (Janz and Prasarnphanich 2003).

H7b: Higher performance is associated with higher levels of knowledge effectiveness.
To investigate coordination, we draw on literature in transactive memory systems (TMS), defined as the “cooperative division of labor for learning, remembering, and communicating relevant team knowledge” (Lewis 2003, p. 587). TMS involve aspects of knowledge specialization, credibility, and coordination. We specifically draw on the coordination dimension of TMS as a focal construct, which relates to the team’s possession of relevant expertise and members’ willingness to act on that expertise. We suggest that teams that perform at higher levels can coordinate knowledge more effectively, both in identifying knowledge sources and bringing knowledge to bear. These teams (and the members therein) have figured out how to coordinate knowledge effectively within the team and are better situated to do so again.

**H8: Higher performance is associated with higher levels of TMS coordination.**

We present the main model in Figure 4.2. We depict the experiential loop as recurring cycles of transition and action, punctuated by periodic performance feedback. We position macro-level outcomes as flowing from the overall performance (indicated by a weighted arrow) of the team during the gamified training experience.

![Figure 4.2. Theoretical Model](image-url)
DATA

Study 1 Context

This study uses a dynamic real-time business simulation, ERPsim, in which teams of participants use an enterprise resource planning (ERP) system (specifically SAP, the market-leading ERP system) to manage firms engaged in bottled water distribution in Germany (Léger et al. 2007). In this simulation, teams are instructed to maximize profit in the German market consisting of 123 customers across three geographic regions. Each team manages the sales of six products, which are identical across teams: standard water (ClearPure), sparkling water (Spritz), and flavored sparkling water (Lemon Spritz) – each available in cases of small (500mL) or large (1L) bottles. The simulation lasts for three rounds of 20 virtual days each, with each virtual day lasting one minute. The entire training and simulation experience lasts approximately three hours (one of which is spent in active gameplay, while the other two are used for classroom instruction on the operation of the game and transition phases as teams prepare for each round).

Prior to the simulation, participants were randomly assigned to teams and seated together. For all games in Study 1, we consider dyads (i.e., two-member teams) as the base unit for team-level analyses. When facilitating the simulation, we provided a brief overview of the experience and showed an 8-minute video introducing the simulation, followed by a 16-minute video describing the reports and decisions to be used in the first round. Participants each received a job aid with brief instructions for each report and action. Participants logged in to the ERP system, and the facilitator demonstrated each report and action using a separate (non-competing) team. Each team then took ten minutes to discuss and prepare for the first round. Participants worked together, communicating face-to-face and using the ERP system side-by-side, during the first
round. After the first round, results for all teams were displayed for three minutes on a projector, including the profit and ranking of each team along with other common financial metrics.

For a subset of the games in Study 1, participants then were dismissed for the day and told that the simulation would continue with the second and third rounds when they returned for the next class two days later. Upon their return, participants were informed that seating assignments had changed (but team assignments had not), and they were to find the seat marked with their username (consisting of their team letter and a sequential number). Seating was arranged such that no team would be able to effectively communicate verbally or see one another’s screens. Participants were then briefed on the use of a lean electronic chat tool (Google Chat), and logged in to communicate with their partner via text chat for the remainder of the simulation experience. All subsequent text communications were recorded and used to operationalize cognitive and emotional communication data in this study.

**Study 2 Context**

Study 2 uses a more advanced scenario for ERPsim, wherein teams use SAP to manage virtual firms engaged in cereal manufacturing in Germany. The simulated German cereal market consists of 194 customers (i.e., retail stores) allocated across three geographic regions (north, south, and west) and three distribution channels (independent grocers, grocery chains, and hypermarkets). Each team manages the sales of up to six products (original, nut, raisin, strawberry, blueberry, and mixed fruit) in two different sizes (500g “small box” and 1kg “large box”). Teams determine which products to manufacture, product design (ingredient mix within ranges specified for each product type), product prices (by distribution channel), and product marketing (by region). Each simulated day, customers needing to place an order will evaluate the available stock for each company and will place an order based on a combination of product
recipe, price, and marketing. The simulator records the details of each order in the ERP system. Each simulated day lasts approximately one minute in clock time. Each game consists of 120 simulated days, divided into four or six rounds.28

Each team, comprised of three or four players, is responsible for managing the full cash-to-cash business cycle, including planning, purchasing, manufacturing, and sales processes. Teams are responsible for key decisions in each process, but ERPsim automates many of the administrative functions within these processes such as processing payments, receiving goods, and delivering orders. Additionally, teams can invest available cash to improve aspects of their business operations but must also maintain enough cash to cover normal operating expenses. Teams self-organize with the goal of maximizing company valuation, which is primarily a function of profit. In addition to dividing responsibilities among team members, teams must balance strategic decision making and efficient execution of operational processes.

Strategically, teams must determine a product strategy (which products to make and sell), manufacturing strategy (e.g., shorter vs. longer production runs), marketing strategy (i.e., approach to pricing and marketing), and investment strategy (i.e., how to reinvest cash into loan repayment, capacity improvement, and setup time reduction). Operationally, teams must continually monitor financial, sales, inventory, purchasing, and market activities to determine (1) adjustments to planning levels, (2) timing for planning execution, (3) production scheduling, (4) pricing, (5) marketing, and (6) investing available cash. Decisions that teams make on each virtual day take effect on the next virtual day.

28 Changes to the manufacturing game in 2016 reduced the number of days per round from 30 to 20 for consistency with other versions of ERPsim. As a result, three of the manufacturing games in this study use the prior version, and six use the newer version. This did not change the overall amount of experience with the ERPsim game, and we empirically address the differences by standardizing performance by game version.
Prior to the simulation, participants completed a pre-simulation survey. They were randomly assigned to teams. The simulation facilitator then conducted a training workshop, where he introduced ERP concepts, explained the simulation environment, and conducted three practice rounds in a simplified version of the simulation focused on operational processes, and two practice rounds in the full version of the simulation to let teams explore strategic decisions while refining operational processes. The instruction and practice rounds took approximately nine hours. The final competitive simulation (120 virtual days) consisted of multiple rounds and breaks for planning between rounds over a period of approximately three hours. After each round, a public leaderboard displayed each team’s financial results and rank in terms of overall company valuation and cumulative and round profit values in Euros. Between rounds, teams then had time to reorganize, adjust strategy, and prepare for the next round. Following the simulation, participants completed a post-survey.

The parameters of the water distribution game are simpler than those of the cereal manufacturing game. The distribution game has no production process and no options for product design or cash investments, and can therefore be delivered in a shorter timeframe. Table 4.1 presents the reports and actions available in each game type (and round, for water distribution). Figure 4.3 depicts a typical “flow” of transactions (i.e., reports and actions) during a 20-day round of the water distribution game. The dyad members are identified by numbers in the figure, and the reports (outputs) and actions (inputs) are identified by abbreviations listed in Table 4.1. Arrows above and below the timeline represent player actions and reports for that day, respectively. For example, on day 4, player 1 changes a price (action) and looks at a summary sales report (report), while player 2 looks at a purchase order report.
Table 4.1. Reports and Actions by Game Type and Round

<table>
<thead>
<tr>
<th>Round</th>
<th>Water Distribution</th>
<th>Cereal Manufacturing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reports</td>
<td>Actions</td>
</tr>
<tr>
<td></td>
<td>Sales Summary (SSR)</td>
<td>Pricing (P)</td>
</tr>
<tr>
<td></td>
<td>Sales Detail (SDR)</td>
<td>Marketing (M)</td>
</tr>
<tr>
<td></td>
<td>Market (MR)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inventory (IR)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Financial (FR)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Same as Round 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>plus:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Same as Round 2, plus:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Forecasting (F)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2 Same as Round 1, plus:

<table>
<thead>
<tr>
<th>2</th>
<th>Purchase Order (POR)</th>
<th>Purchasing (PU)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Same as Round 2, plus:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Forecasting (F)</td>
<td></td>
</tr>
</tbody>
</table>

Figure 4.3. Water Distribution Game – Example Round

Levels of Analysis

We conduct analyses at multiple levels, aligned with the conceptual level of each hypothesis. At the macro level of the gamified training experience, we measure and test constructs at both the individual and team levels. Within the meso experiential loop of gameplay, we consider the nesting of observations within the team over time, and also consider individuals.
over time in order to measure team-over-time constructs. More specifically, in measuring team coordination, we consider the tasks undertaken by individuals and how those tasks change from round to round within the game (individual-round level). We aggregate those changes to the team level through a process described below, and conduct related analyses at the team-round level – that is, the nesting of round-level observations within teams (3 rounds for the games in Study 1, 4 or 6 rounds for those in Study 2). To evaluate emotions and cognitions between team process phases (i.e., transition and action), we consider the team-phase level, where each round consists of both a transition and action phase.

For both studies, we collect data at both the team and individual levels over time, and aggregate individual data to the team level following established practices described in the following section. We measure task coordination for each action phase and performance at the end of each round (following each action phase). For Study 1, we measure cognitions and emotions within the game using coded communications aggregated by team and phase. For Study 2, we measure cognitive and emotional outcomes at the individual level, using team-referent items for team-level constructs, in a post-survey instrument.

