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The Impact of Second Life on Team Learning Outcomes from the Perspective of IT Capabilities*

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3D virtual world has been widely applied in e-learning project, as its several advantages like 3D avatar, rich communication channels. This study focuses on a case of famous virtual world (i.e., Second Life, SL) application in on-line engineering education project. Based on the theory of IT capabilities, we investigated how SL provides value for on-line team as improving their knowledge work outcome. The findings suggested that SL may influence team leaning from two levels. First, at individual level, SL generally positive related to the individual knowledge work, including coding language skills, and personal creativity. Second, at team level, SL positively influence the team learning, by providing rich social resources, social networks, and efficient team dynamics. However, SL also has some disadvantages which may disturb the team learning, like advertising information's, gambling, and sex. We suggest the project must provide some rules to limit students to access information's unrelated to class objectives.

Keywords: second life; team learning outcome; tacit knowledge; IT capabilities; digital options

1. Introduction

3D virtual world is a computer-based simulated 3D environment intended for its users to inhabit and interact via avatars [1]. There are many synonyms for 3D virtual world, such as 'Web 3.D' [2]. From 2006, one virtual world called Second Life, won great success and became the largest platform. As 3D environment can attract students' interests and enhance the engagement, Second Life had widely been applied in e-learning. For example, Hong Kong has established a large engineering learning platform with embraced Second Life, and try to improve students' learning motivation [3]. Some high school also applied Second Life in engineering education [4].

Second Life has several functionalities and advantages, such as interface of 3D, embraced voice and chatting, which may enhance the explicit and tacit knowledge sharing. As requirement of innovative and team learning in engineering education, several educational researchers and practitioners supposed the application of Second Life will improve team learning outcome. However, rare studies have theoretically explained how emerging 3D virtual world technologies (e.g., Second Life) impact innovative learning and team knowledge work outcome in online engineering education.

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In this study, we pursue the following research question: how Second Life impact on the team knowledge work outcome?

The remainder of this article is constructed as follows. In section 2, theory background and previous research are reviewed; then, the case background and data collection methods are introduced; in section 4, interviews are analyzed; and finally, discussions and conclusions are presented.

2. Literature review

2.1 IT capabilities

IT capability is a critical conception of IT resource-based theory, which is derived from resource-based view (RBV) in economics. According to RBV, firm or nations may have special resources or capabilities to enhance their competitive advantages [5]. In IS field, Sambamurthy established the framework of IT resource-based theory, and explained how IT can brings value for organizations through agility [6].

Firms' IT capability comprises IT infrastructure (functionality), IT requirement, and IT-enabled intangibles, and these IT capabilities may impact on organization or team's digital options. Digital options refer to the organizational capabilities enabled by IT and they can mediate the IT and organization performance [6]. In e-learning field, virtual world's digital options comprise knowledge reach, knowledge richness and frequency. 'Reach'

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and 'richness' can be explained by the quantitative and qualitative nature of IT-based capabilities [7].

Knowledge reach can be defined as the comprehensiveness and accessibility of codified knowledge in a firm's knowledge base and the interconnected networks and systems for enhancing interactions among individuals for knowledge transfer and sharing. It comprised at least two functionalities, knowledge distribution and knowledge storing.

Knowledge richness can be defined as the systems of interactions among organizational members to support sense-making, perspective sharing and development of tacit knowledge [6]. It comprised two functionalities, communications and collaborations.

2.2 Knowledge work outcomes

Knowledge can be defined as different types. Nonaka et al. [8] classify knowledge into explicit knowledge and tacit knowledge. Explicit knowledge is codified knowledge that has been articulated in symbolic form; tacit knowledge includes two elements: 1) the cognitive element referring to mental models (e.g., beliefs and viewpoints), and 2) the technical element referring to skills that can be applied in a special context (e.g., know-how).

Among all types of knowledge, tacit knowledge has been highlighted as a valuable intangible resource and a critical source of competitive advantage [9]. Tacit knowledge is theorized to be difficult to imitate, impossible to codify and therefore impossible to separate out for sale through factor markets [10]. According to RBV, tacit knowledge can lead to sustained competitive advantages in organizations. Tacit knowledge is difficult to be taught or learned directly by reading or listening, as Berman mentioned, 'tacit knowledge must be learnt through experience' [10].

