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IMPROVING KNOWLEDGE COORDINATION IN EARLY STAGES OF SOFTWARE DEVELOPMENT USING GAMIFICATION

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ABSTRACT

Research on software development teams, both co-located and virtual, reveals that additional focus is necessary to improve coordination. This research-in-progress explores one element of gamification for improving the initial stages of software team coordination. We develop a model to empirically test the effects of gamification during software requirements elicitation on both co-located and virtual teams based on a controlled 2 x 3 experiment.

Keywords

Knowledge Coordination, Gamification, Team, Software Development

INTRODUCTION

Software development is a collaborative environment that requires the sharing of knowledge across teams; however, much of the time who holds the knowledge is not known and team members are forced to forage for required expertise (Rus and Lindvall, 2002). To that end, knowledge directories provide organizations the ability to map a high percentage of knowledge that remains otherwise uncoded (Alavi and Leidner, 2001). In light of the continuing failures reported in software development and the potential for knowledge management to assist in improvement (Bjørnson and Dingsøyr, 2008), this research proposes new methodologies to aid in software team collaboration.

On-line games are used by researchers to study team development and gamification is currently employed by practitioners to improve employee performance. This research seeks to show that, more than just an Information Systems fad, gamification can be a useful tool for practitioners. Focusing on one aspect of gamification and developing a controlled laboratory experiment, this research addresses the following research questions:

RQ1: Can gamification improve the expertise coordination processes in software development teams?

RQ1a: Initiated at the team-forming state of a project, does gamification increase the ability of team members to locate expertise?

RQ1b: Does gamification lead to better collaboration in newly formed software development teams?

RQ2: Are the effects of gamification more pronounced in co-located or virtual teams?

By exploring these questions, this research contributes to the rich stream of extant knowledge management literature as well as satisfies the call for controlled experiments of Bjørnson and Dingsøyr (2008). Furthermore, the research supports the systems development literature by proposing a validated methodology to improve collaboration. Finally, the research supports a current, relevant, and emerging trend in the business community: gamification.

The rest of the paper is organized as follows. The next section reviews the literature on software development teams and the components of gamification. This is followed by a section describing our proposed model and hypotheses. Next is a discussion of the experiment methodology and expected results. The paper concludes with a brief discussion.

LITERATURE REVIEW

Software Development Teams

Software development relies on the knowledge and expertise within the software group (Bjørnson and Dingsøyr, 2008; Faraj and Sproull, 2000; Rus and Lindvall, 2002). As a result, knowledge transfer is a requirement in software development groups (Joshi, Sarker and Sarker, 2007). In many organizations, knowing who knows what is often

difficult, causing team members to waste time and effort searching for resources (Rus and Lindvall, 2002). This is especially true when attempting to find undocumented knowledge (Rus and Lindvall, 2002) or when personnel are in different groups (Kulkarni, Ravindram, and Freeze, 2006). Knowledge location systems can be used to connect knowledge seekers with knowledge holders (Kulkarni et al., 2006).

Within software development team research, knowledge location and expertise has not been a focal issue. Kraut and Streeter (1995) show in their research that discussions with peers internal to software development teams is the most effective and widely used coordination mechanisms, over CASE tools, source code, discussions with management, status reviews, e-mail, etc. Walz, Elam, and Curtis (1993) discuss the trouble associated with knowledge sharing for requirements definition and software design based on a software project case study.

He, Butler, and King (2007) measure the impact of team interactions and preexisting conditions on team cognition and team performance. The authors use (i) member familiarity, (ii) gender diversity, and (iii) background diversity as proxies for team characteristics. Team cognition is measured through (i) awareness of expertise location and (ii) shared task understanding. Furthermore, the authors show that time has a mediating effect on team cognition from team characteristics.

Faraj and Sproull (2000) look specifically at coordination within software development teams. In their study, the authors measure the effects of (i) conventional team factors and (ii) expertise coordination processes on team performance. Conventional team factors are defined as (i) presence of expertise, (ii) professional experience, (iii) administrative coordination, and (iv) software development methods. Expertise coordination processes are defined as (i) recognizing where expertise is needed, (ii) knowing where expertise is located, and (iii) bringing expertise to bear.

Virtual Software Development Teams

The popularity of virtual teams has grown over the years as technological advances have improved the ability of virtual team members to communicate and collaborate (Bell and Kozlowski, 2002; Hertel, Geister, and Konradt, 2005). Research on virtual software development teams (see Colazo and Fang 2010, Johri 2011; Reed and Knight, 2010) often discuss varying effects of dispersed teams on the development process, but have not focused specifically on how to quickly initiate team interaction and collaboration.

Similarly, while there are a number of issues confronting all virtual teams and their leaders (see Berry 2011; Clear and MacDonell, 2011; Siebdrat, Hoegl, and Ernst, 2009), the ability not only to bring a team quickly on-line, but to have them perform effectively (Bell and Kozlowski, 2002) is rarely discussed. Hertel et al. (2005) propose a five-stage lifecycle for virtual teams that includes key activities such as (i) getting acquainted, (ii) team rules, and (iii) goal clarification. The activities identified by Bell and Kozlowski (2002) as well as those identified by Hertel et al. (2005) are not specific to virtual teams alone, but take on a greater importance and difficulty due to the fact that virtual teams are not co-located.

