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Developmental Paper

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Abstract

Augmented and Virtual reality technologies could provide solutions to improving current online collaboration in teaching and learning. In education, VR and AR are already in use in education, such as in History education. However, there are very few applications and studies in business studies education. This paper intends to apply Gibson's (1978) ecological psychology's concept of affordances including Sensemaking and Orlikowski (1992) Technology frames of reference and explore the extent of experience by experts in VR and AR field can be applied in Business Studies education. Mixed research methods involving interviews and surveys can explore how academics perceive and use VR and AR technologies. Findings from case studies indicate that it enhances collaboration potential using these technologies. The implications discussed in this paper could improve collaboration among academics and students in business studies education.

Keywords: affordance, business studies, virtual reality, collaborative learning, educational technology, augmented reality, technology frames, sensemaking

1. Virtual and Augmented Reality

1.1   Introduction

Virtual Reality (VR) is an experience that encompasses most of the senses, including sight, hearing and touch, which is an alternative to Reality (Reality, n.d.). Augmented Reality (AR) presents additional information that augments objects or real surroundings. There are other terms in Virtual Reality, such as mixed reality (MR), extended reality (XR), Augmented Virtuality (AV). In this context, reality does not exist and closed off from the physical world, creating new environments based on real places or imagined ones (Mealy, 2018). Augmented Reality (AR) is a way of viewing the real world and "augmenting" real-world visuals with computer-generated input such as graphics, audio, or videos. The difference between VR and AR is that AR adds to the real world and not create from scratch (Mealy, 2018). In AR-based Mixed Reality, digital contents are not passively laid on top of the real world but are parts of the real world and, in some instances, interactive and existing physical space. Examples of products straddling the line between AR and MR are Apple's ARKit and Google's ARCore, and Microsoft Hololens. In this context, VR will be loosely used to denote wearable technologies, AR, AV.

1.2   History

VR and AR creation can be traced back to 1838 when Charles Wheatstone created the stereoscope using the image from one eye to create a 3D image. A growing number of virtual technologies give windows to these cyberspatial worlds, described by Frank Biocca (1992) as those in which the user feels present but where objects do not have a physical form and consist of electronic data bits and light particles (Hillis, 1999). Biocca thought of VR as a goal in the evolution of communication and computer technologies.

There were breakthroughs around the late 20th century, such as the telesphere mask, sensorama and motorcycle simulator by pioneer Morton Heilig (Hillis, 1999; Mazuryk and Gervautz, 1996; Mealy, 2018). Morton Heilig is considered the father of VR who imagined a multisensory theatre called "The cinema of the future". Shortly after, he invented the head-mounted displace, which provided stereoscopic 3D visuals and stereo sound. Other inventions in the 1960s included Headsight: the first motion-tracking HMD. (Head-mounted display) that took pictures and designed to allow remote viewing of dangerous situations by the military. Other inventions included: sword of Damocles (1968), Sayre Glove (1977), Power Glove and DataGlove (1982), Air force super cockpit program (1986), Virtual Interface environment workstation (VIEW) (1988), Virtuality Group arcade machines (1991), Cave automatic virtual environment (CAVE)(1992), Virtual Boy (1995) (The History of Augmented and Virtual Reality, n.d.).

Although VR is a popular term and interchangeably called VE (Virtual Environments), there are other important ones such as Synthetic experience, Virtual worlds, Artificial worlds, and Artificial Reality. No matter the name given, all afford real-time interactive graphics, the illusion of participation in a synthetic environment, and computer simulation (Mazuryk and Gervautz, 1996).

1.3 VR and AR in Education

Digital technology is undoubtedly a crucial vehicle for recasting higher education as an individualised operation. The most prevalent framing is students taking responsibility for decision-making such as self-dependence and entrepreneurial thinking with success dependent on self-directing their engagement with learning through various digital technology forms. In this sense, students are required to become industrious self-improvers alongside lecturers and

scholars, motivated by goals that aim to enhance one's performance. (Castañeda and Selwyn, 2018).

