Chapter 11

The Future of Learning is Immersive: Games, Simulations and Virtual Reality

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Abstract

Games and simulations are ushering in a new era of experiential and visceral learning that promises to upend training and human performance as we know it. The new generation mobile learning games and virtual reality (VR) simulations combine the engagement of gaming with the best of human-centered learning design as learners level up and practice increasingly complex skills, gain realistic experience, and build muscle memory and neural connections in a 3D immersive environment. This chapter demonstrates how associates of retail giant Walmart are learning leadership and management skills by playing the *Spark City* learning game on their phones and iPads and lab technicians at pharma leader Novartis rehearse life-saving skills virtual reality "flight simulators." The chapter reviews mobile games and VR simulations from Africa on skills ranging from first-grade math and reading to professional healthcare. The implications of this transformation of video games and virtual reality as a force for good are significant for emerging countries and their capacity for achieving the Sustainable Development Goals. They have a unique opportunity to leapfrog industrial-aged classroom education straight to high-fidelity learning simulations modeled on the way we really learn: experientially.

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Introduction

Hyper-real learning simulations developed by commercial grade game engines are transforming learning. The new generation of learning games and simulations combine the engagement of gaming with the best of human-centered learning design (guided practice, feedback and scenario design) as learners level up and practice increasingly complex skills, gain realistic experience, and build muscle memory and neural connections in a 3D immersive environment. This chapter will demonstrate how associates of retail giant Walmart are learning leadership and management skills by playing a learning game on their phones and iPads and lab technicians at pharma leader Novartis rehearse life-saving cancer treatments in a virtual reality "flight simulator." Such industry leaders are ushering in a new era of *experiential and visceral* learning. The implications for emerging countries are significant, especially in the context of building capacity for achieving of the Sustainable Development Goals (SDGs). For example, Africa's young population will increase by nearly 50 percent in the next three decades and this youth will not only drive a demand for game-based learning but could potentially benefit from learning applications. Other numbers are even more staggering: there are approximately 598 million mobile gamers in China, and it is expected to reach 728 million by 2023 (Niko Partners, 2019). The Indian mobile gaming market is expected to reach 628 million users in 2020. The chapter will provide key takeaways for educational leaders in emerging economies to get started with *games and immersive simulations* for learning and capacity building.

Games That Teach

An interesting lesson from the 2020 lockdown was that people turned to video games more than any other digital activity. After a few weeks of sheltering in place, video game playing time was up 75 percent (compared to a 20 percent increase in web traffic and a 12 percent increase in video consumption). Online video games continue at record levels because they keep gamers engaged and connected. The average 21-year-old has played over 10,000 hours of video games, which is as much time as she or he would have spent in school between fifth and twelfth grade with perfect attendance (McGonigal,2011). One game alone, *Fortnite*, has more than 350 million registered players who have logged 3.2 billion hours of game play (Statt, 2020). While it's hard to dispute the popularity of games, it's becoming equally difficult to contest their instructional value. A meta-analysis of 65 studies and 6,476 trainees found computer-based simulation games to be more effective than traditional approaches by any measure, including being 20 percent more effective in learners' ability to complete training- related tasks (Sitzmann, 2011). One could conclude that the time has come to transform the power of video games as a force for good, especially as it has proven to boost learner engagement and overall learning outcomes.

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Few examples demonstrate that more vividly than *Can't Wait to Learn*, an educational game designed to close the education gap for millions of children around the world (https://www.warchildholland.org/intervention-cwtl). The self-guided serious game teaches math and reading at kindergarten-level and up straight on a tablet. Short video tutorials by slightly

older children, aged 14-15, are mixed with a series of mini-games to practice new concepts. The games challenge players to help other children to become a goat herder, for instance, and award stars when they solve math problems successfully. Research with more than 600 young children demonstrates that they can learn on their own playing the game, without a teacher or parental support (Stubbé et al, 2016). In fact, children who had played the game for six months with just a facilitator present, performed better on standardized math tests than children who had been to school for two and a half years!

