IMMIGRANTS AND TECHNOLOGY: HOW 5G WILL TRANSFORM AND ENHANCE MOBILE EDUCATION

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ABSTRACT: As our society becomes more globalized and interconnected, technology adoption to support lifelong learning presents a continuous challenge for immigrants who need to acquire, update or adjust their learning and skills to the requirements of the host country. Consequently, technology adoption has become an important factor for immigrants to fulfill their specific educational needs with mobile devices allowing ubiquitous access to knowledge at anytime and anywhere. Besides the technical characteristics required for new services that challenge current network architectures, COVID-19 has become an accelerator to immigrants' technology adoption. Social distancing regulations have added pressure to technology adoption for educational purposes. In this paper, we explore how 5G technologies meet these requirements establishing a benchmark for immigrant's mobile learning strategy. Our descriptive framework aims to contribute to the understanding of educational uses of mobile technologies by migrants and the technical requirements to be provided by 5G technologies that will enhance the use of technology for educational purposes. Some 5G applications will be discussed emphasizing their contribution to the learning of immigrants and the actual distance regulations.

Keywords: immigrants, covid-19, mobile learning, 5G technologies, forced migration, social distancing

According to the International Organization of Migration (IOM, 2018) there are around 244 million international migrants in the world. Migration has different causes such as escaping from armed conflicts, civil unrest situation, persecution, environmental disasters, climate change, poor economic situation, oppressive poverty, or threat of physical safety (Aihonsu, 2017; Morrice, Shan & Sprung, 2017). Over the years, immigrants' composition has become more diverse bringing to host countries a wide range of educational backgrounds (Teranishi, Suárez-Orozco & Suárez-Orozco, 2011). Immigrants face different challenges for continuing their education in a host country using technology as a way to fill the occupational requirements and gaps. The COVID-19 pandemic has forced education to move to an online approach accelerating the global online transition. Consequently, the use of technology in education for immigrants provides opportunity for enhancing their learning experience by adding different multimedia layers of richness such as videos, podcasts, infographics, concept maps, and others (Johnson & Lock, 2018). This poses an opportunity for institutions, instructors, and immigrants to embrace technology and to foster online immediacy to cope with the distancing and isolating effects of online education. The purpose of this study is to explore how 5G Technologies and their related developments support immigrant learning.

Theoretical Framing

This research explores from a human-technology standpoint the manner in which 5G technologies can support immigrants to identify gaps in their knowledge and promote learning to achieve their educational goals with the aim of integrating to the local

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economy. This combination brings to the analysis how immigrants approach education and enables the study of how migrants might employ 5G technologies to support their learning needs. Our descriptive framework aims to contribute to the understanding of educational uses of mobile technologies by migrants during the integration phase and the technical requirements to be provided by 5G technologies that will enhance the use of technology for educational purposes.

Literature Review

Adult Education

Globalization is a worldwide phenomenon. Consequently, today's classrooms have become a demographic amalgamation of people with different cultural backgrounds, race, ethnicity, economic status, disabilities, and gender. Most adult immigrants bring many formal and informal learning experiences to the host country and are eager to continue their education expecting from the local educational institutions and practitioners an educational proposition that will positively impact their actual situation. Andragogy as defined by Knowles (1984) is "a theory of adult learning that takes into account what we know from experience and research about the unique characteristics of adult learners" (p. 40). The andragogical theory developed by Knowles (1984) relates to immigrants because it is based on the main assumptions that adults (as most immigrants) are ready and oriented to learn, bring experiences to the classroom, and should have an active role in their learning practical experience. Practice is an important part of learning for adult educators, and simulation techniques offer the opportunity to apply knowledge and improve skills in a hands-on approach before facing a real education setting. Consequently, to support immigrant learning, institutions and practitioners can use different technologies such as software simulation, virtual and augmented reality, tactile internet, and internet of skills to effectively adapt their practices to adult learning.