VR's positioning as a new technology reflects a transcendental desire to deny history and the necessary limits that include and organise material realities and related forms. This is the relative ability to reformulate the virtual environment at will, which sits right in with denying history as a narrative and reliance on software and codes solidifying the social constructionist argument that the world is made of text, including the human body (Hillis, 1999). This applies across all industries that adopt VR application, even in education.

Learning is a method in which a person constructs himself or herself. From this educational and teaching point of view, it is shown that the improvements that the person actively engages in learning processes are aimed at the actions, awareness, and approaches of individuals (Yildirim et al., 2018). The use of virtual reality in education dates back to 1989. VR implementations for education use are being discussed frequently in recent years and are being developed for various purposes (Yildirim et al., 2018).

There are continuous VR implementations from entertainment, tourism, manufacturing, e-commerce, configuration, Medicine, Education. In education, VR technology has special education applications, architecture, history and geography, science and mathematics, medical education, military, and airtime industry (Yildirim et al., 2018). In the educational context, rapid technological advances and the use of these technologies involve continuous study into various technologies and examining educational aspects (Yildirim et al., 2018).

1.4   Research Problem and Question

Garzón et al. (2019) literature review of 61 studies published between 2012 and 2018 shows usage of AR in education and the impact on the learning processes with reported learning gains and motivation. Different tools and methodologies are being developed by scientists, engineers, teachers, and researchers to benefit both students and teachers in possibly transforming the experience. However, as Garzón et al. (2019) has demonstrated in the following chart, most research is concentrated in the natural sciences, mathematics, and statistics. Business, Administration, and law have zero research. Granted, this is just one piece of research, but the evidence clearly shows that the Business field has not been researched.

Broad field	Number of studies	Percentage (%)
Natural sciences, mathematics and statistics	30	49.2
Arts and humanities	10	16.4
Social sciences, journalism and information	7	11.5
Information and communication technologies	5	8.2
Engineering, manufacturing and construction	4	6.6
Health and welfare	4	6.6
Education	1	1.6
Business, administration and law	0	0.0
Agriculture, forestry, fisheries and veterinary	0	0.0
Services	0	0.0

Figure 1: Garzón, J., Pavón, J. and Baldiris, S., 2019. Systematic review and meta-analysis of augmented reality in educational settings. Virtual reality, 23(4), pp.447-459

Due to lack of evidence in Business studies research, the question would be:

How can VR and AR technologies be effectively integrated to transform business studies education in higher education?

The objective is to evaluate user interaction of VR and AR technologies in other fields of study and identify perceptions of any challenges in use in an organisation.

In dissecting the question, this research explores virtual and augmented reality technologies interactions in an organisational setting, such as a university between Academics and learners.

2. Literature Review

The studies/literature that contributes to this research is awareness of the concepts, ideas, and methods associated with this field, thereby allowing a thorough examination of this paper and the participants. Participants use them to develop their subjectivity (Greener, 2011).

2.1 Studies

2.1.1 Research in VR and AR timeline

Jensen et al. (2018) review of head-mounted VR displays proved problematic based on the keywords (Virtual learning, learning, education, and training) used in the search were very generic terms with no agreed-upon vocabulary because of the interdisciplinary nature of the fields. Studies on non-HMD technologies, such as virtual worlds, surgery simulators, learning management systems, also studies in rehabilitation and health care, non-experimental technical descriptions of hardware or software were excluded (Jensen et al., 2018). After following a strict systemic sorting of 165 documents, 21 passed all the steps design. Jensen et al. (2018) criteria were as follows: (1) full-text version accessible and available, (2) full-text version in English, (3) describes the use of HMD with high field of view (FOV), (4) describes an experimental or quasi-experimental study of the educational use of HMDs and (5) reports original data that is not analysed more thoroughly by the same authors in another of the included documents (Jensen et al., 2018). Of the 21 studies, 14 examined the learner experience, 11 measured learning outcomes for study participants using HMDs, 19 studies use exclusively or primarily quantitative methods (Jensen et al., 2018).