**Data Collection**

For Study 1, we consider data from seven games consisting of 107 teams of two members each (dyads). These games took place in an undergraduate introduction to IS course. To collect emotion and cognition data through online chat logs, we use data from three of the seven games comprising 50 teams and 100 members. For these three games, each participant used a separate Gmail account that was set up specifically for this study. The chat tool was configured to save all

---

29 We collected data from a total of 312 participants in 150 teams. Due to odd numbers of students and large class sizes, some teams consisted of three members each. For this study, we only consider dyads in which both members attended class for the entire process (spanning two or three class days in most cases).
messages sent or received by the participant to a chat log that can be accessed via the standard Gmail interface. Chat logs were captured for all conversations occurring between dyad members during the second class meeting, which began with preparation for the second round and concluded with any post-game discussion between members. Following each class, a research assistant logged in to the Gmail accounts to export chat logs into a spreadsheet.

Each chat log consists of a sequence of individual messages demarcated by a line feed which signifies that a participant pressed the enter key to send the message. Each message consists of the date, the hour and minute, the username of the sender, and the content of the message. Messages sent during the same minute are stored in the order they were sent. Each chat username is tied to a specific SAP username for matching purposes. For the 50 teams included in the analyses, we captured a total of 3,306 chat messages.

For Study 2, we collected data from 11 games consisting of 60 teams and 201 team members. Seven games were part of a new hire training program for two large energy firms conducted over four consecutive years. These games were part of 12-hour (1.5-day) training workshops, with the first day focused on instruction and practice rounds, and the second day reserved for the final competitive game. Four games were part of a graduate ERP course designed for working professionals, delivered over four consecutive years. Each course included instruction and practice rounds spread across multiple class meetings. The final competitive game took place in the last face-to-face meeting. The total amount of time spent in simulation instruction, practice, and the final game was similar for all groups (approximately 12 hours).

**Chat Communications**

For the subset of 50 dyads in Study 1 that used Google Chat during rounds 2 and 3 of the competition, each chat log represents a complete time-bound conversation (approximately 75
minutes) between two participants. Participants in this study were undergraduate students, who are generally accustomed to lean chat communication through text messaging platforms. Accordingly, the style of communication in these conversations is consistent with what one might expect from undergraduate students using a lean chat tool: replete with grammatical shortcuts, abbreviations and acronyms, capitalization and spelling errors, and inconsistent use of punctuation. We provide a representative example Table 4.2.

<table>
<thead>
<tr>
<th>Time</th>
<th>Participant</th>
<th>Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:07 AM</td>
<td>member 1</td>
<td>drop price or spend more in marketing?</td>
</tr>
<tr>
<td>9:07 AM</td>
<td>member 2</td>
<td>drop prices</td>
</tr>
<tr>
<td>9:07 AM</td>
<td>member 2</td>
<td>except clear pure</td>
</tr>
<tr>
<td>9:08 AM</td>
<td>member 1</td>
<td>wthl</td>
</tr>
<tr>
<td>9:09 AM</td>
<td>member 1</td>
<td>haven't sold any of either spritz</td>
</tr>
<tr>
<td>9:10 AM</td>
<td>member 2</td>
<td>just uped mkt. dont drop prices</td>
</tr>
<tr>
<td>9:10 AM</td>
<td>member 1</td>
<td>I already had...</td>
</tr>
<tr>
<td>9:11 AM</td>
<td>member 2</td>
<td>ok just bump them up like .25</td>
</tr>
<tr>
<td>9:12 AM</td>
<td>member 2</td>
<td>bump up spritz</td>
</tr>
<tr>
<td>9:12 AM</td>
<td>member 1</td>
<td>why&gt; we still haven't sold any at all</td>
</tr>
<tr>
<td>9:13 AM</td>
<td>member 2</td>
<td>jk never mind then. i just uped the mkt dollars</td>
</tr>
</tbody>
</table>

To analyze group communications, we draw on Bales (1950) interaction process analysis (IPA), one of the most widely used communication frameworks for analyzing the content of group communications due to its systematic and comprehensive approach to classifying both instrumental and expressive messages (McGrath 1984). IPA classifies interactions as either task (instrumental) or social-emotional (expressive). We consider most task interactions to be cognitive in nature, and many social-emotional interactions to be emotional in nature. Task interactions are further subdivided into active (i.e., giving suggestion, opinion, or orientation) or passive (i.e., requesting suggestion, opinion, or orientation). Social-emotional interactions are
further subdivided into positive (i.e., show solidarity, show tension release, agreement) and negative (i.e., show antagonism, show tension, disagree).

Appendix 4.1 provides a detailed description of the coding process. Our final classification resulted in 5,024 thought units, defined as the smallest segment of behavior that can be classified into exactly one of the available categories (Bales 1950), across ten categories. Table 4.3 presents the counts for each category. We aggregate thought units by team and time period for one of five phases: 1) pre-round 2 communication (transition phase), 2) round 2 communication (action phase), 3) pre-round 3 communication (transition phase), 4) round 3 communication (action phase), and 5) post-round 3 communication.

<table>
<thead>
<tr>
<th>Code</th>
<th>Category</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Acknowledging Uncertain Orientation</td>
<td>189</td>
</tr>
<tr>
<td>1</td>
<td>Giving Orientation</td>
<td>1,889</td>
</tr>
<tr>
<td>2</td>
<td>Giving Suggestion / Opinion</td>
<td>939</td>
</tr>
<tr>
<td>3</td>
<td>Requesting Orientation</td>
<td>357</td>
</tr>
<tr>
<td>4</td>
<td>Requesting Suggestion / Opinion</td>
<td>287</td>
</tr>
<tr>
<td>5</td>
<td>Agree</td>
<td>595</td>
</tr>
<tr>
<td>6</td>
<td>Other Positive Social-emotional</td>
<td>539</td>
</tr>
<tr>
<td>7</td>
<td>Disagree</td>
<td>12</td>
</tr>
<tr>
<td>8</td>
<td>Other Negative Social-emotional</td>
<td>91</td>
</tr>
<tr>
<td>9</td>
<td>Non-task, Non-expressive, or Other</td>
<td>126</td>
</tr>
</tbody>
</table>

Variables

Table 4.4 summarizes the concepts, constructs, and measures. Each row also indicates the relevant study and level(s) of measurement. We discuss each measure in further detail below.

To operationalize emotions in Study 1, we use the Google Chat data collected for 50 dyads at the team-phase (i.e., transition and action for each round) level. Based on the procedure describe above, we measure positive emotion as the proportion of thought units during a phase that are classified as “Other Positive Social-emotional” (category 6 in Table 4.3). Similarly, we measure negative emotion as the proportion that are classified as “Other Negative Social-
emotional” (category 8 in Table 4.3). We do not include statements of agreement or disagreement because they are not explicitly cognitive or emotional (e.g., the message “OK” is a common “Agree” category thought unit but is not particularly expressive of an emotion or indicative of meaningful cognition). To operationalize cognitions in Study 1, we measure sense seeking as the proportion of task-focused “seeking” thoughts, in which a dyad member requests orientation, suggestion, or opinion (categories 3 and 4 in Table 4.3). Similarly, we measure sense giving as the proportion of task-focused “giving” thoughts in which a dyad member gives orientation, suggestion, or opinion (categories 1 and 2 in Table 4.3).

<table>
<thead>
<tr>
<th>Concept</th>
<th>Construct</th>
<th>Level</th>
<th>Study</th>
<th>Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotions</td>
<td>Positive emotion</td>
<td>Team-Phase</td>
<td>1</td>
<td>Positive emotion thoughts (proportion)</td>
</tr>
<tr>
<td></td>
<td>Negative emotion</td>
<td>Team-Phase</td>
<td>1</td>
<td>Negative emotion thoughts (proportion)</td>
</tr>
<tr>
<td></td>
<td>Shared Identity</td>
<td>Team-Game</td>
<td>2</td>
<td>Postmes et al. (1999) (survey)</td>
</tr>
<tr>
<td>Cognitions</td>
<td>Sense seeking</td>
<td>Team-Phase</td>
<td>1</td>
<td>Task-focused seeking thoughts (proportion)</td>
</tr>
<tr>
<td></td>
<td>Sense giving</td>
<td>Team-Phase</td>
<td>1</td>
<td>Task-focused giving thoughts (proportion)</td>
</tr>
<tr>
<td></td>
<td>Knowledge Effectiveness</td>
<td>Team-Game</td>
<td>2</td>
<td>Becerra-Fernandez &amp; Sabherwal (2001) (survey)</td>
</tr>
<tr>
<td></td>
<td>Focused Immersion</td>
<td>Individual-Game</td>
<td>2</td>
<td>Agarwal and Karahanna (2000) (survey)</td>
</tr>
<tr>
<td>Coordination</td>
<td>Coordination Change</td>
<td>Team-Round</td>
<td>1+2</td>
<td>Euclidean distances of task activities</td>
</tr>
<tr>
<td></td>
<td>Transactive memory systems</td>
<td>Team-Game</td>
<td>2</td>
<td>Lewis (2003) (survey)</td>
</tr>
<tr>
<td>Performance / Feedback</td>
<td>Score</td>
<td>Team-Round / Team-Game</td>
<td>1+2</td>
<td>Standardized profit by game type</td>
</tr>
<tr>
<td></td>
<td>Leaderboard rank</td>
<td>Team-Round / Team-Game</td>
<td>1+2</td>
<td>1 - ((Rank - 1) / (Team Count-1))</td>
</tr>
</tbody>
</table>

To operationalize emotions, cognitions, and coordination in Study 2, we draw on established scales to capture team-level and individual-level constructs using post-survey data. Emotional outcomes include enjoyment (Agarwal and Karahanna 2000; Davis et al. 1992) at the
individual level and shared identity (Postmes et al. 1999; Swaab et al. 2002) at the team level. Cognitive outcomes include focused immersion (Agarwal and Karahanna 2000) at the individual level and knowledge effectiveness (Becerra-Fernandez and Sabherwal 2001) at the team level. We measure team coordination using the coordination dimension of TMS (Lewis 2003).