Technology and Immigrants

Collin, Kanserti, and Calonne (2015) found that information and communications technologies (ICTs) play an important role as a catalyzer during the different stages of migration. Specifically, during the post-migration phase, migrants use a myriad of Information and Communication Technologies (ICT) to integrate to the host society (Collin, Kanserti & Calonne, 2015). The use of mobile applications enables more immigrants to support their social integration through a personalized experience with the aim of fulfilling their specific educational needs (Morrice, Shan & Sprung, 2017). Moreover, the use of mobile learning can be targeted both to formal and informal learning activities.

Technology has been used for many purposes including education and has opened more opportunities for ubiquitous interaction among students and instructors. The pandemic has accelerated the transition for online instruction confirming that the actual system of education is close to expiring Technology in education can be used for improving students' engagement, enhancing participation, improving critical thinking and problem solving, having immediate feedback, performing hands-on learning, and increased

technology skills. Technology also improves student collaboration, which is a highly effective tool for learning.

5G Technologies.

5G is a network technology that will provide unlimited access to information with the ubiquity capacity to share data (Ericsson, 2014). The advent of 4G technologies allowed people to experience broadband services with their mobile devices (Yu, Lee, & Yeon, 2017). However, users increased their requirements for high speed, rapid response, high reliability, and energy efficiency, which is difficult to provide with the current 4G/LTE networks (Yu et al., 2017). New services such as virtual reality in education can be potentially developed using 5G services capabilities such as unlimited data transmission, a massive number of active connections, and new types of mobile devices, especially sensors (Yu et al., 2017). Consequently, 5G services can support immigrant's educational requirements by extending its focus on technology educational improvement through the use of mobile phones, wearable devices, robots, and so on. Additionally, 5G technologies support many user's requirements becoming the key infrastructure that will provide a technology platform for continuous educational innovation.

According to Yu et al. (2017), some of the most important megatrends related to educational technology that can be possible by using 5G technologies are

- The increasing use of mobile data traffic
- The rapid increase in connected devices
- The convergence of services in the cloud

According to Cisco (2019) the amount of monthly mobile traffic in 2022 (77 Exabytes per month, 1EB 1,000,000 TB) will be 6.7-times higher than in 2017 (11.5 Exabytes per month) with smartphones surpassing 90 percent of mobile data traffic and video accounting for 79 percent of total mobile data traffic. This traffic is due to the new types of multimedia services such as augmented reality, virtual reality and holograms, which all require huge traffic volumes (Cisco, 2019). The Global System for Mobile Communications Association (GSMA, 2017) reported that by 2020 there will be 12.3 billion mobile-connected devices such as wearable devices, sensors, vehicles, drones and robots which also will increase the mobile data traffic. Regarding mobile cloud traffic, this will increase year by year from 35% in 2013 to 70% by 2020 and is expected to be fully integrated with the mobile services in the 5G era. Also, services like Augmented Reality (AR)ad Virtual Reality (VR) will be completely enabled under 5G technologies (GSMA, 2017)

Relevant aspects of 5G

Faster Data-Transfer Speed

One of the key changes with 5G is the increase in speed. According to the European Commission (2016), 4G evolution scenarios data rates are about 3 Gb/s. However, according to the Generation Partnership Project (3GPP), the first phase for standardization foresees ultra-fast mobile broadband solutions capable of delivering

speeds of 20 gigabits per second. The most demanding service for the highest speeds is usually driven by video consumption with 4K video (video with roughly 4,000 pixels of horizontal resolution) requiring around 20 Mbps. (Webb, 2018). With multiple occupants in the home, however, requirements might peak at around 60–80 Mbps (Webb, 2018).

Latency

This is the second key feature of 5G related to instant response time. According to the European Commission (2016), while 4G provide a latency of 10–20 ms., 5G will meet low-latency requirements of as little as 1ms. Most applications where latency is seen as a critical issue involve video— such as Virtual Reality VR or remote-control applications (Webb, 2018).

Increased Data Volume

1,000x increase over current levels allowing to send large files and to transact across a wireless connection without performance impact (Ericsson, 2014).

More Devices Connected

10-100x devices. 5G intends to increase the number supported in a given area by a factor of between 10x and 100x sometimes stated as one million devices per square kilometer – with devices able to travel at up to 500km per hour (Ericsson, 2014).