Antonis's (2010) ten-year (1999-2009) review of empirical research result showed that most of the 53 articles found were on science and mathematics, with some researchers from social sciences appreciating the value of VR, thereby incorporating learning goals in the Virtual

environments (Antonis, 2010). Forty (40) out of the 53 empirical studies refer to science, technology and mathematics, which was predictably more than social science topics. Science and mathematics concerned space and time scale far from everyday experience, unobservable phenomena, abstract concepts, and difficulty understanding physical laws and magnitudes (Antonis, 2010).

2.1.2 Uses of VR and AR technologies

These technologies can also be defined differently, such as Barfield's (2015) definition of a wearable computer as a fully functional, self-powered computer worn on the body that offers access to information and interaction with information whenever possible. (Barfield, 2015; Bower and Sturman, 2015). Newer virtual reality models are wearable, with some not self-contained and require power source and streaming media connectivity.

Wearable technologies can incorporate different sensors for measuring mechanical information (position, displacement, acceleration, force), acoustic information (volume, pitch, frequency), biological information (heart rate, temperature, neural activity, respiration rate), optical information (refraction, lightwave frequency, brightness, luminance) and environmental information (temperature, humidity) (Bower and Sturman, 2015). Such devices can identify, adapt, and respond to their owner, location, and activity being carried out (Viseu, 2003; Bower and Sturman, 2015). Barfield's definition shifts from a monolithic computer definition to a more agile technology definition or concept.

However, Bower and Sturman (2015) lament a few empirical examples regarding wearable technologies in education within the literature. More recently, head-mounted displays have been used in History education to overlay incidents from the past, and live scenes from the present enable students to acquire a more visceral sense of history in the places it occurred

(Nakasugi and Yamauchi, 2002; Bower and Sturman, 2015). There have been uses in medical training using google glasses affording first-person point of view and recordings (Wu et al., 2014; Bower and Sturman, 2015).

The action possibilities that these technologies afford, according to Bower (2008), can be classified using a system for discussion and several vocabularies used in e-learning adapted for wearable or VR technologies. According to Bower (2008), these vocabularies include (1) Media affordances such as text, video, audio. (2) Spatial affordances afford resizing and movement of elements. (3) Temporal affordances where the user can have access anytime, record and be recorded, and playback capabilities. (4) Navigation affordances such as being able to search and browse resources. (5) Emphasis affordances – the capacity to highlight aspects of resources. (6) Synthesis affordances – the combination of multiple tools to create mixed media learning and (7) Access-control affordance where the user can allow or deny who can edit/upload/download/broadcast/view, one-one/one-many/many-many contributions and collaborations.

2.1.3   Empirical Studies

Study 1

A study by Yildirim et al. (2018) established students' views on VR technology and determine their views on the use of virtual reality glasses in history education and their proposals for this topic privately. The questions asked were about the opinions of participants towards the use of VR glass, differences of use of multiple environment contents provided with VR glasses and use of materials, i.e. video and images, provided in traditional learning processes, what are the opinions of participants toward the content provided in VR environment for the course history

of civilisations and what are the opinions of participants towards the use of VR glasses in history education (Yildrim et al., 2018).

The case study method was used as one of the qualitative research methods determining general opinions and reasons behind these opinions shaped by the method. Twenty-five participants of 12 were male, and 13 female were freshmen in the Primary School teaching department attending the History of Civilisation course at Bayburt University (Yildrim et al., 2018).

During implementation, VR glass activity was used to adapt the learning environment organised with close to 5 minutes of learning content not previously seen by participants. The experience was expanded by allowing interactivity with content, and time limitations were removed. Also, the above affordances, rotating chairs were used to increase experience, which allowed more movements. The VR glasses afforded various head movements facilitating control. Audio and visual elements were added, introducing Kaaba related studies to Islam History education. Data collection involved six open-ended semi-structured interviews, and to ensure the validity of the interviews, opinions of three experts were obtained, and forms were created with Turkish language experts.