We operationalize coordination change in both studies as the Euclidean distance between team member task activity proportions from one round to the next. A task activity represents a team member viewing a report or taking an action in the system. Each task activity is referred to as a transaction in SAP. The composition of transactions used by a team member reflects her role in the coordinated process of managing the virtual firm. We first calculate the individual changes in proportions relative to the team for each of $n$ different transactions from the previous round.\(^{30}\)

We adjust $n$ based on the number of transactions that any team member accessed during the round, thus removing unused transactions from consideration. We then take the square root of the sum of squares for these changes and divide it by $n$. To aggregate this measure to the team level, we average the team member measures for $m - 1$ members,\(^{31}\) where $m$ is the number of team members, to account for the proportional nature of the data, as shown in Equation 4.1.

\[
\frac{\sqrt{\sum_{i=1}^{n-1} \frac{\sum_{1}^{n} PropChange_{i}^{2}}{n}}}{m - 1}
\]

Equation 4.1. Coordination Change Calculation

\(^{30}\) A total of 10 (6) standard reports are available in the manufacturing (distribution) game. We combine 2 of them for calculations due to their high degree of similarity: sales summary and sales detail reports. We suggest that, for the purpose of evaluating task coordination, one attribute is most suitable to represent the retrieval of team sales information. Similarly, a total of 8 (5) standard actions are available in the manufacturing (distribution) game. Two of these actions occur in a nearly invariant sequence to complete the purchasing process ($r > 0.9$), so we remove the first of these sequential transactions from the data to calculate coordination change. This is appropriate because the second step is the final execution of the first (planning) step.

\(^{31}\) The values for each team’s member sum to 1, hence the exclusion of one team member from such computations.
We operationalize performance in two ways, consistent with the delivery of performance feedback through two game design elements: score and leaderboard rank. First, we measure \textit{score} as the profit in Euros for each round. We standardize this variable by game type (distribution, 4-round manufacturing, 6-round manufacturing) prior to analyses to account for differences between performance scales. Second, we measure \textit{leaderboard rank} as the percentile rank relative to other teams in the game on a scale between 0 and 1, calculated as $1 - \left( \frac{\text{RoundRank} - 1}{n - 1} \right)$, where $n$ is the number of teams in the game and RoundRank is the team’s rank for that round. Thus, a rank of 1.0 represents first place on the leaderboard, where a rank of 0.25 might represent fourth place in a game with five teams ($1 - \left( \frac{4 - 1}{5 - 1} \right)$).

We also incorporate game-level measures including aggregations of prior measures as well as perceptual outcomes using a post-survey. We aggregate performance as the standardized cumulative profit across all rounds, and the final cumulative leaderboard rank. We control for \textit{total activity}, measured as the total number of distinct daily transactions at each level of analysis (i.e., team-round, team-game, and individual-game). For game-level analyses, we also control for several factors that may influence individual- and team-level outcomes, including computer anxiety (Heinssen et al. 1987), computer self-efficacy (Compeau and Higgins 1995),\textsuperscript{32} prior SAP experience (months), and flags for gender (1 = female) and current student status (1 = current “professional” program graduate student). \textbf{Appendix 4.2} provides the measurement items.

\section*{ANALYSES AND RESULTS}

We present analyses and results in the order of hypotheses, drawing on Study 1 and Study 2 to test H1, Study 1 only to test H2-H5, and Study 2 only to test H6-H8. \textbf{Figure 4.4} presents a summary of the study contexts, data, and analyses related to each hypothesis.

\textsuperscript{32} All multi-item survey measures use 7-point Likert-type scales except for computer self-efficacy, which uses the original 10-point scale to measure computer self-efficacy confidence (Compeau and Higgins 1995).
Performance and Coordination Change

To test H1, which posits the reciprocal effects of performance and coordination change, we use strongly balanced panel data sets containing 321 (Study 1) and 328 (Study 2) team-round observations. Because we use the first round of each game for baseline measurements (coordination for H1a, lagged performance for H1b and H1c), our effective sample sizes for Study 1 and Study 2 analyses are 214 and 268, respectively. Appendix 4.3 presents correlations and descriptive statistics for Study 1 and Study 2 samples. Appendix 4.4 presents a post hoc analysis of trends in cognitions and emotions over time by transition and action phase.

We use panel regressions to analyze changes in task coordination based on performance, and to analyze performance based on those changes. We test H1a with the dependent variable task coordination change predicted by prior round performance, and control for total activity. To test H1b and H1c, we use panel regression to predict performance (measured as standardized round profit) based on task coordination change and an interaction between prior round performance and task coordination change, also controlling for total activity. We use the xtreg function in Stata to test panel regressions, with standard errors clustered by team. Table 4.5 and Table 4.6 present the results of analyses for Study 1 and Study 2, respectively.
Table 4.5. Hypothesis 1 Results: Study 1

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Coordination Change</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Activity</td>
<td>-0.0011 (.0008)</td>
<td>0.0013 (.0051)</td>
</tr>
<tr>
<td>Profit&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>-0.0280** (.0105)</td>
<td>0.3527** (.1050)</td>
</tr>
<tr>
<td>Coordination Change</td>
<td></td>
<td>0.7367* (.3695)</td>
</tr>
<tr>
<td>Coordination Change * Profit&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>-0.3594 (.6585)</td>
<td></td>
</tr>
</tbody>
</table>

R<sup>2</sup> within: 0.10 0.08
R<sup>2</sup> overall: 0.04 0.20

Notes. * p < 0.05, ** p < 0.01 based on 1-tailed tests for hypothesized effects, 2-tailed tests otherwise. N<sub>obs</sub> and N<sub>teams</sub> are 214 and 107, respectively, for both regressions.

Table 4.6. Hypothesis 1 Results: Study 2

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Coordination Change</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Activity</td>
<td>0.0000 (.0001)</td>
<td>0.0024* (.0012)</td>
</tr>
<tr>
<td>Profit&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>-0.0107** (.0033)</td>
<td>0.2670** (.0512)</td>
</tr>
<tr>
<td>Coordination Change</td>
<td></td>
<td>0.6624 (.8870)</td>
</tr>
<tr>
<td>Coordination Change * Profit&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>-0.6830 (1.0338)</td>
<td></td>
</tr>
</tbody>
</table>

R<sup>2</sup> within: 0.05 0.02
R<sup>2</sup> overall: 0.02 0.12

Notes. * p < 0.05, ** p < 0.01 based on 1-tailed tests for hypothesized effects, 2-tailed tests otherwise. N<sub>obs</sub> and N<sub>teams</sub> are 268 and 60, respectively, for both regressions.

For both studies, the results indicate a significant negative effect of prior round performance on coordination change, suggesting that lower-performing teams will enact more significant changes to task coordination, while higher-performing teams will continue with fewer changes. Thus, H1a is supported. The effect of coordination change on subsequent performance is positive and significant in Study 1, suggesting support for H1b. However, the coefficient for coordination change in Study 2, while similar in magnitude, exhibits higher variance and is
therefore not significant, tempering support for H1b. For both studies, the interaction between prior performance and coordination changes is not significant, thus H1c is not supported.33

Emotions and Cognitions in Process Phases

To test H2 and H3, we use data from the 50 dyads that were separated during rounds 2 and 3 of the simulation and provided with an online chat tool to communicate. We look specifically at the transition phase prior to round 2, the action phase of round 2, the transition phase prior to round 3, and the action phase of round 3. Thus, we situate and analyze this data at the team-phase level. This results in 100 possible observations for dyad transition phases, and 100 possible observations for dyad action phases. Some teams did not communicate at all during a phase, resulting in the inability to calculate a proportion, and are excluded from the analyses, resulting in 95 dyad-action phase observations and 94 dyad-transition phase observations.

We measure emotions and cognitions as proportions (bounded at 0 and 1), thus violating distributional assumptions of ordinary least squares regression techniques. We therefore use a generalized least squares (GLM) binomial logit approach (Papke and Wooldridge 1996), specifically the glm function in Stata with logit link and binomial family specifications. As with H1 analyses, we cluster standard errors by team.