Kanawattanachai and Yoo (2007) consider temporal aspects of knowledge location and team performance in their study of virtual teams. The authors note that, with regards to knowledge location: “. . . due to the unique characteristics of virtual teams – the lack of past history, the separation in time and space, and the use of computer-mediated communication – virtual team members will face even greater challenges” in developing knowledge location (Kanawattanachai and Yoo, 2007, pp. 787).

Jarvenpaa and Leidner (1999) considered communication and trust in their research; the authors' case study provides examples of where a lack of early communication and social exchanges affected team performance. Berry (2011) notes that virtual team members are often slower to share information than are co-located teams. Ahuja (2010) notes the effect on trust within virtual teams due to often lacking social communications.

Cramton's (2001) study of dispersed teams explores mutual knowledge. Cramton elucidates on five types of communication failures, (i) failure to communicate and retain contextual information, (ii) unevenly distributed information, (iii) difficulty communicating and understanding the salience of information, (iv) differences in speed of access to information, and (v) difficulty interpreting the meaning of silence.

Espinosa, Slaughter, Kraut and Herbsleb, (2007) also explore distributed software development teams. In their research, the authors consider the effects of time on coordination and knowledge sharing, and specifically look at what they classify as long-term and fleeting knowledge. Shared knowledge including knowledge of which team members have what knowledge is a form of long term knowledge that takes time to develop but remains intact over time.

Gamification

Gamification is a mixture of game design ideology, positive psychology, and the philosophy of games used to create an environment that employees find more challenging and rewarding which results in an increased desire to participate and contribute (McGonigal, 2011b). Gamification is a growing trend in practitioner IS (Gartner Group, 2011) and is being implemented already by companies such as SAP (Clark, 2011). In fact, the theme of SAP's 2011 Tech-Ed conference was gamification (SAP Tech-Ed, 2011) at which McGonigal provided the keynote address (McGonigal, 2011a).

Gamification can be used to exploit the aspects of game design that envelope game players and uses them to encourage the same intensity in reality. It is the exhibition of (i) urgent optimism, (ii) social fabric, (iii) blissful productivity, and (iv) epic meaning that gamification attempts to leverage (McGonigal, 2010). Effective game design must include elements of possibility (i.e., optimism), interest (i.e., curiosity), self-motivation (i.e., agency) and meaning (i.e., awe and wonder) (McGonigal, 2009).

Gamification can be implemented in systems design, but it can also be implemented through game-type activities. Examples of game-type activities that are currently in use are (i) airline frequent flyer programs that allow 'players' the ability to 'level-up' and receive increased benefits, (ii) special badges for frequenting certain websites (Ng, 2011a), and (iii) in the future websites that provide overt interactions in a game-centric manner (Ng, 2011b).

In addition to borrowing from game design elements, gamification also borrows from both positive psychology and the study of games (McGonigal, 2011b). Positive psychology is a movement in the psychological discipline to move away from primarily diagnosing and identifying adverse mental conditions and to move back towards researching what makes people positive and productive (Seligman and Csikszentmihalyi, 2000).

Beginning in 2000, positive psychology is a push to move away from the pathological stream of research and focus that has dominated psychology since post-World War II and towards a psychology that studies what "mak[es] normal people stronger and more productive and mak[es] high human potential actual" (Seligman and Csikszentmihalyi, 2000, pp. 8).

Seligman and Csikszentmihalyi (2000) describe positive psychology as focusing on four personal traits: (i) subjective well-being (see Diener, 2000), (ii) optimism (see Peterson, 2000), (iii) happiness (see Myers, 2000), and (iv) self-determination (see Schwartz, 2000). Vaillant (2000) discusses the use of three coping mechanisms, (i) seeking social support, (ii) conscious cognitive strategies, and (iii) involuntary mental mechanisms in his quest to develop a positive psychology measure. Studies (see Salovey, Rothman, Detweiler, and Steward, 2000; Tayler, Kemeny, Reed, Bower, and Gruenewald, 2000) also show that positive outlooks can actually help with physical illness. Positive psychology has also been extended to the study of positive organizational behavior (Avey, Luthans, and Youssef, 2007; Luthans and Youssef, 2007; Youssef and Luthans, 2007). Positive psychology also includes elements of play and voluntary exercises (Seligman and Csikszentmihalyi, 2000).

Play and voluntary exercises fit within the framework of games described by Suits. Playing a game, to quote Suits, is:

to engage in activity directed toward bringing about a specific state of affairs, using only means permitted by specific rules, where the means permitted by the rules are more limited in scope than they would be in the absence of the rules, and where the sole reason for accepting such limitation is to make possible such activity (Suits, 1967, pp. 156).