The research outcome showed that participants rated the new learning environment saying that it was realistic and gave the feeling of being present in a related environment. They also said the contents provided could be used for people with disabilities. VR environment provided a more memorable experience when compared to the classroom settings (Yildrim et al., 2018).

Study 2

The result from Martín-Gutiérrez et al's. (2015) study presents tools that achieve a connection between theory and laboratory practices using augmented reality. The collaborative task can be enhanced using Augmented Reality, such as in this study where actions have been performed

with 50 engineering students from the electrical machine course. An augmented reality application called ElectARmanual is an assistant developed to train the use of dangerous machines safely that involves checking symbols on diagrams and checking notes by teaches (Martín-Gutiérrez et al., 2015).

The goal was to explore the usability of applications and feedback from students about their use by applying the System Usability Scale (SUS) questionnaire for measuring usability and feedback survey. The usability results offered very high scores according to the ease of use (Martín-Gutiérrez et al., 2015). The overall result showed that AR applications allow students independent learning saving the teacher time on repeating explanations. The tools developed achieved a dual effect: (1) allowing teachers to improve guidance, and (2) offer motivational tools to the student during the process (Martín-Gutiérrez et al., 2015).

In conclusion, the empirical study has shown that the inquiry-based AR tool has potential and acceptance and is suitable for promoting collaboration and autonomous learning. It also offers a more cost-effective alternative to providing students with appealing content than paper (Martín-Gutiérrez et al., 2015).

2.2   Theoretical Concepts

Whether in the classroom, online or blended, all learning involving interaction with online and offline courses occurs within an ecological context (Terras and Ramsay, 2012).

Leonardi (2013), citing Markus and Silver, state that discussing the relationship between the features of technology and how people use the features is better articulated by the concept of affordance. One technology can extract multiple affordances because affordances do not exist without a user's intentions or goals (Leonardi, 2013; Markus and Silver, 2008).

Workplace technology influence naturally emerges between co-workers when they discuss it by comparing experiences with expectations. This discussion or communication creates "technology frames", which means employees have expectations and assumptions regarding what technology should do and how it should be used (Treem et al., 2015). Treem et al. (2015) argue that people first encounter new technologies at work and are being influenced socially by their co-workers, but little is known about ICT interpretations before workplace use and Post workplace. In articulating the relationship between technologies, users, and organisation, ecological psychology's affordances is integrated into this research with sensemaking and Technology frame of reference (TFR).

2.2.1   Affordances

There are two distinct ideas with the term Affordance from Gibson (1979) and Norman (1988). Gibson's definition is about the object's fundamental characteristics in relation to the user meaning utility. Norman focuses more on how an object is perceived, which means usability and not only utility.

The concept of affordance conceptualises how an organisation's environment or setting (Work arrangement, including technical systems) at once enables and constrains discretionary action

(Fayard and Weeks, 2014). Fayard and Weeks (2014) believe that affordance provides a powerful lens to study co-constitutive relations between technology and people in an organisation providing better language to describe practices shaped and patterned by structure and settings. Affordance connects practice with perception. One of the objectives laid out by Fayard and Weeks (2014) involves the focus on action, which means shifting from technology to practice. Instead of focusing on technologies or objects' capabilities, it is about human actors engaging with technology. In the context of Sociomateriality, Fayard and Weeks (2014) state the people shape the affordances of objects and the environment in how they are designed.

Technological Affordance is a way to explore certain educational technologies. Affordance is defined as an object or medium's properties that affect how the artefact can be used, how and if it is perceived, and the relationship between the properties and the user (Feyzi Behnagh and Yasrebi 2020; Järvelä et al., 2015). By applying affordance, focus on technology features is eliminated but instead on what the technology can do (Wagner et al., 2014). However, focusing on technology features is technology determinism which is the notion that technological development is separate or autonomous to society, existing outside society, not reciprocally influenced but also influencing social change. In some extreme cases, it is seen as the most important determining factor of society's nature (Mackay and Gillespie, 2016).