To test H2 and H3 (regarding the effects of prior performance on emotions and cognitions during the transition phase), we run four GLM models, one each for positive emotion, negative emotion, sense giving, and sense seeking, each with lagged Rank as the predictor. To test H4 and H5 (predicting emotions and cognitions during the action phase based on emotions and cognitions during the transition phase), we run four GLM models as before, with all four lagged emotion and cognition measures as predictors. All models exhibit good fit based on a chi-

---

33 For completeness, we conducted the same analyses using leaderboard rank and found no significant effects.
square test using reported deviance values (McCullagh and Nelder 1989). **Appendix 4.3** presents correlations and descriptive statistics. *Table 4.7* and *Table 4.8* present these results.\(^{34}\)

**Table 4.7. Effects of Performance on Emotions and Cognitions in Transitions**

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Transition Phase</th>
<th></th>
<th>Positive Emotion</th>
<th>Negative Emotion</th>
<th>Sense Giving</th>
<th>Sense Seeking</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rank(_t)</td>
<td></td>
<td>0.77'</td>
<td>(.44)</td>
<td>-2.29'</td>
<td>0.06</td>
<td>-0.08</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log pseudolikelihood</td>
<td></td>
<td>-27.74</td>
<td>-7.69</td>
<td>-46.58</td>
<td>-38.56</td>
<td></td>
</tr>
</tbody>
</table>

Notes. * p < 0.05, ** p < 0.01 based on 1-tailed tests for hypothesized effects, 2-tailed tests otherwise. N = 95 for all regressions.

**Table 4.8. Effects of Emotions and Cognitions from Transition to Action**

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Action Phase</th>
<th></th>
<th>Positive Emotion</th>
<th>Negative Emotion</th>
<th>Sense Giving</th>
<th>Sense Seeking</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sense Giving(_t)</td>
<td></td>
<td>-1.68'</td>
<td>(.74)</td>
<td>1.27</td>
<td>0.01</td>
<td>0.79</td>
</tr>
<tr>
<td>Sense Seeking(_t)</td>
<td></td>
<td>-1.71'</td>
<td>(.59)</td>
<td>0.31</td>
<td>-0.31</td>
<td>1.63**</td>
</tr>
<tr>
<td>Positive Emotion(_t)</td>
<td></td>
<td>-0.94</td>
<td>(.70)</td>
<td>1.12</td>
<td>-0.15</td>
<td>0.91</td>
</tr>
<tr>
<td>Negative Emotion(_t)</td>
<td></td>
<td>1.19</td>
<td>(.97)</td>
<td>4.37**</td>
<td>-1.19*</td>
<td>0.99</td>
</tr>
</tbody>
</table>

Notes. * p < 0.05, ** p < 0.01 based on 1-tailed tests for hypothesized effects, 2-tailed tests otherwise. N = 94 for all regressions.

As expected, better performance leads to higher positive emotions and lower negative emotions, supporting H2a and H2b respectively. Counter to our hypotheses, performance does not affect sense giving or sense seeking. Thus, H3a and H3b are not supported. We expected both positive and negative emotions during a transition phase to carry over to the subsequent action phase. While this was not the case for positive emotions (H4a not supported), the effect of negative emotions on subsequent negative emotions is significant (H4b supported). Interestingly, both sense giving and sense seeking during the transition phase lead to lower positive emotions during the subsequent action phase. We expected sense giving during the transition phase to

\(^{34}\) For completeness, we conducted the same analyses using profit and found no significant effects.
reduce sense giving during the subsequent action phase (H5a) but did not see this effect. Sense seeking in the transition phase increases sense seeking in the action phase, supporting H5b.

**Post-game Emotional, Cognitive, and Coordination Outcomes**

Prior to analyzing post-game outcomes, we use structural equation modeling (SEM) to conduct confirmatory factor analysis (CFA) for multi-item survey measures using Stata. Model fit is acceptable: $\chi^2 = 279.515$; df = 227; RMSEA = 0.035; CFI = 0.983; TLI = 0.979; SRMR = 0.044; CD = 1.00. Large and significant factor loadings for expected items (loadings > 0.5, p < .001, z > 8.8) support adequate convergent validity. Cronbach’s alpha and composite reliability for all but one construct (Coordination $\alpha = 0.66$) exceed 0.7, and the average variance extracted (AVE) for constructs exceeds the recommended level of 0.5, further supporting convergent validity. We evaluate discriminant validity by comparing the square root of construct AVEs to correlations with other constructs. All correlations among constructs are below the square root of the construct AVE values, indicating adequate discriminant validity (Fornell and Larcker 1981).

**Appendix 4.5** provides the CFA factor loadings.

Because we measure outcomes at the individual level, with some outcomes representing team-level constructs via team referent items, we assess the suitability of aggregating measures to the team level by assessing intraclass correlation (ICC) and within-group agreement ($rwg(j)$). ICC(1) represents the proportion of variance in the construct that is accounted for by team membership. ICC(2) provides an estimate of the reliability of group means. **Table 4.9** presents the ICC and $rwg(j)$ measures for each construct. The team-level constructs exhibited moderate to adequate $rwg(j)$ values of 0.88 (knowledge effectiveness), 0.79 (shared identity) and 0.66 (TMS Coordination), one of which falls slightly below the 0.70 suggested guideline (James et al. 1984; Klein and Kozlowski 2000). ICC(1) values for all team-level constructs exceed 0.2. ICC(2)
values for team constructs are between 0.47 and 0.55. Prior literature suggests ICC(1) values can be as low as 0.06 to be considered acceptable, and ICC(2) values of 0.50 are acceptable (e.g., Maruping and Magni 2015). Interestingly, enjoyment – an individual-level construct – exhibits group aggregation measures in line with the team-level constructs, consistent with the concept of emotional contagion in teams (Barsade 2002), and indicating that shared enjoyment of experiences can be measured and assessed using a measure similar to that at the individual-level.

<table>
<thead>
<tr>
<th>Construct</th>
<th>rwg(j)</th>
<th>ICC(1)</th>
<th>ICC(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge Effectiveness</td>
<td>0.88</td>
<td>0.24</td>
<td>0.51</td>
</tr>
<tr>
<td>Shared Identity</td>
<td>0.79</td>
<td>0.21</td>
<td>0.47</td>
</tr>
<tr>
<td>TMS Coordination</td>
<td>0.66</td>
<td>0.27</td>
<td>0.55</td>
</tr>
<tr>
<td>Immersion (Individual)</td>
<td>0.77</td>
<td>0.05</td>
<td>0.16</td>
</tr>
<tr>
<td>Enjoyment (Individual)</td>
<td>0.61</td>
<td>0.22</td>
<td>0.49</td>
</tr>
</tbody>
</table>

Because some metrics were slightly below suggested cutoff levels (TMS Coordination rwg(j) = 0.66; Shared Identity ICC(2) = 0.47), while most clearly indicate a nested structure in the data, we conduct our primary analyses for H6-H8 using mixed effects regression (using the mixed function in Stata) to evaluate individual outcomes while accounting for random intercepts at the team level. In doing so, we assess members’ perceptions of team-level constructs without explicitly analyzing them at the team level. Table 4.10 presents the correlations and descriptive statistics for H6-H8 based on individual-level data, as well as convergent and discriminant validity measures. Table 4.11 presents the results.

For validation, we also aggregate team-level constructs and perform standard ordinary least squares regressions with consistent results. Table 4.12 presents the results of the team-level analyses using a subset of control variables appropriate to the team level of analysis.

---

35 We report unstandardized survey measures for descriptive statistics and standardize them prior to analyses.
### Table 4.10. Correlations and Descriptive Statistics for H6-H8

