2017

IDENTIFYING THE RELATIONSHIP BETWEEN TECHNOLOGY CURIOSITY AND KNOWLEDGE ABSORPTIVE CAPABILITY IN AN AUGMENTED REALITY SMART CLASS

Iris Reychav
Ariel University Center, irisre@ariel.ac.il

Lin Zhu
Southwest Petroleum University, China

Dezhi Wu
Southern Utah University

IDENTIFYING THE RELATIONSHIP BETWEEN TECHNOLOGY CURIOSITY AND KNOWLEDGE ABSORPTIVE CAPABILITY IN AN AUGMENTED REALITY SMART CLASS

IRIS REYCHAV[a], LIN ZHU[a,b], DEZHI WU[c]

a DEPARTMENT OF INDUSTRIAL ENGINEERING &MANAGEMENT, ARIEL UNIVERSITY, P.O.B 40700, ARIEL, ISRAEL.

b SCHOOL OF CIVIL ENGINEERING AND ARCHITECTURE, SOUTHWEST PETROLEUM UNIVERSITY, XINDU 610500, CHENGDU, CHINA

c DEPTMENT OF COMPUTER SCIENCE & INFORMATION SYSTEMS, SOUTHERN UTAH UNIVERSITY, CEDAR CITY, UT 84720, USA

Abstract:

Augmented reality (AR) is changing today's education landscaping by bringing an innovative immersive experience to actively engage learners and unlocking their knowledge absorptive capabilities (KAC) for innovation. Through the theoretical lens of technology curiosity (TC) and KAC, this research attempts to identify the relationship between TC and KAC in an AR-enabled smart class, and thereafter how this relationship impacts learning performance. Accordingly, we designed a two-phase research study, and recruited 93 participants for the first pilot study. The study is currently ongoing, and we expect this study will provide some useful insights to the adoption of AR technologies for both research and practice in this area.

Keywords: curiosity, knowledge absorptive capability, augmented reality, smart class, mobile AR, innovation, educational mobile app

I. INTRODUCTION

Today's emerging technologies are rapidly changing the way that we see and experience the world, and thus are playing an important role to engage learners in a more innovative and interactive way, for example, mobile technologies (Reychav & Wu, 2015, 2016; Reychav et al, 2016), virtual world (Berge, 2008), and second life (Phang & Kankanhalli, 2009), have been experimented and adopted in promoting more engaging learning experiences. Currently as a promising emerging technology, augmented reality (AR) is receiving increasing attention to engage students in a more immersive learning environment (Kesim & Ozarslan, 2012), because AR allows educators and students to "unlock or create layers of digital information on top of physical world that can be viewed through an Andriold or iOS device" (Nesloney, 2013). Even with a great promise on the latest mobile AR technologies for education, especially in the STEM fields, the use of such technologies as a new medium to achieve desired learning outcomes is still a myth and being hampered by a lack of in-depth understanding how the learning occurs when learners interact AR technologies to create new objects and innovate.

It is pervasive for today's tech-savvy learners to be exposed to new emerging technologies in their personal lives and the academic world. Curiosity, regarded as "a capability of pleasure in knowing" (Ruskin, 1819), drives learners' desire to explore new technologies to gratify their different needs. Knowledge absorptive capabilities (KAC) at the individual levels in firms reflect how individual learning occurs and applies to business innovation (Marabelli & Newell, 2014; Fabrizio, 2009; Fosfuri & Tribo, 2008), however, in academia, KAC is rarely connected with individuals' technology curiosity (TC) in an innovative and immersive learning environment. Therefore, we are making a bold step to explore the possibility of adopting a new mobile AR technology enabled in a smart classroom, and to further investigate potential ways to actively engage students for innovation in order to achieve enhanced learning outcomes. Through theoretical lens of TC and KAC, we aim to first understand whether TC and KAC are related and furthermore whether and how they are playing a role in engaging learners' knowledge exploration process in order to achieve better learning performance.