2.2.2 Sensemaking and Technology frame of reference

Sensemaking is defined by Weick (1993) as the fundamental idea that reality is an ongoing achievement. This results from efforts to establish order and make sense of what happens in retrospect (Bansler and Havn, 2006). Search for meaning to address uncertain and demanding situations. How people make sense of situations they encounter, why, and what implications are the critical questions for researchers interested in sensemaking (Bansler and Havn, 2006).

Sensemaking is not about reading text or understanding but about how the text is read and created. Bansler and Havn (2006), therefore, state that sensemaking is about authoring as well as reading. There are properties of sensemaking that enable an analysis of technology use mediation: (1) It is grounded in construction. (2) Sensemaking is driven by plausibility instead of accuracy, continuing to redraft emerging, incorporating more observed data. Hence, it holds up to scrutiny or criticism (Weick et al., 2005) and (3) Sensemaking is a social process influenced by a myriad of social factors such as discussion among colleagues, power relations, public discourse, and institutionalised patterns of behaviour and thinking (Bansler and Havn, 2006).

Technology frame concept identifies a subset of organisational members' frames concerning assumptions, expectations, and the knowledge they use to understand information and communications technology in organisations (Orlikowski and Gash, 1994). Technology frames have potent effects in that people's assumptions, expectations, and knowledge about the purpose, context, importance, and role of technology will strongly influence the choices made regarding the design and use of those technologies (Orlikowski and Gash, 1994). Making sense of technology is crucial to organisational change where information technology plays a significant role (Davidson, 2016). Organisation members can have a group with technological artefacts that include a local understanding of specific uses and knowledge (Orlikowski and Gash, 1994). Orlikwoski and Gash (1994) and Pinch and Bijker (1987) state that different interpretations of technological artefacts by multiple social groups is based on their interaction with it and, to varying degrees, are shaped by the purpose, context, power, knowledge base and the artefact itself. Treem et al. (2015) state that since technological frames are social constructions, different views of a technology's meaning and purpose can be held by different individuals. Moreover, different artefacts can be viewed in diverse ways, which can affect behaviours.

3. Research Methodology

This section discusses how can this research be conducted in the field, the philosophies, research strategy and data collection processes.

3.1 Philosophy

Volkoff and Strong (2013) argue that critical realism provides the necessary philosophical framework for developing information technology affordance-based theories. Critical realism explains how information technology is implicated in organisation change (Volkoff and Strong, 2013). An affordance arises from the relation between a structure or object and a goal-directed actor or actors, which the actor triggers or actualises. Volkoff and Strong (2013) argue that affordances are subsets of generative mechanisms. Generative mechanisms can arise from structures alone, and their causal power may be triggered without an actor's intervention (Volkoff and Strong, 2013). The more focused nature of affordance is beneficial when the question relates to how technology's introduction affects the organisation (Volkoff and Strong, 2013). Ontological Critical realism is an objective, stratified reality consisting of structures, mechanisms, and events (Tsang, 2014). Epistemologically, it is retroduction used to create theories regarding the structures and mechanisms that generate the observable events, emphasising explanation over prediction and has no preference in terms of specific research methods (Tsang, 2014).

3.2 Data Collection and Analysis Methods

Many technological advancements have not been made for education, specifically teaching and learning, meaning that educators need to analyse the technologies' affordances and constraints and repurpose them in a particular educational context (Mishra and Koehler, 2006; Bower and

Sturman, 2015). This research's strategy is Mixed method research and to find affordances from other areas that have been implemented and repurpose for Business studies, such as business case study simulations. Qualitative research methods can be used because it is about depth rather than breadth and developing a deep understanding of a phenomenon as it is experienced (Neuman, 2014) in a University setting specifically designed to expand knowledge. The methods of collection of data can be interviews and surveys.