<table>
<thead>
<tr>
<th>Construct</th>
<th>Mean</th>
<th>S.D.</th>
<th>α</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Final Profit (standardized)</td>
<td>0.02</td>
<td>0.98</td>
<td>NA</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Final Ranking</td>
<td>0.60</td>
<td>0.28</td>
<td>NA</td>
<td>0.665</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Enjoyment</td>
<td>5.07</td>
<td>1.43</td>
<td>0.94</td>
<td>0.146</td>
<td>0.229</td>
<td>0.814</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Immersion</td>
<td>5.83</td>
<td>1.00</td>
<td>0.87</td>
<td>0.165</td>
<td>0.169</td>
<td>0.455</td>
<td>0.567</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Shared Identity</td>
<td>6.16</td>
<td>1.02</td>
<td>0.93</td>
<td>0.219</td>
<td>0.281</td>
<td>0.257</td>
<td>0.312</td>
<td>0.764</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Knowledge Effectiveness</td>
<td>6.12</td>
<td>0.83</td>
<td>0.88</td>
<td>0.030</td>
<td>0.407</td>
<td>0.418</td>
<td>0.388</td>
<td>0.516</td>
<td>0.779</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 TMS Coordination</td>
<td>5.18</td>
<td>1.37</td>
<td>0.66</td>
<td>0.303</td>
<td>0.429</td>
<td>0.309</td>
<td>0.269</td>
<td>0.509</td>
<td>0.540</td>
<td>0.581</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 Computer Anxiety</td>
<td>1.64</td>
<td>0.90</td>
<td>0.86</td>
<td>-0.027</td>
<td>0.035</td>
<td>0.041</td>
<td>-0.104</td>
<td>-0.131</td>
<td>-0.101</td>
<td>-0.092</td>
<td>0.561</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Computer Self-Efficacy</td>
<td>7.75</td>
<td>1.56</td>
<td>0.78</td>
<td>-0.060</td>
<td>-0.056</td>
<td>-0.016</td>
<td>0.077</td>
<td>0.005</td>
<td>0.172</td>
<td>0.087</td>
<td>-0.185</td>
<td>0.664</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Team Coordination Change</td>
<td>0.05</td>
<td>0.04</td>
<td>NA</td>
<td>0.038</td>
<td>0.021</td>
<td>0.018</td>
<td>-0.053</td>
<td>-0.030</td>
<td>0.021</td>
<td>0.088</td>
<td>-0.108</td>
<td>-0.073</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 Total Activity</td>
<td>254.70</td>
<td>100.81</td>
<td>NA</td>
<td>0.123</td>
<td>0.083</td>
<td>0.084</td>
<td>0.111</td>
<td>0.231</td>
<td>0.117</td>
<td>0.097</td>
<td>-0.114</td>
<td>-0.044</td>
<td>-0.013</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 Prior SAP Experience</td>
<td>3.64</td>
<td>9.60</td>
<td>NA</td>
<td>-0.71</td>
<td>-0.081</td>
<td>0.050</td>
<td>-0.009</td>
<td>0.060</td>
<td>0.049</td>
<td>-0.019</td>
<td>-0.114</td>
<td>0.121</td>
<td>0.067</td>
<td>0.064</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 Current Student</td>
<td>0.40</td>
<td>0.49</td>
<td>NA</td>
<td>0.121</td>
<td>0.015</td>
<td>-0.199</td>
<td>0.024</td>
<td>-0.124</td>
<td>0.007</td>
<td>0.044</td>
<td>0.083</td>
<td>0.131</td>
<td>0.080</td>
<td>0.450</td>
<td>0.150</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>14 Gender (1=Female)</td>
<td>0.29</td>
<td>0.45</td>
<td>NA</td>
<td>-0.059</td>
<td>0.002</td>
<td>0.145</td>
<td>-0.038</td>
<td>-0.105</td>
<td>0.002</td>
<td>-0.121</td>
<td>0.167</td>
<td>-0.106</td>
<td>0.058</td>
<td>0.014</td>
<td>0.027</td>
<td>0.065</td>
<td>1</td>
</tr>
</tbody>
</table>

Max: 197; Min: -1.82.
Notes. N=197; correlations > |0.135| are significant at p < 0.05; diagonals for multi-item constructs indicate AVE.

### Table 4.11. Mixed-level Regression: Effects of Performance on Post-game Outcomes

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Enjoyment</th>
<th>Immersion</th>
<th>Shared Identity</th>
<th>Knowledge Effectiveness</th>
<th>TMS Coordination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final Profit (standardized)</td>
<td>0.19**</td>
<td>0.13**</td>
<td>0.20**</td>
<td>0.30**</td>
<td>0.26**</td>
</tr>
<tr>
<td>Final Ranking</td>
<td>0.65**</td>
<td>0.41**</td>
<td>0.76**</td>
<td>0.69**</td>
<td>1.09**</td>
</tr>
<tr>
<td>Computer Anxiety</td>
<td>0.06</td>
<td>0.07</td>
<td>-0.10</td>
<td>0.09</td>
<td>0.08</td>
</tr>
<tr>
<td>Computer Self-Efficacy</td>
<td>0.04</td>
<td>0.07</td>
<td>-0.01</td>
<td>0.08</td>
<td>0.02**</td>
</tr>
<tr>
<td>Team Coordination ∆</td>
<td>0.02</td>
<td>0.07</td>
<td>-0.12</td>
<td>0.09</td>
<td>0.08</td>
</tr>
<tr>
<td>Total Activity</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Prior SAP Experience</td>
<td>0.01*</td>
<td>0.01*</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Current Student</td>
<td>-0.42</td>
<td>-0.38</td>
<td>0.13</td>
<td>-0.17</td>
<td>0.04</td>
</tr>
<tr>
<td>Gender (1=Female)</td>
<td>0.28*</td>
<td>0.27*</td>
<td>-0.01</td>
<td>-0.20</td>
<td>-0.07</td>
</tr>
</tbody>
</table>

Log pseudolikelihood: -247.0 -245.3 -241.2 -240.5 -248.1 -244.9 -241.0 -234.5 -233.1 -223.9
Wald χ² (8): 29.99 35.22 16.01 16.52 22.65 27.08 25.74 35.63 32.65 66.42
N: 197 197 197 197 198 198 198 198 198 198

Notes. * p < 0.10, ** p < 0.05, *** p < 0.01 based on 1-tailed tests for hypothesized effects, 2-tailed tests otherwise. N_teams = 60 for all regressions.
Table 4.12. Team-level Regression Analyses

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Team Regression Model 11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final Profit (standardized)</td>
<td>0.19** (.08)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final Ranking</td>
<td>0.74** (.21)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team Coordination Change</td>
<td>-0.86 (2.10)</td>
<td>-0.82 (2.00)</td>
<td>-1.37 (2.03)</td>
<td>-1.29 (1.85)</td>
<td>1.59 (2.02)</td>
<td>1.65 (1.76)</td>
</tr>
<tr>
<td>Total Activity</td>
<td>0.00* (.00)</td>
<td>0.00* (.00)</td>
<td>0.00* (.00)</td>
<td>0.00* (.00)</td>
<td>0.00* (.00)</td>
<td>0.00* (.00)</td>
</tr>
</tbody>
</table>

**F-statistic**

<table>
<thead>
<tr>
<th></th>
<th>4.05*</th>
<th>6.54**</th>
<th>5.88**</th>
<th>11.05**</th>
<th>5.49**</th>
<th>13.28**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjusted R²</td>
<td>0.13</td>
<td>0.22</td>
<td>0.20</td>
<td>0.34</td>
<td>0.19</td>
<td>0.38</td>
</tr>
</tbody>
</table>

Notes. * p < 0.05, ** p < 0.01 based on 1-tailed tests for hypothesized effects, 2-tailed tests otherwise. N = 60 for all regressions.

Models 1 through 10 in Table 4.11 predict outcomes at the individual level, accounting for team-level random intercepts. Odd-numbered models use standardized cumulative profit as the performance measure, and even-numbered models use final leaderboard rank as the performance measure. Models 1 and 2 show performance to positively influence perceived enjoyment, supporting H6a. Additionally, females and non-student working professionals report higher enjoyment. Models 3 and 4 show performance to positively influence immersion, supporting H7a. Models 5 and 6 predict shared identity, with both performance measures positively influencing this outcome, supporting H6b. Total activity in the system is positively associated with shared identity, suggesting that more intensive work processes may build stronger bonds among team members. Models 7 and 8 show performance to positively influence knowledge effectiveness, supporting H7b. Computer self-efficacy emerges as a significant (p < 0.01) control in both models, suggesting that confidence in using IS in general is positively associated with the perception of the team’s ability to effectively leverage knowledge in an EIS. Models 9 and 10 show performance to positively influence TMS coordination, supporting H8.

Models 11-16 in Table 4.12 replicate the main findings at the team level of analysis using aggregated measures, based on generally strong indicators to justify aggregation. Figure 4.5
presents a summary of the findings in an emergent model. This figure expands emotions (positive and negative) and cognitions (sense giving and sense seeking) in the original model to more clearly convey the emergent findings. Solid lines indicate full support for proposed hypotheses, and the dashed line indicates partial support for one hypothesis.

![Figure 4.5. Emergent Model](image)

**DISCUSSION**

Taken together, we have unpacked team experiences of competing in a business simulation game using an EIS. As a result, we have developed several insights about how teams coordinate work through EIS, the role of emotions and cognitions, and how the broader experience of gamified EIS training can engage teams while developing core emotional, cognitive, and coordination competencies.

Teams reorganize in response to negative performance feedback, and “stay the course” in response to positive performance feedback (H1a). This reorganization (i.e., changes to task coordination) can result in improved performance (H1b), but not more so for lower performers as hypothesized (H1c). To explain the mixed support for H1b, the context of Study 1 was
unfamiliar to most participants and was therefore more likely to foster learning in a way that would have a more immediate impact on performance. By contrast, the context of Study 2 was a “final game” following several rounds of learning and practice. Incremental learning and changes at this later stage are less likely to result in performance improvements among more experienced competitors.

Emotions and cognitions are complex phenomena that, while not easily distillable in organizational settings, can influence team processes. We specifically considered emotions and cognitions in a process transition phase carrying over to a subsequent action phase. While we observed the expected continuance of negative emotions and sense seeking, we did not see positive emotion carry over from transition to action phases, nor did we see sense giving in transition lead to a lower need for sense giving in the subsequent action phase. We also note significant negative effects of sense giving and sense seeking on subsequent positive emotion, suggesting that a stronger task focus during transition may lead to a more “heads down” approach to action. These findings are consistent with the view of current neuroscience research that emotions and cognitions are related in complex ways (Pessoa 2018).