This research-in-progress paper proceeds as follows: following the introduction, we present a brief theoretical background. Then we present our research questions. Afterwards, we describe our study design and plan for next steps for this study. Lastly study implications are discussed.

II. BRIEF THEORECTICAL BACKGROUND

In this section, we briefly introduce the related theoretical background for this study.

Curiosity and Related Theories

Curiosity is regarded as a human being's intrinsic "desire for acquiring new information and knowledge" (Renner, 2006, p. 305). It is an important form of cognitively induced deprivation that arises from the perception of a gap in knowledge or understanding (Golman and Loewenstein, 2015), as a result, satisfying curiosity needs is achieved by acquiring knowledge with pleasure and thereafter improving decision making through innovation. Furthermore, Litman (2008) theorized and differentiated this notation into "epistemic curiosity" (EC), being a uniquely human "drive to know" (Berlyne, 1954, p. 187), that motivates individuals to eliminate information-gaps and conquer intellectual obstacles in adopting a technology (Oehlhorn et al., 2016), in addition to "interpersonal curiosity," which is defined as a personal intrinsic motivation to seek for other people in order to reduce the level of uncertainty (Litman and Pezzo, 2007).

In theory, there are two different theoretical views of curiosity (Litman, 2005): (1) *Curiosity-driven theory* assumes coherence is disrupted by stimuli that are novel, complex, or ambiguous, and therefore equates curiosity to unpleasant uncertainty and tension, that drives information-seeking and problem-solving behavior. Berlyne (1954)'s study indicated that learning was reinforced when the certain degree of curiosity that was reduced. However, this curiosity theory fails to consider

that both satiation and activation of curiosity could be a rewarding process. (2) *Optimal arousal model* takes a different point of view that "curiosity induction is rewarding, and involves feelings of interest rather than uncertainty" (Litman, 2005, p. 795), given that humans are motivated to maintain an optimal level of pleasurable arousal, which might stimulate the exploration of the subject which excites organism's curiosity, and therefore gain positive feelings of interest (Dember & Earl, 1957). As a result, individuals are likely to reduce or eliminate their ignorance by being deficient of information, but would nevertheless enjoy learning something new. Further, two different aspects of curiosity were identified as a feeling-of-deprivation (CFD) and a feeling-of-interest (CFI) (Litman & Jimerson, 2004). The arousal of CFI refers to as very positive feelings of interest and joy while learning new information, and reflects a "take it or leave it" approach to learn. On the other hand, the arousal of CFD involves negative affection such as tension, dissatisfaction and frustration associated with uncertainty, which represents a "need to know" experience.

In terms of technology curiosity, it is defined as a cognitive need for learning and understanding information technologies and equipment (Chang et al., 2013). According to cognitive absorption theory by Agarwal and Karahanna (2000), curiosity was identified as part of cognitive absorption process for technology use, which creates immersive user experiences. However, there is a gap in the existing literature on how technology curiosity plays a role in individuals' knowledge exploration processes while being immersed in a latest mobile AR technology, and additional empirical work is needed to examine effective ways to adopt mobile AR in education.

Knowledge Absorptive Capacity

At the organizational level, absorptive capacity (AC) describes an organization's ability to learn from external sources of knowledge (Cohen and Levinthal, 1989; Escribano et al., 2009). Cohen and Levinthal (1990) also argued that AC is similar to creative capability in the psychology literature. The AC capability is crucial for organizations to be innovative by recognizing the value of new external knowledge, assimilating and applying it for a business competitive advantage. At the individual level, a firm's AC capability can be reflected and developed through understanding the underlying mechanism of individuals' KAC process for innovation.

Prior research (Lane et al., 2006; Zahra & George, 2002) has classified KAC into four dimensions including are *acquisition*, *assimilation*, *transformation* and *exploitation*. *Acquisition* refers to the ability to locate identify, value and acquire critical external knowledge. *Assimilation* is defined as a capability to absorb, analyze, process, and interpret external knowledge. *Transformation* defines the ability to develop and refine internal routines to transfer newly assimilated knowledge. *Exploitation* refers to as the ability to apply knowledge to routine practice (Camison & Fores, 2010).