[Insert Figure 11.1 here]

Figure 11.1 *Can't Wait to Learn* game is more effective than classroom training

Educational games are not just for children. *Life-Saving Instruction for Emergences, LIFE,* is a game that teaches healthcare workers in Africa to treat covid-19 sick children (https://oxlifeproject.org). The 3D simulation is played straight on their smart phones. The aim is to train over one million health providers across Sub-Saharan Africa on new-born resuscitation skills. A study with over 500 participants found that the gamified smartphone approach offers significant learning gains over traditional training approaches (Tuti et al., 2020). It is now being rolled out across Kenya with thousands of healthcare workers already using the app. The successful momentum of the mobile game enabled the LIFE team to develop a virtual reality version of the simulation. Healthcare workers can strap on a VR headset and enter a realistic 3D virtual hospital and practice resuscitating newborn babies.

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Figure 11.2 LIFE, Virtual Reality training on life-saving skills in Africa

Creating such a high-resolution, life-size rehearsal space it not a new concept. Pilots have been trained with flight simulators for over 100 years. Every six months pilots must go into a flight simulator to practice emergency procedures. It was years of simulated water landing training that allowed Captain Sullenberger to famously glide a powerless jet liner into the Hudson River in New York and save all 155 lives on board. It was a lack of flight simulation training on Boeing's new 737 Max that is attributed to killing 346 people in the recent Ethiopian and Indonesian crashes. The same simulation technology that is used to train airline pilots is now available to nurses and doctors to save lives cost effectively.

The above examples reflect the widespread usage of learning games in several vocations because the institutions and individuals had invested sufficient funds to attract game developers to customize games that delivered relevant learning solutions. In the development space there are a wide variety of stakeholders representing politicians, policy makers, engineers, planners and citizens who could better appreciate contesting viewpoints on how future economic growth should be managed. For example, climate change policies advocate mitigating the carbon footprint of cities, and there are several competing ideas on how to proceed. City stakeholders secure a better appreciation of tradeoffs of competing priorities with limited budgets (such as, promoting transit-oriented development, green housing, affordable housing and sponge cities) through a game developed to mitigate climate change.

Lessons from Cognitive Science on How We Really Learn

Most games are modeled on what cognitive science teaches us about how we really learn: *experientially*. We can learn skills from lectures or e-learning classes, but it is not complete without practical applications from the real world. Educational theorists as far back as Aristotle

have pointed out that *we cannot learn what we haven't experienced*. The pixelated experience of a computer simulation can provide realistic experience and a digital sandbox for rehearsals.

The new simulation-based learning approaches are already making inroads into the training world. They provide hands-on training through tailored virtual scenarios that prepare learners and employees for the actual work they will encounter on the job. Like any good game, the simulations challenge players to level up through increasingly complex real-world tasks and get feedback and recognition along the way—which reflects the constructivist learning theory at work. The success of gaming in entertainment and corporate learning offers a vision of how game play could become a new and radically different training platform for the emerging countries. A caveat is the availability of adequate resources are invested to promote the development of quality games that teach. The Walmart Spark City game discussed next provides a good illustration.

Walmart "*Spark City*" Mobile Management Game

How does the world's largest retailer attract and develop a new generation of managers? Investing in a game, of course, complete with confetti rain and happy dance moves every time the player avatar completes a task successfully. Walmart used the Gronstedt Group developed "*Spark City*", a mobile management game.

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Figure 11.3 Download the Walmart learning game from the App stores

Modeled on popular mobile resource management games like *Sims* and *Clash of Clans*, *Spark City* challenges Walmart associates to run their departments like small businesses. Players make inventory, staffing and customer service decisions, packing months of business processes

into hours of gameplay. By unlocking new levels, tools and useful information, they learn to consistently execute Walmart's "One Best Way" department management routine. Highlights include:

- Familiar mission and storyline, hint-system and feedback, level progression and freedom to fail elements keep learners engaged.
- Real-time feedback – in the form of customer service, inventory and sales scores – keeps them focused on business results.
- *Spark City* leverages a “learning while having fun” model, maximizing repetition of critical job tasks.
- Helps associates visualize a clear career path and advancement opportunities as they level up from department to department (and eventually to store and district manager).