Energy Efficiency

The 5G initiative aims to extend device battery life by a factor of 10 and reduce core network consumption by 90% (Ericsson, 2014).

100% coverage

The ability to provide good coverage in all areas is another aspirational goal of 5G – the extent and achievability of this is highly debatable (Ericsson, 2014).

Rapid Service Deployment

One goal is to rapidly reduce the time it takes to deploy 5G network connections, using self-organizing network technology (Ericsson, 2014).

Benefits of 5G to Immigrants.

The 5G communication will provide better and faster Internet connectivity. Consequently, ICT in education can better serve the educational system providing the opportunity for a self-directed learning (SDL) approach for Immigrants. Individual access to a mobile device holds the promise to connect each learning adult into an intelligent personalized system that can cluster adult learners in different groups and suggest

different multimedia content. Then, by capturing adult learners' experiences, technology applications can update and redefine adult's education pathways.

Video Learning

Nowadays, the advancement in technology has made possible to adapt different improvements to the learning and teaching activities. According to a recent study in *Statista*, the number of online video platform viewers will amount to 1.86 billion in 2021 (Clement, 2018). In a survey conducted by Pearson and Harris Poll, it was found that 59% of Generation Z -those between ages from 14 to 23 years-, and 55% of Millennials -those between ages from 24 to 40 years- prefer YouTube videos over other forms of instruction based on the quality of images, sounds, special effects, animations, and interactivity they provide (Schaffhauser, 2018). Therefore, the main value of video games is that it allows "people [to] participate in new worlds" allowing players new ways of thinking and creating powerful contexts for learning (Shaffer, Squire, Halverson & Gee, 2005, p. 105). Based on this, educators are prone to find ways to adapt case-based activities into a video approach as a way to boost motivation and student engagement. Video Game Based Learning (VGBL) are video games used as alternative educational models in which players by inhabiting virtual worlds learn to develop core skills and work as socially valued practitioners (Shaffer et al., 2005). Additionally, case-based learning is used as an educational tool aimed to foster analytical and problem-solving skills and to expand personal perspectives by putting in practice conceptual knowledge (Goeze, Zottmann, Vogel, Fischer, & Schrader, 2014). High-quality video applications can be used to teach immigrants to develop entrepreneurial skills with the aim of improving those marginalized minorities that cannot improve their economic situation otherwise.

Virtual Reality

Technology can be used as an enabler element to foster SDL among individuals and institutions opening the opportunities for a richer experience using virtual environment (Merriam et al., 2007). Virtual reality (VR) has high relevance in education and training for Immigrants. Virtual Reality technologies allow users to fully interact with virtual 3D environments and objects providing audio, visual and even haptic feedback (Allcoat & Mühlenen, 2018). All of these requirements including very high bandwidth and very low latency can be supplied by 5G. VR's interactivity and instant feedback would be more valuable traits for teaching specific subjects as it promotes active learning (Allcoat & Mühlenen, 2018). A study by Allcoat & Mühlenen (2018) found that compared to other forms of learning such as lectures or videos, participants in the VR condition showed a better performance for 'remembering', a higher engagement, and can improve learning experience. VR capacity of visual, audio and movement tracking integration allow three types of learning styles such as visual, auditory and kinesthetic that can be targeted in one application matching a variety of instructional methods and Immigrants' learning preferences (Allcoat & Mühlenen, 2018). Consequently, VR application can be used to teach immigrants engineering science concepts, or procedures related to specific vocational occupations. Also, VR can open new learning possibilities for immigrants that have not been explored. By tailoring these services to adult's specific needs, the learning process can be target on developing specific skills. This also can bring new opportunities

for distance learning, enabling the virtual presence of immigrants (e.g., located in a specific area) in the classroom. Immigrants can create an avatar to interact with other immigrants in a VR environment. An avatar is virtual characterization that will represent real people during their interaction in the virtual environment. According to Cryss Brunner, Hitchon, & Brown (2002) virtual reality offers the opportunity for immigrants to learn and promote social justice. As the authors suggest, if our real race, gender, and sex defines how we interact with each other in a society, avatars will allow immigrants to remove or alter factors related to our personal real identity Consequently, immigrants can have the opportunity to learn and interact in a more equitable environment (Cryss Burner et al., 2002). Also, underrepresented groups can use virtual reality to construct and interact within environments and roles where they normally feel alienated such as minority women virtually working in leading positions in academia or technology providing reassurance on the opportunities to occupy such positions (Cryss Burner et al., 2002).