Gamified EIS training gives trainees an opportunity to immerse themselves in a safe space and enjoy learning how these systems support business processes. Teams who performed well in the training showed improved emotional, cognitive, and coordination outcomes. Consistent with Liu et al. (2017), the dual experiential and instrumental outcomes are a gold standard for successful gamification. However, teams that perform worse do not benefit as much in developing shared identity, knowledge effectiveness, and coordination, and their members experience lower levels of enjoyment and immersion. Given that the mean values for all of these construct are fairly high (on a 7-point scale, ranging from 5.07 for enjoyment to 6.16 for shared
identity), it is likely that lower performing teams still benefit from the experience, though we cannot establish this empirically due to the non-experimental nature of our studies.

We observed a few interesting patterns among the control variables in these outcomes as well. Specifically, women tend to enjoy the team competition more than men did. This is somewhat at odds with prior research that women do not enjoy competition (Niederle and Vesterlund 2007), but consistent with prior research that women enjoy more social (e.g., team) activities in traditional (Eagly and Wood 1991) as well as technology-supported (Kimbrough et al. 2013) contexts. Additionally, “working students” report lower levels of enjoyment than the full-time working professionals. Given that students also had extrinsic motivators tied to this experience (i.e., a graded project), this is consistent with prior research that introducing extrinsic motivators can reduce intrinsic enjoyment of educational activities (Deci et al. 2001). The extent of total activity (i.e., system use) during the game is associated with higher levels of shared identity, suggesting that teams who work harder on a task may develop a stronger emotional bond. Finally, computer self-efficacy was positively associated with knowledge effectiveness, suggesting that individuals with greater confidence in their ability to use an enterprise system consider their group to be more capable of effectively using the knowledge in that system.

**Limitations**

We discuss our findings and contributions in light of the studies’ limitations. Our ability to measure emotion and cognition during the experience was limited to 50 teams of undergraduate students. Because the primary objective in all cases was pedagogical (i.e., EIS training), it was not feasible to disrupt valuable training time of working professionals with an imposed condition that may detract from the core learning objectives.
We limited our studies of coordination to workload distribution changes during the process, and survey-based measures after the process. We thus did not identify specific patterns of coordination, which could be accomplished through techniques such as event sequence analysis and clustering. The data present numerous empirical challenges in accomplishing this, so such inquiry is beyond the scope of this paper. Future research should unpack coordination and collective IS use patterns (Negoita et al. 2018) in this and other IS-related experiences.

We could not test the full model in a single study due to practical limitations. However, we tested the full model with some redundancy across two studies in related but different contexts: one involving traditional undergraduate students in classroom learning and playing a simple game for the first time, and the other involving working professionals (including some part-time students) competing in a more advanced game that they had practiced previously.

We acknowledge the potential for endogeneity in the perceptual outcome variables with performance, as the outcome variables may reflect underlying reasons that teams performed at higher or lower levels. All teams were randomly assigned, and we assume these perceptual measures are reasonably stable. Thus, whether the constructs resulted in better performance or vice versa is less important than the fact that higher performing teams emerge from the training experience with stronger shared identity, more effective knowledge management, and better coordination capability.

Contributions to Theory

We offer the IS literature a process theory of emotion, cognition, and coordination (TECC) in the context of gamified training, highlighting multiple levels through which team processes operate to influence important outcomes and answering calls to examine the temporal evolution of team dynamics and the emergent states resulting from team processes (Mathieu et
al. 2017). We test our theory in the context of a business simulation game in which teams must use an EIS to successfully manage organizational processes. We build on the temporally based framework of team processes (Marks et al. 2001) to unpack the dynamics of team emotion, cognition, and coordination in alternating periods of transition and action, and propose how the broader experience promotes enjoyment and immersion in members, and identity, effectiveness, and coordination in teams.

Organizational processes are complex in terms of both levels of analyses (e.g., individuals, teams, competitions) and levels of temporal aggregation (e.g., specific actions, stages, the overall process). By studying simulated organizations in a relatively controlled environment, we develop a process theory to consider the recurrent cycles of IS use at various levels of analyses and temporal aggregation. We specifically consider the broader cycle of the gamified training experience, the feedback cycle of round-to-round performance, and the phasic periods within rounds as teams oscillate between transition and action. We propose, but do not empirically investigate, a more granular cycle of work patterns within phasic periods. Future research can more deeply investigate these patterns using techniques such as clustering (e.g., Lehmann-Willenbrock et al. 2016) and event sequence analysis (Abbott 1995). With the increasing availability of trace data and organizations’ desire to optimize work processes, future research can apply similar mixed methods approaches to more deeply study work processes within organizations.

We use a combination of analytical methods to test the theory, including text content analysis, panel regression, GLM binomial logit regression, and multi-level mixed effects regression. While none of these methods are new to IS literature, this work illustrates how such methods can be integrated to effectively to test process theories. By combining process and
variance methodologies, we can examine the processes in motion and the resulting outcomes. Given the increasingly social nature of games (Hamari and Keronen 2017), and the need to improve outcomes related to collaboration and coordination, this paper also informs theory and practice by offering a deeper look into the dynamics of a team-based gameful IS.

Contributions to Practice

Games present a “safe space” in which to learn, experiment, and try new things. By immersing teams in a friendly competition using EIS, organizations can encourage exploration of how to more effectively organize and re-organize to improve performance. This exploration yields benefits beyond learning how to use an IS, as teams in Study 2 report high levels of shared identity, knowledge effectiveness, and coordination capability – important team characteristics that can have lasting positive impacts – and they enjoy being immersed in a gamified training process.

Conclusion

We hope that these studies of team emotions, cognitions, and coordination can advance future research in this important area. We utilize a business simulation game involving an EIS for the dual purposes of studying team development through training and understanding how emotions, cognitions, and coordination evolve in teams during the course of a game. Immersive and enjoyable training can serve to develop critical team capabilities, and future research can test TECC in other IS (and non-IS) training contexts. To the extent that games serve to simulate aspects of reality, we believe our findings also warrant further study in real-world work settings.
REFERENCES


Léger, P.M., Robert, J., Babin, G., Pellerin, R. and Wagner, B. 2007, ERPsim, ERPsim Lab, HEC Montréal, Montréal, QC.


Appendices

APPENDIX 4.1. CHAT COMMUNICATION CODING PROCESS

We began with the twelve original IPA categories, and added one additional category for “non-task, non-expressive” communication, which includes greetings, goodbyes, off-task messages with no positive or negative social-emotional connotation, or unintelligible or ambiguous utterances. To establish framework adequacy and coding reliability, a conversation was selected randomly from the sample. Each message sent was initially considered as the unit of classification, and two coders independently categorized each message based on its primary focus. Differences in coding were then discussed and another conversation was selected for coding. Interrater reliability is assessed using Cohen’s (1960) Kappa, with initial Kappa values between 0.25 and 0.50. After further discussion of differences, it became apparent that many of the messages contained two or more distinct thoughts that would fall under different classifications. For example, in Table 1, the message “just uped (sic) mkt. dont (sic) drop prices” expresses two distinct but related ideas: member 2 expresses orientation that she has increased the marketing amounts, and gives a suggestion that member 1 not reduce prices. Conversely, two separate messages may together comprise a single idea. For example, the subsequent messages from member 2 – “drop prices” and “except clear pure” – should be taken together as a single suggestion. To address this, the primary unit of analysis subsequently became the thought unit, defined as a segment of communication behavior for which an observer can determine a distinct classification based on a particular set of categories (Bales 1950).

The two raters continued through several more rounds of coding conversations split into thought units, resulting in Kappa values between 0.57 and 0.66. These levels of agreement are considered moderate to substantial (Landis and Koch 1977), but are not consistent with typical
levels of agreement in current IS literature (e.g., Hong and Pavlou 2014; Tsai and Bagozzi 2014). As a result of this process, the raters determined two further changes that were likely to benefit coding accuracy. First, we observed that the context of lean text communication in decision making leads to ambiguity between suggestions and opinions. For example, “I think we should lower the prices” is the expression of an opinion, but if the speaker’s partner is responsible for updating prices in the system, it is also an indirect (via the use of the collective “we”) suggestion. The difficulty of making this distinction was a major factor in the low levels of agreement during earlier rounds of coding. Thus, we collapsed the categories for “giving suggestion” and “giving opinion” into a single category for “giving a suggestion or opinion,” and the categories for “requesting suggestion” and “requesting opinion” into a single category for “requesting suggestion or opinion.” Second, we determined in several instances that one rater’s lack of experience with the ERPsim context resulted in different interpretations of a thought unit. Thus, we invited a faculty member familiar with ERPsim to participate in further rounds of coding. I and a new rater coded three subsequent rounds of thought units, discussing differences between rounds prior to continuing to the next round. The resulting Kappa values were 0.74, 0.79, and 0.87 for the first, second, and third rounds respectively. Having established sufficient interrater reliability, the first author completed the coding process for 5,024 thought units based on the 3,306 original messages. During the full coding process, we noted an apparent distinction between two types of thought units that were both initially classified as “giving orientation.” One type involved providing information about the simulated environment or the system (e.g., “Sales have slowed down,” “The report code is ZMB52.”), while the other type involved the acknowledgement of a lack of orientation (e.g., “I don’t know what the price is,” “I’m a little lost right now.”). After agreeing on the importance of this distinction, we underwent one additional
round of coding by selecting 50 random thought units from the pool of 2,078 that were initially
classified as “giving orientation.” Agreement in distinguishing between these two types was very
high (Kappa = 0.92), so all 2,078 “giving orientation” thought units were reconsidered, resulting
in 189 thought units identified as our tenth category: “acknowledging lack of orientation.”
APPENDIX 4.2. MEASUREMENT ITEMS

Heightened Enjoyment
1. I have fun interacting with SAP.
2. I enjoy using SAP.
3. (reversed) Using SAP bores me.
4. Using SAP provides me with a lot of enjoyment.