Suits provides this definition of a game in his 1967 monograph and later incorporates the same definition in his work *The Grasshopper: Games, Life and Utopia*. In his manuscript (1978) Suits builds and supports the definition of a game to inhibit argument of what constitutes and what does not constitute a game. Furthermore, Suits at first proposes a Utopian environment where all there is to do is play games, but in the end postulates that mankind would not be satisfied by this sort of frivolous life and therefore concedes that life must include a useful purpose and that what we consider work can also be considered a voluntary choice¹.

¹ The overview of Suits' work does not attempt to capture the entirety of Suits' philosophy on games; readers are strongly encouraged to read Suits' *The Grasshopper* for a true understanding of *Games, Life and Utopia*.

MODEL

Faraj and Sproull (2000) support the notion that expertise location positively affects team performance. The conceptual model of He et al. (2007) tells us that team interaction improves team cognition and team performance. This was further proved by He et al. (2007)'s empirical model which showed that communication frequency and member familiarity were directly related to team cognition; awareness of expertise location and shared task understanding. As He et al. (2007) show that cognition evolves over time, we posit that:

H_{1a}: Interaction during team formation is positively related to team members' ability to locate expertise.

H_{2a}: Interaction during team formation is positively related to team collaboration.

Furthermore, gamification provides that the more involved or interested people are in their tasks the better they do (McGonigal, 2011b). Game playing helps to promote positive psychological traits and create a sense of purpose while also weaving a social fabric (McGonigal, 2011b). Due to these characteristics of gamification, we also posit that:

H_{1b}: Game-based interaction during team formation is more positively related to team members' ability to locate expertise (than non-game-based interaction).

H_{2b}: Game-based interaction during team formation is more positively related to team collaboration (than non-game-based interaction).

Finally, because knowledge coordination in virtual teams is more of an issue (Kanawattanachai and Yoo, 2007), we posit that:

H_{3a}: The effects of interaction will be greater for virtual teams than co-located teams.

H_{3b}: The effects of interaction during team formation will be greater for virtual teams than co-located teams.

H_{4a}: The effects of game-based interaction will be greater for virtual teams than co-located teams (than non-game-based interaction).

H_{4b}: The effects of game-based interaction during team formation will be greater for virtual teams than co-located teams (than non-game-based interaction).

EXPERIMENT DESIGN

To test the eight hypotheses, a 2 X 3 experiment will be used. The experiment will measure the differences between teams performing a software development task under three conditions both co-located and virtual² (Table 1).

	Co-Located	Virtual
No Introduction	1A	1B
Controlled Introduction	2A	2B
Gamified Introduction	3A	3B

Table 1: Experiment Design

Knowledge location will be measured by monitoring the team discussions during the assigned task. Higher levels of knowledge location are signaled by teams that are able to incorporate unshared knowledge and hidden knowledge. Team collaboration will be measured by the final product delivered from the task. Higher collaboration will result in more complete deliverables.

Procedure

Experiment subjects are divided into proposal teams consisting of 5 members plus a proposal team lead to help control the proposal building process. Each team member is provided a copy of the client's request for proposal and given 5 minutes to review it. Following this, each team member is shown a different 5 minute video recording of the client explaining specific requirement interpretations of the system to be proposed.

After viewing the videos the group members are brought together and the proposal lead provides an overview of the task and procedures. The task is to generate a proposal based on the client's requirements augmented by the discussion provided via video. Group 1A and 1B are to immediately begin to work on the task without any further

² While real-world virtual teams can be synchronous or asynchronous, this study focuses on synchronous only.

direction. Group 2A and 2B are told to introduce themselves and given 10 minutes to interact prior to beginning the task. Group 3A and 3B play a 10 minute game that helps to expose the knowledge location and ignite collaboration. Following this, each team is given 45 minutes to complete the assignment.

Design

The interactive group introduction game played by Group 3 is intended to not only introduce the players to each other, but also to prompt the players to identify the knowledge they have been given as well as to jump-start the collaboration of the team by having them play together. In this way, the gamification of Group 3 should increase the expertise coordination processes which should result in better team performance.

Subjects

Subjects for the research experiment are students enrolled in the Computer and Information Sciences bachelor degree programs in a Mid-Western University.

Expected Results

The research design expects to empirically support the hypothesis that gamification can be used to improve the expert coordination process in software development teams and activities. The research also expects to support the original Faraj and Sproull (2000) model in that both conventional team factors and expert coordination processes are positively related to team performance, and that expert coordination processes have more impact than conventional team factors.

The research also hopes to prove that in virtual team environments, gamification has an even greater impact on expert coordination processes than in face-to-face situations.

DISCUSSION

This research contributes to the existing literature on many fronts. First, the study extends Faraj and Sproull (2000)'s model on coordinating software development team expertise which in turn should help improve the success of software development projects. Additionally, the research supports the existing literature on knowledge management. Finally, the research weighs in on a fast growing trend in practitioner information systems: gamification.

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