Telepresence

Telepresence services gives the users the experience that they are at the same place as a remote user (Yu, 2017). Usually, telepresence services consist of big screens connected to cameras that project in real time and with great video and audio quality what is happening in a room to other multiple and interconnected remote sites. Participants have instant interaction among them and are able to instantly catch human expressions, gestures, voice, and eye contact. Telepresence services need to be more realistic by offering the capability to use the five senses (Yu et al., 2018). In this case, 5G will secure the higher transmission rate and low latency required for effective telepresence services. Because of the benefits provided such as reducing travel time, access to wider audiences, and reduced costs (Loera, Kuo, & Rahr, 2007), telepresence can provide to underrepresented communities the educational access that would not be possible under other circumstances. Also, telepresence would meet the learning of these communities providing remote and multiple training for immigrants for discussion, lectures, or demonstrations, under a self-directed learning approach. Self-directed learning (SDL) refers to the ability of some immigrants for looking and acquiring knowledge by themselves approaching learning in a deep and meaningful way with the goal of improving their self-image and performance and creating an inner empowerment to change (Garrison, 1997; Merriam, Caffarella, & Baumgartner, 2007; Morris, 2019). Morris (2019) has argued that self-directing learning "is as a fundamental competence for immigrants living in our modern world" (p. 634). As stated by Merriam et al. (2007), the three main goals of self-directed learners can be grouped as means to improve their self-learning ability, to foster transformational learning, and to promote social actions. The authors added that self-directed learning presents a new paradigm for immigrants to take full responsibility for the impact of the new knowledge on their performance, to learn at their own pace without the need of an instructor, and to design their own educational program based on their specific needs. Therefore, facilitators that are unable to be physically in the place of lecture, can use telepresence to provide the initial guidelines to learners so that they can take further control of the direction of learning (Hiemstra, 1994). Finally, telepresence services can be used to train rural educators, to hold conferences,

and to connect with global educational institutions to increase the portfolio of courses and training.

Augmented Reality

As defined by Rosenblum (2000), augmented reality (AR) superimposes computer-generated imagery above real world scenarios using a see-through display. AR supplements reality and can enable new ways of learning because technically can be used to enhance all five senses (Kipper & Rampolla, 2012). According to Radu (2014), AR allows a better learning when compared to other tools such as printed media such as textbooks or desktop software. Also, the author states that students exhibit better short-term and long-term memory after learning using AR technology. The interactive 3D visualization plays an important cognitive role that improve learning (Radu, 2014). In fact, the combination of a real environment combined with the overlying virtual scenarios make AR as one of the best options for transferring knowledge to a real-life situation (Radu, 2014). The intense requirements about latency, speed, and bandwidth for real-time AR are fulfilled by 5G. Free AR platforms provide the opportunity for teacher to meet the needs of Communities of Color (Hidalgo, 2015). By using augmented reality glasses and a wearable computer, AR can be used as of portable way for learning about historical places (Rosenblum, 2000). Thus is, AR can be used to create stories connected with location-triggered applications to promote marginalized populations' cultural learning and social heritage (Hidalgo, 2015; Jones et al., 2017). Hidalgo (2015) created some Augmented Fotonovelas aimed at providing "alternative narratives that counter established narratives, and for raising consciousness by acknowledging the Latina/o community's cultural wealth and resilience, while advocating for social justice and social transformation" (p. 312).