Now downloaded by over 500,000 Walmart associates, *Spark City* is used by the Walmart Academy and played on iPad Minis during week-long training programs. It has already proven to be both viral and effective.

On the net-promoter question, “*how likely are you to recommend playing the simulation to a Walmart colleague*?" pilot session participants rated it an average of 9.625 on a 10-point-scale. Classes that played the game improved 22 percent from pre-assessment to post-assessment.

Spark City thrives on the sense of engagement, storytelling, character identification, immersion, problem solving, control, and feeling of accomplishment offered by well-designed games. Cloud-hosted training content makes updates to the training instantaneous and matching the pace of technological change. The system can capture all *essential learner data*. Most importantly, it

offers high psychological fidelity, prompting cognitive, behavioral, and emotional responses of the real performance situation. Games like *Spark City* represent the future of learning, and the future is already here. Now that it's available to all 1.4 million associates (and beyond), the app promises to simultaneously challenge conventional understandings about what is possible in training, selection and recruitment. With over half a million active users, *Spark City*'s popularity is undeniable in basic skills building and appreciation of the core corporate values.

Virtual Reality, the Ultimate Learning Machine

Now, what if students could step into the 3D world, instead of just watching it on a glowing rectangular screen as in the case of the game discussed earlier? That is the promise of virtual reality (VR). Strapping on a VR headset and grabbing a controller in each hand, learners are provided a sensory experience of touch, vision, and sound that makes the brain suspend disbelief and feel a visceral sense of presence—you feel you are going to another place. Students of disaster risk management can respond on a real time basis to a typhoon or hurricane, physically walk around a devastated area or simulate the terror of a home getting flooded or a roof blown off. VR is learning in the context of where the skill will be applied. The *holodeck* is finally here.

The newest generation of VR headsets are mobile, no cords or beefy gaming computers are needed anymore. Just slip on a headset and move freely through the 3D landscape reaching out with your hands to manipulate objects in the virtual space. This new generation mobile VR is poised to transform learning. Hyper-realistic performance environments with positional audio and haptic response effectively "hack our senses," creating a complete sense of presence. With

unlimited do-overs, learners can practice repeatedly to accelerate and master skill development. Learners and instructors can even interact with each other in multiplayer VR simulations.

Imperial College London reported the results of a study showing no fewer than 83 percent of surgeons who completed surgical training via virtual reality were later successful in a physical lab, while zero percent of those trained via traditional methods were successful (Johnson & Johnson News, 2019).

VR has also been hailed as "*the ultimate empathy machine*," allowing a learner to step into the body of another person. Study upon study has validated the "*Proteus effect*," in which an individual's behavior in a virtual world is changed by the appearance of their avatar (Yee and Bailenson, 2007). Diversity and inclusion training and sexual harassment training can be taken to new levels using VR.

Let's take a look at a case study of VR at work.

Novartis VR Simulation

Pharmaceutical industry leader Novartis had to quickly train hundreds of people on best practice production and aseptic procedures for a new leukemia treatment. They had limited physical training labs and subject matter experts to train people on skills where mistakes have life and death consequences. The Gronstedt Group developed a new state-of-the-art VR simulation that allows learners to strap on a VR headset, grab hand controllers and step into a hyper-realistic virtual manufacturing facility to practice life-saving procedures. Walking around in a state-of-the-art virtual reality lab, they weld tubes, remove bag caps, label bags, sanitize their hands, and practice surgical skills in a safe non-threatening environment.