In this study, we are thus motivated to explore how both TC and KAC are connected in an innovative learning process with the immersion of AR technologies, and aim to further explore individual knowledge exploration behavior in such an environment. In the next section, we proposed our initial research framework and research questions for this study.

III. Proposed Research Framework and Research Questions

In this study, using the following proposed research framework as a guideline (Figure 1), we attempt to answer the following two main research questions. In this study context, our major goal is to understand student KAC processes, which might result in enhanced learning performance and to explore how innovation occurs by immersing students in a new mobile AR-enabled learning environment. Therefore, our two major dependent variables to be measured would be higher-order learning outcomes (note: both perceived and actual learning will be measured) and perceived innovation through experiencing the immersive AR learning environment.

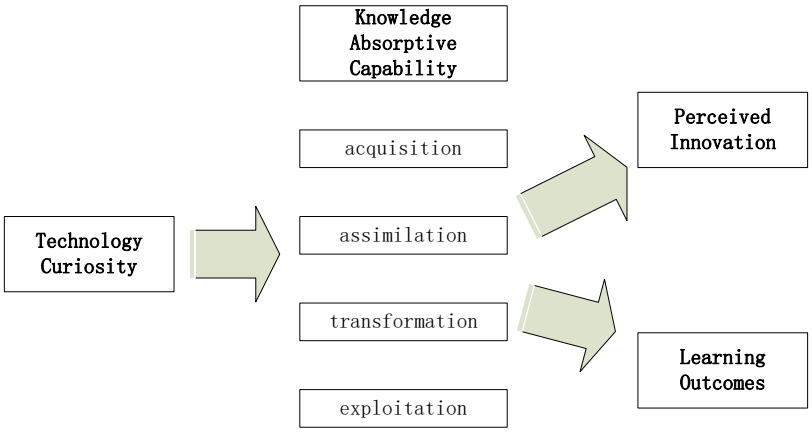

Figure 1: The Research Framework

RQ1: What is the relationship between technology curiosity (TC) and knowledge absorptive capability (KAC) in an immersive mobile AR learning environment?

RQ2: Do mobile AR-enabled technologies in a smart classroom impact the student knowledge absorption capability? If so, in what way? If not, why not?

III. RESEARCH METHOD

In this study, we plan to conduct a set of two-phase field experiments to answer our proposed research questions. During the first phase, study participants will experience a mobile AR app to create a QR code for a smart refrigerator to understand whether there is a relationship between TC and KAC. We plan to measure both objective user performances and subjective user perceptions about AR experience in various scenarios to answer our two key research questions. The second phase study will focus on understanding how the four KAC processes impact student learning outcomes especially on their innovative behavior and learning performance in an AR-enabled setting in comparison to a traditional classroom setting without AR. Furthermore, it is also likely for us to further differentiate two aspects of technology curiosity (i.e., CFI and CFD) during different KAC processes. We are currently still designing the research instruments and field experimental scenarios, while aiming to capture such data through a more in-depth experiment design based on the ongoing first-phase pilot study.

So far, we have recruited 93 volunteer study participants from three majors including Information Systems, Production Operation, and Technology Management in a University to participate in this study in a smart class equipped with mobile AR technologies. First, we will debrief the study participants about the experimental environment and let them try and experience the emerging AR technologies. Afterwards, we introduce them a mobile AR app called Aurasma, through which the study participants can create their own “Auras” (or AR experiences), and use these “Auras” for KAC in creative ways, while involving a remote communication robot (VGo) and other control equipment in such a smart class. After the study participants complete a few learning tasks by creating a QR code to easily access their materials, they are asked to fill out an exit-survey in an iPad. The initial experimental setting is shown in the following Figure 2:

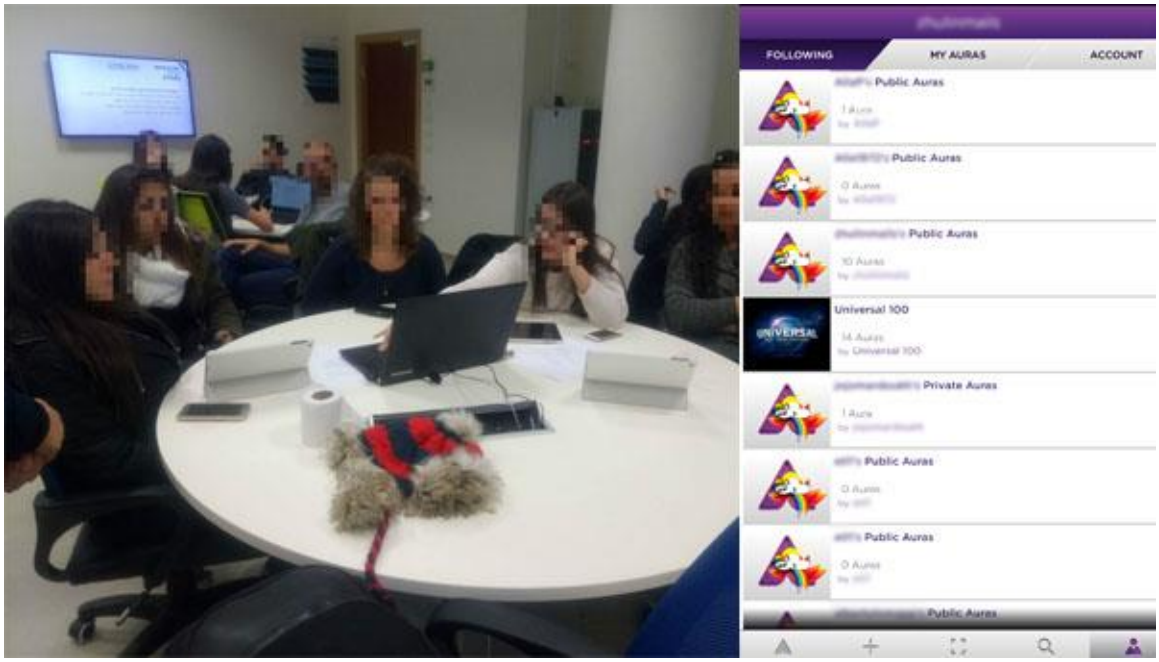

Figure 2: Snapshots of Study Participants Using Mobile AR and VGo in a Smart Class

IV. POTENTIAL STUDY IMPLICATIONS

The study results shall provide us with rich information to understand whether introducing AR to our pedagogical practice would be a good idea and how this AR-enabled immersion experience can possibly improve student engagement and innovation, and result in higher-order learning outcomes. Our proposed study will clearly contribute to the field with an in-depth understanding how technology curiosity plays a role in transforming learning experiences to a more immersive learning experiences through AR technologies. This study is currently ongoing. By the time when the SIGED meeting will be held in Dec., we should be able to report and share our empirical findings with the SIGED participants.

REFERENCES

Agarwal and Karahanna (2000). Time flies when you're having fun: Cognitive absorption and beliefs about information technology use. MIS Quarterly, 24 (4), pp. 665-694.

Berge, Z. L. (2008). Multi-user Virtual Environments for Education and Training? A Critical Review of Second Life. Educational Technology, 48(3), pp. 27-31.

Berlyne, D. E. (1954). A theory of human curiosity. British Journal of Psychology, 45, pp.180–191.

Camison, C. and Fores, B. (2010). Knowledge absorptive capacity: new insights for its conceptualization and measurement. Journal of Business Research, 63, pp. 707-715.

Chang, C., Tseng, K., Liang, C., & Yan, C. (2013). The influence of perceived convenience and curiosity on continuance intention in mobile English learning for high school students using PDAs. Technology, Pedagogy and Education, 22(3), pp. 373–386.

Cohen, W.M.C. and Levinthal, D. A. 1989. Innovation and learning: the two faces of R&D. Economic Journal, 99, pp. 569-596.