Focused Immersion
1. When I was using SAP, I felt completely absorbed in what I was doing.
2. When I was using SAP, I was able to block out all other distractions.
3. When I was using SAP, I felt totally immersed in what I was doing.
4. When I was using SAP, my attention did not get diverted very easily.

Shared Identity
1. This is an enjoyable group to be in.
2. I feel connected to the group.
3. I identify with this group.
4. I see myself as a member of this group.

Knowledge Effectiveness
1. The available knowledge improves my group's effectiveness in performing this task.
2. The knowledge shared by my group members improved our effectiveness during the task.
3. I am satisfied with the availability of knowledge for my tasks for this exercise.

Transactive Memory System Coordination
1. Our group had very few misunderstandings about what to do.
2. We accomplished the task smoothly and efficiently.

Computer Self-Efficacy – Confidence
I could complete the job using an unfamiliar information system…
1. … if I had seen someone else using it before trying it myself.
2. … if I could call someone for help if I got stuck.
3. … if someone else had helped me get started.
4. … if I had a lot of time to complete the job for which the software was provided.

Computer Self-Efficacy
1. Computers are somewhat intimidating to me.
2. I feel apprehensive about using computers.
3. I hesitate to use a computer for fear of making mistakes that I cannot correct.
APPENDIX 4.3. DESCRIPTIVE STATISTICS AND CORRELATIONS

Table A1. Correlations and Descriptive Statistics for H1 (Study 1)

<table>
<thead>
<tr>
<th>Construct</th>
<th>Mean</th>
<th>S.D.</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Round Profit (standardized)</td>
<td>0.00</td>
<td>1.00</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2  Coordination Change</td>
<td>0.17</td>
<td>0.18</td>
<td>0.081</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>3  Total Activity</td>
<td>73.81</td>
<td>20.92</td>
<td>0.059</td>
<td>0.271</td>
<td>1.000</td>
</tr>
<tr>
<td>Max</td>
<td>4.013</td>
<td>0.806</td>
<td>142</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min</td>
<td>-6.764</td>
<td>0.000</td>
<td>19</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes. N=321. All correlations > |0.13| are significant at p < 0.05.

Table A2. Correlations and Descriptive Statistics for H1 (Study 2)

<table>
<thead>
<tr>
<th>Construct</th>
<th>Mean</th>
<th>S.D.</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Round Profit (standardized)</td>
<td>0.00</td>
<td>1.00</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2  Coordination Change</td>
<td>0.05</td>
<td>0.06</td>
<td>0.194</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>3  Total Activity</td>
<td>155.30</td>
<td>50.80</td>
<td>0.169</td>
<td>0.271</td>
<td>1.000</td>
</tr>
<tr>
<td>Max</td>
<td>3.325</td>
<td>0.373</td>
<td>293</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min</td>
<td>-3.688</td>
<td>0.000</td>
<td>42</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes. N=328. All correlations > |0.11| are significant at p < 0.05.

Table A3. Correlations and Descriptive Statistics for H2-H5

<table>
<thead>
<tr>
<th>Construct</th>
<th>Mean</th>
<th>S.D.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Round Rank</td>
<td>0.52</td>
<td>0.30</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2  Positive Emotion (Action)</td>
<td>0.08</td>
<td>0.06</td>
<td>-0.078</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3  Negative Emotion (Action)</td>
<td>0.01</td>
<td>0.02</td>
<td>-0.207</td>
<td>0.120</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4  Sense Seeking (Action)</td>
<td>0.15</td>
<td>0.08</td>
<td>-0.076</td>
<td>-0.353</td>
<td>0.080</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5  Sense Giving (Action)</td>
<td>0.62</td>
<td>0.10</td>
<td>0.157</td>
<td>-0.242</td>
<td>-0.248</td>
<td>-0.546</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6  Positive Emotion (Transition)</td>
<td>0.13</td>
<td>0.14</td>
<td>0.074</td>
<td>0.079</td>
<td>0.029</td>
<td>-0.045</td>
<td>-0.006</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7  Negative Emotion (Transition)</td>
<td>0.02</td>
<td>0.07</td>
<td>-0.167</td>
<td>0.217</td>
<td>0.231</td>
<td>0.025</td>
<td>-0.176</td>
<td>0.000</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8  Sense Seeking (Transition)</td>
<td>0.23</td>
<td>0.21</td>
<td>-0.102</td>
<td>-0.138</td>
<td>-0.086</td>
<td>0.350</td>
<td>-0.126</td>
<td>-0.301</td>
<td>-0.076</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>9  Sense Giving (Transition)</td>
<td>0.47</td>
<td>0.20</td>
<td>0.099</td>
<td>-0.111</td>
<td>0.056</td>
<td>-0.180</td>
<td>0.137</td>
<td>-0.299</td>
<td>-0.129</td>
<td>-0.611</td>
<td>1</td>
</tr>
<tr>
<td>Max</td>
<td>1.00</td>
<td>0.29</td>
<td>0.10</td>
<td>0.35</td>
<td>0.81</td>
<td>0.67</td>
<td>0.40</td>
<td>1.00</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.33</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes. N=94. All correlations > |0.19| are significant at p < 0.05.
APPENDIX 4.4. CHANGES IN COGNITION AND EMOTION

Given business simulations’ focus on learning, we conduct a limited post hoc analysis of cognitions and emotions across phases. Figures A1-A4 show changes from Round 2 Transition to Round 3 Transition for cognitions and emotions (A1 and A3, respectively), and from Round 2 Action to Round 3 Action for cognitions and emotions (A2 and A4, respectively). Notably, sense seeking went down while sense giving went up from one transition phase to the next, suggesting that learning took place as teams sought less knowledge and provided more.
Figure A3. Emotion in Transition

Figure A4. Emotion in Action
## APPENDIX 4.5. FACTOR LOADINGS IN CONFIRMATORY FACTOR ANALYSIS