According to the knowledge learning outcome perspective, we divide tacit knowledge into two types: individual tacit knowledge and team tacit knowledge. Individual tacit knowledge is closely related to the concept of skills, and experience is believed as a critical source of individual tacit knowledge [10]. Several studies found that the greater of unique knowledge held by individuals, the greater for new knowledge generated by the team dynamics [9]. Thus, the increases of individual tacit knowledge or skills will be positively associated with the creation of new knowledge in e-learning project.

Team knowledge can be defined as 'the combination of individual cognitive schemata, patterns, or gestalts acquired through mutual experience and expressed through unconscious synchronicity of action when the group is confronted with complex tasks that must be performed within the context of a challenging environment' [10]. Team tacit knowledge cannot be codified, and the utility of it is contingent with the context. Differentiated from individual tacit knowledge, team knowledge is another source of knowledge creation, and is a relatively dynamic concept. Shared experience is important for the generation of team tacit knowledge. In other words, team tacit knowledge should be established over a long time, a group of unfamiliar people is hard to establish trust and establish team knowledge.

3. Case method

3.1 Research framework

According to IT resource-based theory, we adopt the logic of 'IT capability-digital option-knowledge outcome' as the overarching framework, to explain how virtual world impact on team learning performance with mediated by digital options.

For Second Life (SL), IT capability comprises IT infrastructure (functionality), IT requirements, and IT-enabled intangibles. SL's IT functionalities include: 1) interface of 3D: In SL, users plays and communicates with others in the 3D environment; 2) network: The network to run the game smoothly. IT requirements includes: 1) hardware requirements, 2) server requirement, 3) using skills, 4) coding knowledge. IT-enabled intangibles include: 1) social network and connections, 2) free social culture.

Considering characteristics of e-learning project, the digital options comprise: 1) knowledge reach, include knowledge distribution, and knowledge storing; 2) knowledge richness, includes communication and collaboration; 3) frequency.

Knowledge outcome includes: 1) individual knowledge outcome, related to personal skills; 2) team knowledge outcome, related to team dynamics and experience.

3.2 Case background

We chose Second Life as the platform for examining the relationship between virtual world and team learning performance, as it is the largest and most successful virtual world. Second Life was founded by Linden Lab in 2003. At first glance, Second Life seems strange as it has no predefined goals or objectives. Based on Linden Lab's research data from August 2006 and March 2007, the daily average residents online increased from 6,000 to 24,000 and total residence exploded from 450,000 to 4 million. By December 2007, there were almost 11 million inhabitants on Second Life. In 2007, the annual GDP of Second Life was equivalent to US$500 million.

Several universities have established virtual class-

rooms in Second Life, such as Harvard, Pepperdine, Elon University, Ohio University, New York University, Stanford University, etc. In this study, we considered the case of an Asia e-learning project, called BOHKNET.

The BOHKNET project uses a variety of tools, most notably Blackboard and Second Life. From 2007, project team started to apply Second Life, and established alpine executive center, which a virtual classroom in SL. They created a meeting environment and a meeting experience. During the class, all teams have their own meeting facility. This project has already lectured to over 50 Avatars with four teachers on stage. The students were part-time engineering postgraduates in Hong Kong and The Netherlands. The teachers were in Hong Kong, The Netherlands and Switzerland. Each BOHKNet team consisted of 10 to 12 students in 3 locations, and each team was assigned a software-related topic (e.g., 'policy programs for e-service').

3.3 Data collection

The data was collected during the course from a variety of sources. First, we directly observed the participants' behaviour and team dynamics in Second Life from 2-3 months. Second, the logs of their discussions and meetings documents they posted were collected. Third, interviewees were chosen from 10-12 teams to answer the questions about their ideas on using SL and knowledge work performance. The interviews were semi-structured but did not preclude elaboration. On average, the interviews lasted 45-60 min.