Qualitative interviews are informal and guided by interview guides to draw information from participants about the details of the phenomenon under study. These guides include questions and probes based on research questions and data sometimes obtained by observations or surveys and preliminary data analysis. (Neuman, 2014). To get insights into VR and AR technologies' affordances, it would require, as Bower and Sturman (2015) suggest eliciting higher education experts in the learning technology field using surveys. The surveys would be distributed to the members of scholarly organisations via their respective websites. Instead of eliciting generic responses to how learning and teaching would benefit using these technologies, this research would ask how it would enhance or transform teaching and learning in Business Studies education.

4. Conclusion

There are uses of virtual and augmented reality technologies in various industries and education, but very few or none in Business Studies Education. With V.R. and AR eliciting expert views, perceptions, and opinions are beneficial, which leans towards Norman's (1988) perceived affordance. Due to the unique technological features that differentiate them from other ICT applications, virtual reality technologies seem to have become a powerful and promising tool in education (Antonis, 2010).

Martín-Gutiérrez et al. (2015) state that collaborative learning is where the most significant potential of AR is, according to researchers, because it involves social interactions. However, these technologies have drawbacks such as privacy, cost and they can easily distract student focus. It can also be riddled with technical issues, lack of support and educators worry it could be used to cheat. Nevertheless, new technologies are always accompanied by new issues, but they can be mitigated with more research.

Copying and pasting VR technology features from other fields of studies would be easy, but it would be unproductive and wasteful. Assuming this study goes further than a development paper, further Affordance analysis can provide a methodology concentrating directly on the critical aspects of the selection process: the underlying features of tools and the cognitive and collaborative requirements of learning task (Bower, 2008) and much potential for enhanced studies in Business Studies education.

References

Antonis, N.M. *Educational virtual environments: A ten-year review of empirical research (1999–2009),* Exeter : Elsevier Science.

Bansler, J. and Havn, E. (2006). Sensemaking in Technology-Use Mediation: Adapting Groupware Technology in Organizations. *Computer Supported Cooperative Work.* 15 (1), 55-91. Available from.

Barfield, W. (2015). *Fundamentals of wearable computers and augmented reality* CRC press.

Bower, M. (2008). *Affordance analysis – matching learning tasks with learning technologies,* London : Routledge.

Dalto, J. (2018). AR, VR and 3-D can make workers better. *ISE ; Industrial and Systems Engineering at Work.* 50 (9), 42-47. Available from.

De Freitas, S. and Levene, M. (2003). Evaluating the development of wearable devices, personal data assistants and the use of other mobile devices in further and higher education institutions. *JISC Technology and Standards Watch Report.* (TSW030), 1-21. Available from.

Fayard, A. and Weeks, J. (2014a). Affordances for practice. *Information and Organization.* 24 (4), 236-249. Available from.

Fayard, A. and Weeks, J. (2014b). Affordances for practice. *Information and Organization.* 24 (4), 236-249. Available from.

Garzón, J., Pavón, J., Baldiris, S. (2019). *Systematic review and meta-analysis of augmented reality in educational settings,* London : Springer-Verlag.

Greener, I. (2011). *Designing social research : a guide for the bewildered* Los Angeles ;: SAGE.

Hillis, K. (1999). *A Critical History of Virtual Reality,* University of Minnesota Press.

Jensen, L., Jensen, L., Konradsen, F., Konradsen, F. (2018). A review of the use of virtual reality head-mounted displays in education and training. *Education and Information Technologies.* 23 (4), 1515-1529. Available from.

Liu, Q., Geertshuis, S., Grainger, R. (2020). Understanding academics' adoption of learning technologies: A systematic review. *Computers and Education.* 151 103857. Available from http://dx.doi.org/10.1016/j.compedu.2020.103857 .