Cohen, W.M.C. and Levinthal, D. A. (1990). A new perspective on learning and innovation. Administrative Science Quarterly, 35 (1), pp. 128-152.

Dember, W. N. and Earl, R. W. (1957). Analysis of exploratory, manipulatory, and curiosity behavior. Psychological Review, 64, pp. 91-96.

Escribano, A., Fosfuri, A. and Tribo, J. A. (2009). Managing external knowledge flows: the moderating role of absorptive capacity. Research Policy, 38, pp. 96-1058.

Fabrizio, K. R. (2009). Absorptive capacity and the search for innovation. Research Policy, 38, pp. 255-267.

Fosfuri, A. and Tribo, J. A. (2008). Exploring the antecedents of potential absorptive capacity and its impact on innovative performance. Omega, 36, pp. 173-187.

Golman, R., and Loewenstein, G. (2015). Curiosity, information gaps, and the utility of knowledge. URL: https://www.cmu.edu/dietrich/sds/docs/golman/golman_loewenstein_curiosity.pdf, accessed on July 20, 2017.

Kesim, M. and Ozarslan, Y. (2012). Augmented reality in education: current technologies and the potential for education. Pocedia – Social and Behavioral Sciences, 47, pp. 297-302.

Lane, PJ., Koka, B., Pathak, S. (2006). The reification of absorptive capacity: a critical review and rejuvenation of the construct. Academy Management Review, 31(4), pp. 833-863.

Litman, J. A. (2005). Curiosity and the pleasure of learning: Wanting and liking new information. Cognition and Emotion, (19)6, pp. 793-814.

Litman, J. A. (2008). Interest and deprivation factors of epistemic curiosity. Personality and Individual Differences, 44, pp. 1585-1595.

Litman, J. A. and Jimerson, T. L. (2004). The measurement of curiosity as a feeling-of-deprivation. Journal of Personality Assessment, 82, pp. 147-157.

Litman, J. A. and Pezo, M. V. (2007). Dimensionality of interpersonal curiosity. Personality and Individual Differences. 43, pp.; 1448-1459n

Marabelli, M. and Newell, S. (2014). Knowing, power, and materiality: a critical review and reconceptualization of absorptive capability. International Journal of Management Review, 21 pages.

Nesloney, T. (2013). Augmented reality brings new dimensions to learning. https://www.edutopia.org/blog/augmented-reality-new-dimensions-learning-drew-minock (accessed on July 18, 2017)

Oehlhorn, C., Maier, C., Wirth, J., Laumer, S. and Durr, S. (2016). A temptation to stalk: the impact of curiosity on user acceptance of social networking sites. Proceedings of Twenty-one Americas Conference on Information Systems, San Diego, CA, USA, 10 pages.

Phang, C. W., and Kandanhalli, A. (2009). How do perceptions of virtual worlds lead to enhanced learning? an empirical investigation. *Proceedings of International Conference on Information Systems*, 17 pages.

Ruskin (1819), http://www.happyotter.com/hoquote/Quote_1Page63.html (accessed on July 20, 2017).

Renner, B. (2006). Curiosity about people: the development of a social curiosity measure in adults. Journal of Personality Assessment, 83(3), pp. 305-316.

Reychav, I., and Wu, D. (2016). The interplay between cognitive task complexity and user interaction in mobile collaborative training. Computers in Human Behavior, 62, pp. 333-345.

Reychav, I., Ndicu, M., and Wu, D. (2016). Leveraging social networks in the adoption of mobile technologies for collaboration. Computers in Human Behavior, 58, pp. 443-453.

Reychav, I., and Wu, D. (2015). Mobile collaborative learning: the role of individual learning in groups through text and video content delivery in tablets. Computers in Human Behavior, 50, pp. 520-534.

Zahra, S. A., and George, G. (2002). Absorptive capability: a review, reconceptualization, and extension. Academy of Management Review, 27 (2), pp. 185-203.