4. Analyses and results

4.1 IT Capabilities impact on digital options

Based on the interviews and observations, we found that SL has several special IT capabilities and spirits, which significantly influence the users' digital options. These influences include: knowledge reach, knowledge richness, and increasing communication frequency. The relationships between IT capabilities and digital options are illustrated in Table 1.

First, SL has 3D interface. The interface is the important media in human computer interaction. People can operate avatars, create new buildings and communicate with others via the interface. SL provides very rich communication options, participants can communicate with us by using VoIP and this virtual face-to-face communication will help them to build mutual trust fast. In SL, they could build their own cooperation platform, which has good functionalities to support team work. Thus, 3D interface will improve the user digital options by enhancing knowledge richness.

Second, SL has high requirements on hardware and skills. For example, SL has at least 10 categories with 5–6 functions in each category. The complex interface may lead to difficulties for users to become skillful, that is, it takes several hours to become skillful. Furthermore, participants could not to track others' words easily due to complex interface. As one interviewee mentioned, '*When we discussed in SL, the content disappeared quickly and we did not know what the others just told about*'. Sometimes, the complex functionalities may reduce the communication frequency, as the other interview mentioned '*SL is interesting and funny, but it has too many graphs, which get the PC running too slowly*'.

Third, SL has special IT-enabled spirit, like social network and free culture. These spirits may also influence on the digital options. As an interviewee mentioned, '*SL is funny. . . all the team members like and are proud of the platform*'. In SL, people with same interests will find each other more easily, and they can communicate with other more smoothly.

4.2 Digital options impact on individual knowledge work

From the perspective of learning, SL could significantly influence individual knowledge work, by changing users' digital options. Based on the analysis, we found these influences include: 1) coding language skills, and 2) personal creativity.

Second Life promotes 'free creation.' Linden Lab developed four creation systems: 3D product design, figure design, land edit, and higher language coding system-LSL (Linden Script Language). With the LSL, people can design the most amazing things that they can imagine. Thus, some people call Second Life a 'dream land' where people can enjoy a different life. Users can find new figures every time they access it. Thus, we found IT functionalities of SL provide rich resources and efficient communication channels, that users can learn how to use LSL to design 3D products, and create new product with innovative way.

Table 1. Relationships between IT Capabilities and Digital Options

	Knowledge reach	**Knowledge richness**	**Frequency**
IT Functionality	Positive	Positive	~
IT Requirement	~	~	Negative
IT Intangibles	Positive	Positive	Positive

4.3 Digital options impact on team knowledge work

Based on analysis, SL could also significantly influence team knowledge work, especially for tacit knowledge. These influences include: 1) rich social resources and networks, 2) efficient team dynamics.

First, SL provides rich social resources for team learning. Currently, millions of people live in SL. Most inhabitants are separated by distance, and they can 'teleport' to different places when they want to join in a conference and communicate with others. In SL, there are rich valuable social events, and students can establish social network with each other easily.

Second, SL increases the frequency of team dynamics. As SL's free culture, 3D avatar, and self-created building and group, it can help a group of students to establish a team with their ideas. For example, at the start point of project, students met each others' avatar but just MSN ID, the real figure makes them build mutual trust more quickly. In SL, students will have more engagement, and spent more time in discussion, these are both positively related to building team knowledge and experiences.

5. Discussions and conclusions

The most important contribution of this paper is exploratively explaining how SL impact on team learning. Based on the findings, IT capabilities of SL (i.e., functionalities and intangibles) are generally positive related to users' digital options, and then improve the individual and team knowledge work. 3D interface, rich social networks and free culture are effective on improving students' learning motivation and team dynamics in engineering education which requires innovative and creative learning.

However, SL still has some disadvantages in educational application. SL has high requirements of hardware, network, these may lead to high costs of investment in education. Second, SL is more complex than other communication tools (e.g., MSN), students must spend more time to learn before create any innovative product. Some students may leave at the early stage in the project.

There are some other risks for team learning work in SL. Nowadays, the top two industries in Second Life are gambling and sex. Millions of users spend a lot of time on gambling and virtual sex. These activities and advertising information sometimes may disturb these team dynamics. The project must provide some rules to limit students to visit these two industries.

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