Ludvigsen, S., Law, N., Rose, C., Stahl, G. (2017). Frameworks for mass collaboration, adaptable scripts, complex systems theory, and collaborative writing. *International Journal of Computer-Supported Collaborative Learning.* 12 (2), 127-131. Available from https://search.proquest.com/docview/1919693597 .

Mackay, H. and Gillespie, G. (2016). Extending the Social Shaping of Technology Approach: Ideology and Appropriation. *Social Studies of Science.* 22 (4), 685-716. Available from https://search.datacite.org/works/10.1177/030631292022004006 .

Martín-Gutiérrez, J., Fabiani, P., Benesova, W., Meneses, M.D., Mora, C.E. (2015). Augmented reality to promote collaborative and autonomous learning in higher education. *Computers in Human Behavior.* 51 752-761. Available from.

Mazuryk, T. and Gervautz, M. (1996). Virtual reality-history, applications, technology and future. Available from.

Mealy, P. (2018). *Virtual & Augmented Reality For Dummies*, 1. For Dummies.

Mishra, P. and Koehler, M.J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record.* 108 (6), 1017-1054. Available from.

Mwanza Ben Jephta, Nkhata Bentry, 1., 2 D M S, S E, U Z, L, Z *Using mobile technologies in mathematics Education: Perspectives from student teachers and teacher educators in Chipata district, Zambia, .*

Neuman, D. (2014). Qualitative research in educational communications and technology: a brief introduction to principles and procedures. *Journal of Computing in Higher Education.* 26 (1), 69-86. Available from.

Orlikowski, W. and Gash, D. (1994). Technological frames: making sense of information technology in organizations. *ACM Transactions on Information Systems.* 12 (2), 174-207. Available from.

Stefan, L. and Moldoveanu, F. (2013). *GAME-BASED LEARNING WITH AUGMENTED REALITY - FROM TECHNOLOGY'S AFFORDANCES TO GAME DESIGN AND EDUCATIONAL SCENARIOS,* Bucharest: "Carol I" National Defence University.

Sung, Y., Yang, J., Lee, H. (2017). The Effects of Mobile-Computer-Supported Collaborative Learning: Meta-Analysis and Critical Synthesis. *Review of Educational Research.* 87 (4), 768-805. Available from https://search.datacite.org/works/10.3102/0034654317704307 .

Treem, J.W., Dailey, S.L., Pierce, C.S., Leonardi, P.M. (2015). Bringing Technological Frames to Work: How Previous Experience with Social Media Shapes the Technology's Meaning in an Organization. *Journal of Communication.* 65 (2), 396-422. Available from.

Tsang, E.W.K. (2014). Case studies and generalization in information systems research: A critical realist perspective. *The Journal of Strategic Information Systems.* 23 (2), 174-186. Available from.

Viseu, A. (2003). *Simulation and augmentation: Issues of wearable computers,* Dordrecht, Netherlands : Kluwer Academic Publishers.

Volkoff, O. and Strong, D. (2013). *CRITICAL REALISM AND AFFORDANCES: THEORIZING IT-ASSOCIATED ORGANIZATIONAL CHANGE PROCESSES,* Minneapolis, Minn. : Society for Management Information Systems.

Wright, S. and Parchoma, G. (2011). Technologies for learning? An actor-network theory critique of 'affordances' in research on mobile learning. *Research in Learning Technology.* 19 (3), 247-258. Available from.

Wu, J., Guo, R., Wang, Z., Zeng, R. (2019). Integrating spherical video-based virtual reality into elementary school students' scientific inquiry instruction: effects on their problem-solving performance. *Interactive Learning Environments.* 1-14. Available from.

Wu, T., Dameff, C., Tully, J. (2014). Integrating Google Glass into simulation-based training: experiences and future directions. *Journal of Biomedical Graphics and Computing.* 4 (2), 49. Available from.

Yildirim, G., Elban, M., Yildirim, S. (2018). Analysis of use of virtual reality technologies in history education: A case study. *Asian Journal of Education and Training.* 4 (2), 62-69. Available from.