AR is strongly appropriate for influencing learning through embodied interactions (Radu, 2014). Consequently, AR can be used to create a better knowledge of our bodies to address imbalances in social power through recreating virtual environments to "evoke a tolerable amount of bodily sensation in relation to issues of power, privilege, and difference" (Johnson, 2018, p. 106). On the other side, AR can be used to make people aware of their oppressive behavior (Johnson, 2018). Additionally, the physical immersion of AR fosters the conceptual understanding of educational content making people with low literacy to understand difficult theoretical concepts (Radu, 2014).

IoT

The Internet of Things (IoT) involves a myriad of interconnected digital devices and humans able to interact anytime and anyplace via the Internet (Tzafestas, 2018). According to Gartner (2017), by 2020 there will be more than 20 billion of IoT devices that will shape our future in different and novel ways. Wearable devices worn on the human body include sensors that collect and transmit information about the surrounding environment and are considered a special class of IoT devices (Tzafestas, 2018). IoT devices are any kind of computing devices that connect wirelessly to a network to transmit specific data (Tzafestas, 2018). Some of these devices can be found in health technologies to monitor the health of patients, textile technologies that allow clothes to change their color on demand, and consumer electronics that allow connection with the

surrounding environment (Tzafestas, 2018). Wearable devices and network-connected home devices that communicate with each other generate much exchange of information that can be used to support immigrants' educational needs. By tracking immigrants' real-time feedback and behavior, IoT applications will support instructors to concentrate on those immigrants' specific needs, thus enhancing learning and teaching experience (Bower & Sturman, 2015). Anxiety based on class assignments can be detected allowing the instructor to reach the student immediately. Google glasses can be used can be used during adult training role-play activities to provide a first-person viewpoint and recordings (Bower & Sturman, 2015). Also, consumer electronic devices can help immigrants to connect with other immigrants in order to cooperate in solving an assignment or to discuss a specific topic (Bower & Sturman, 2015). IoT can support long-term monitoring and management of health and chronic illness in minorities. Adult health's parameters such as heart rate, respiration, blood glucose and body weight can be monitored by wearable devices alongside with behavioral parameters and be sent to a central hospital or caregiver facility (Mittelstadt, 2017). Also, fitness or well-being wearable devices can be used as a reminder for immigrants to take medicine or to exercise according to their physician recommendation (Mittelstadt, 2017). In the case of a health issue, an alarm can be triggered and sent to a nearby hospital along with the patient history. This will provide adult minorities who cannot afford hospitalization or specialized care with an affordable alternative to eliminate the need for in-person care, to keep track of their health issues, and to regain independence (Mittelstadt, 2017).

Robots

5G will provide networking functions leveraging the robot evolution (Yu et al., 2018). According to Buller et al. (2018), robots are computers capable of sensing, thinking, and moving all on their own. Robotics motivation is to modify their environment based on their capabilities to move objects (Simoens et al., 2018). Adaptive learning systems acting as a robotic tutor can provide a personalized instruction and assistance to adult students adjusting the pace of learning and matching student capabilities (Ford, 2018). Cloud-based robots can be considered as a full- time assistant and can be precisely controlled dynamically in near real-time and be connected to people and machines locally and globally helping disabled immigrants interact with the educational environment and their peers (Yu et al., 2018). Immigrants who need to acculturate in a host country but have a lack of language abilities, can use robots to learn a second language (Toh et al., 2016). In fact, robots can create an interactive and engaging learning experience increasing the motivation of learners through extensive repetition and gesture recognition (Toh et al., 2016).

Conclusion

Learning is not anymore, a transaction between a teacher and a student, but an interaction between the technology and the sensorial capacity of learners. Technology is at the center of the learning process and teachers act as facilitators that provides the most useful sources of information. Given the advance of technology as well as the growing numbers of immigrants who need to adapt their educational background to the changing requirements of a globalized society, 5G technologies will provide the technical requirements that will enhance the use of different applications to reduce educational

gaps among immigrants and foster their empowerment. Some of the main challenges faced by instructors teaching in an online environment is to keep students engaging in their learning activities. However, the multimedia layers provided by 5G will keep the richness during the instructional sessions to immigrants despite the isolation forced by the COVID-19 pandemic.

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