Table A5. CFA Factor Loadings

<p>| Measurement | Coef.     | Std. Err. | z      | P&gt;|z| | [95% Conf. Interval] |
|-------------|-----------|-----------|--------|-----|----------------------|
| ENJ1        |           |           |        |     |                      |
| ENJ         | 0.926175  | 0.012407  | 74.65  | 0   | 0.9018572 0.950493   |
| _cons       | 3.519846  | 0.195626  | 17.99  | 0   | 3.136427 3.903266    |
| ENJ2        |           |           |        |     |                      |
| ENJ         | 0.97309   | 0.007984  | 121.89 | 0   | 0.9574427 0.988738   |
| _cons       | 3.278183  | 0.18412   | 17.8   | 0   | 2.917314 3.639052    |
| ENJ3        |           |           |        |     |                      |
| ENJ         | 0.820469  | 0.025301  | 32.43  | 0   | 0.7708791 0.870059   |
| _cons       | 3.172106  | 0.17911   | 17.71  | 0   | 2.821056 3.523155    |
| ENJ4        |           |           |        |     |                      |
| ENJ         | 0.88235   | 0.017811  | 49.54  | 0   | 0.8474419 0.917259   |
| _cons       | 3.062829  | 0.173978  | 17.6   | 0   | 2.721834 3.40382     |
| IMM1        |           |           |        |     |                      |
| IMM         | 0.839031  | 0.033046  | 25.39  | 0   | 0.774261 0.9038      |
| _cons       | 5.967036  | 0.316251  | 18.87  | 0   | 5.347196 6.586877    |
| IMM2        |           |           |        |     |                      |
| IMM         | 0.594407  | 0.053046  | 11.21  | 0   | 0.49044 0.698374     |
| _cons       | 4.355119  | 0.235339  | 18.51  | 0   | 3.893863 4.816375    |
| IMM3        |           |           |        |     |                      |
| IMM         | 0.889494  | 0.03042   | 29.24  | 0   | 0.8298726 0.949115   |
| _cons       | 5.641076  | 0.299919  | 18.81  | 0   | 5.053246 6.228907    |
| IMM4        |           |           |        |     |                      |
| IMM         | 0.647883  | 0.048431  | 13.38  | 0   | 0.5529608 0.742806   |
| _cons       | 4.134941  | 0.225371  | 18.35  | 0   | 3.693223 4.576659    |
| SIDENT1     |           |           |        |     |                      |
| SIDENT      | 0.751436  | 0.033838  | 22.21  | 0   | 0.6851143 0.817758   |
| _cons       | 7.046473  | 0.370641  | 19.01  | 0   | 6.320031 7.772915    |
| SIDENT2     |           |           |        |     |                      |
| SIDENT      | 0.953227  | 0.011582  | 82.3   | 0   | 0.9305268 0.975926   |
| _cons       | 5.360883  | 0.285925  | 18.75  | 0   | 4.800481 5.921284    |
| SIDENT3     |           |           |        |     |                      |
| SIDENT      | 0.910524  | 0.01559   | 58.4   | 0   | 0.8799672 0.94108    |
| _cons       | 5.0208    | 0.269003  | 18.66  | 0   | 4.493563 5.548037    |
| SIDENT4     |           |           |        |     |                      |
| SIDENT      | 0.867577  | 0.020653  | 42.01  | 0   | 0.8270989 0.908055   |
| _cons       | 6.356156  | 0.335809  | 18.93  | 0   | 5.697982 7.01433     |
| KEFF1       |           |           |        |     |                      |
| KEFF        | 0.840196  | 0.029427  | 28.55  | 0   | 0.782521 0.897872    |
| _cons       | 7.501767  | 0.370641  | 19.01  | 0   | 6.730151 8.273382    |
| KEFF2       |           |           |        |     |                      |
| KEFF        | 0.946531  | 0.026915  | 35.17  | 0   | 0.8937778 0.999283   |
| _cons       | 7.137307  | 0.375235  | 19.02  | 0   | 6.401861 7.872753    |
| KEFF3       |           |           |        |     |                      |
| KEFF        | 0.856997  | 0.035178  | 24.36  | 0   | 0.7880494 0.925945   |
| _cons       | 5.605717  | 0.298151  | 18.8   | 0   | 5.021352 6.190081    |
| TMSCOORD1   |           |           |        |     |                      |
| TMSCOORD    | 0.529649  | 0.06014   | 8.81   | 0   | 0.4117763 0.647521   |
| _cons       | 2.53313   | 0.149616  | 16.93  | 0   | 2.239888 2.826372    |
| TMSCOORD2   |           |           |        |     |                      |
| TMSCOORD    | 0.938339  | 0.052782  | 17.78  | 0   | 0.8348886 1.04179    |
| _cons       | 4.206075  | 0.228845  | 18.38  | 0   | 3.757548 4.654602    |
| CSE1        |           |           |        |     |                      |
| CSE         | 0.876298  | 0.043413  | 20.19  | 0   | 0.7912103 0.961385   |</p>
<table>
<thead>
<tr>
<th></th>
<th>cons</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CSE2</td>
<td>3.36506</td>
<td>0.188242</td>
<td>17.88</td>
<td>0</td>
<td>2.996111</td>
</tr>
<tr>
<td>CSE</td>
<td>0.757125</td>
<td>0.040404</td>
<td>18.74</td>
<td>0</td>
<td>0.6779349</td>
</tr>
<tr>
<td>cons</td>
<td>4.543496</td>
<td>0.245401</td>
<td>18.51</td>
<td>0</td>
<td>4.062519</td>
</tr>
<tr>
<td>CSE3</td>
<td>0.952273</td>
<td>0.037986</td>
<td>25.07</td>
<td>0</td>
<td>0.8778219</td>
</tr>
<tr>
<td>cons</td>
<td>4.530645</td>
<td>0.244768</td>
<td>18.51</td>
<td>0</td>
<td>4.050908</td>
</tr>
<tr>
<td>CSE4</td>
<td>0.638405</td>
<td>0.048461</td>
<td>13.17</td>
<td>0</td>
<td>0.5434232</td>
</tr>
<tr>
<td>cons</td>
<td>4.209961</td>
<td>0.229035</td>
<td>18.38</td>
<td>0</td>
<td>3.761061</td>
</tr>
<tr>
<td>CANX1</td>
<td>0.80116</td>
<td>0.046898</td>
<td>17.08</td>
<td>0</td>
<td>0.7092421</td>
</tr>
<tr>
<td>cons</td>
<td>1.575041</td>
<td>0.109165</td>
<td>14.43</td>
<td>0</td>
<td>1.361082</td>
</tr>
<tr>
<td>CANX2</td>
<td>0.699497</td>
<td>0.051525</td>
<td>13.58</td>
<td>0</td>
<td>0.598509</td>
</tr>
<tr>
<td>cons</td>
<td>1.410624</td>
<td>0.103011</td>
<td>13.69</td>
<td>0</td>
<td>1.208726</td>
</tr>
<tr>
<td>CANX3</td>
<td>0.741949</td>
<td>0.048242</td>
<td>15.38</td>
<td>0</td>
<td>0.6473972</td>
</tr>
<tr>
<td>cons</td>
<td>1.640028</td>
<td>0.111681</td>
<td>14.68</td>
<td>0</td>
<td>1.421138</td>
</tr>
</tbody>
</table>

Notes. ENJ = Enjoyment; IMM = Immersion; SIDENT = Shared Identity; KEFF = Knowledge Effectiveness; TMSCOORD = TMS Coordination; CSE = Computer Self-efficacy; CANX = Computer Anxiety
APPENDIX REFERENCES


Chapter 5. Conclusion

Overall, this dissertation contributes to research and practice in several ways. Essay 1 brings conceptual clarity to the myriad phenomena at the convergence of work and play by establishing a theoretically grounded classification of gameful IS and enhancing it through identification of emergent categories based on in-depth interviews with working professionals. We use the lens of affordances, extending the recent needs-affordances-features framework (Karahanna et al. 2018) to the domain of gameful IS, to consider the intentions of both the designer and player in shaping emergent narratives of IS in use. We propose nine categories of gameful IS in use and identify five emergent clusters (which are compatible with theorized categories) based on text mining of interview data. We offer these classifications as kernels of theory that emphasize salient contextual factors for guiding richer theory development on gameful IS. Taken broadly, Essay 1 findings illustrate the generativity of play, underscoring the need for further research and application of gameful IS.

Essay 2 develops a process theory of online competitions (PTOC) by integrating the social comparison view of competition (Garcia et al. 2013) with the input-mediator-output-input process model (Ilgen et al. 2005) and drawing on relevant literature in feedback and social comparison. At the heart of PTOC is a self-correcting feedback loop involving emotions, cognitions, accumulated effort, continued participation, and performance. We find support based on an initial test of the theory in the context of online analytics competitions. Online competitions such as the one studied in Essay 2 (Kaggle) generally fall into the emergent category of “productive play” identified in Essay 1, where novices and experts alike compete in hopes of developing new skills and possibly winning monetary rewards. We highlight the importance of studying episodic IS use by studying player submission cycles in online
competitions, and further contribute to IS literature by adapting the survival analysis method to predict continued use of an IS.

Essay 3 develops a theory of emotion, cognition, and coordination (TECC) in teams, situated in a gameful IS context. As with Essay 2, we draw attention to nuance in the level of theorizing and analyses by considering multiple levels of temporal aggregation inherent in gameful IS (e.g., an instance of playing a game within its lifecycle, the progression through rounds of a game, and phases within rounds). Also consistent with Essay 2, we highlight the important role of emotions and cognitions as mediators of action. We ground our theory in literature on task coordination (e.g., Knoblich and Jordan 2003) and team processes (Marks et al. 2001), and consider the emotional, cognitive, and coordination mechanisms in recurrent processes, and the subsequent emotional, cognitive, and coordination outcomes from the broader experience. We test and find general support for the theory in the context of a simulation game in which teams compete by using an enterprise IS to manage virtual firms. This experience generally falls into the emergent category of “enjoyable discovery” identified in Essay 1, as players learn about business process integration through enterprise IS in a fun and engaging way. Simulations such as the one in Essay 2 offer an excellent canvas to study human behavior in a realistic setting, and they do so in a way that individuals and teams can “fail safely” as they learn and explore new environments.

Much work remains to be done in the nascent domain of gameful IS. This dissertation lays important foundations for future theory development by offering a classification that situates the IS in use as the focal unit. It is through the study of IS in use that we can better understand human motivation to engage in enjoyable activities, and how enjoyment and instrumentality correlate through gameful experiences with IS. We study two emergent types of gameful IS,
productive play and enjoyable discovery, in developing PTOC in Essay 2 and TECC in Essay 3, respectively. Consistent with the focus of Essay 1 on the experience of the player, PTOC and TECC adopt a keen focus on player experiences through process-centric theory and methods to unpack the recurrent and hierarchical cycles of play, and the emotions and cognitions enmeshed therein. Through understanding gameful IS phenomena as complex processes, scholars can meaningfully inform practice through design guidance at multiple levels of abstraction.

We hope that this greater conceptual clarity will be beneficial not only to future research in IS and related disciplines, but also to practitioners seeking to harness the allure and motivational power of games to enhance the performance of individuals, teams, and organizations. We situate our studies in the important contexts of analytics and enterprise systems. These topics embody prevalent concerns in modern organizations as decision making becomes more data-driven and enterprise systems remain critical in an age of big data and increasing integration.

The domains of work and play are converging, and they are doing so in large part due to technological advances and the consequent ability of IS to afford experiences that are both enjoyable and practical. As a field, IS is well-positioned to lead the way in developing theory and informing practice to maximize the positive impacts, and minimize the negative impacts, of gameful IS. This dissertation represents an important step in advancing our understanding of how gameful experiences with IS influence emotions, cognitions, and behaviors.
REFERENCES