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Figure 11.4 Novartis VR lab training

The simulation also helps demonstrate the *invisible*. For instance, it's important for lab technicians to minimize disruption of air flow in the biological safety cabinet. The VR sim demonstrates how to do this by moving the hands slowly and holding bags vertically, while not covering the air grille (which *sounds simpler* than it is). Thanks to the technology, learners can actually see air flow as they move around in the environment. Learners rehearse techniques over and over in preparation for real-life performance, building "*muscle memory*." The VR experience offers "*embodied cognition*," which means learning with your mind and body. Research studies have confirmed the importance of activating muscle memory, getting up on your feet and using the entire body helps commit skills to the memory and aids in retention and application.

The Novartis VR simulation offers *three* forms of fidelity.

- Seasoned artists working with professional-grade game engines can create high physical fidelity that looks, sounds and even feels like the real work environment. Developers can also create accurate functional fidelity, where equipment and other objects in the performance environment act like the real thing. In the Novartis lab sim, users can stretch the plastic tubes in such realistic ways that that the brain tricks them into feeling the resistance in your hands. However, designing for realism doesn't guarantee learning.
- Simulations also need to be designed for cognitive fidelity, applying sound instructional principles to ensure that people actually learn the correct skills (Straus, 2019). Human-centered learning simulations with tutorials, feedback, guided practice, engagement and scenario design in VR can provide skill practice under a variety of stressful conditions. Learners frequently report a level of focus and immersion so powerful they lose track of time.

Most importantly, VR promotes learning in the context where the skills will be applied – a quality that is increasingly appropriate when one mistake can contaminate the entire process. The Pharma leader is using virtual reality learning to enable "*hands-on*" practice on invaluable life-saving procedures. The research is conclusive: Repeated actions in virtual reality alter neural wiring, in turn improving real world performance (Adamovicha, 2009).

The Future: Augmented Reality and Artificial Intelligence

While VR immerses the user in a virtual world through a headset that largely shuts out the real world, its cousin, **Augmented Reality (AR)** inserts virtual objects and information into the real world. Instead of treating the phone as a screen, it uses the phone as a *lens*—one that can, figuratively speaking, arm people with superpowers. However, watching the world through a phone or tablet is not practical for longer periods of time. The real promise of AR will not be realized until mass market headsets arrive on the market. Lightweight glasses that will leave the hands free to perform tasks is the future of AR. These headsets are still years away. The AR revolution will happen – and it will be amazing – but not until later in the decade. Meanwhile, The United Nations Industrial Development Organization (UNIDO) is using smart glasses to provide remote support to laboratories in West Africa. Lab workers in Accra, Ghana, wears smart glasses that experts 6,000 kilometers away in Rome can watch in real time to provide technical support (Newsroom, 2020). These smart glasses have cameras and microphones and are Internet connected. In the future, fully featured AR glasses that are powered by artificial intelligence (AI) will recognize the lab environment and superimpose holographic images to assist the lab worker. The remote expert might not even need to guide them any longer for more routine issues. This is the promise of

augmented reality, as a utility to provide performance support. Think of the difference between VR and AR in terms of the airline pilot: VR is the flight simulator that immerses the pilot for safe practice before they step on the plane. AR is the heads up display on the cockpit windshield when the pilot is flying the plane that guides them through their flights. These technologies are closely related, but the applications are quite different. Together, they will *revolutionize* learning and performance support as we know it.

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Figure 11.5 Remote experts in Rome can assist lab workers in Ghana with smart glasses, a precursor to augmented reality

Table 11.1 Summary of immersive media for learning

Immersive media	**What is it**	**How does it benefit learning**	**Maturity**
3D on phone, tablet, or PC	**Availability**: Learning in your pocket	Smart phones and tablets are ubiquitous, providing spaced repetition and micro-learning	Technology and devices are here.
VR	**Immersion**: Can put you anywhere	Complete sense of presence, being inside the environment where skills will be used	Technology is here but investment in VR headsets needed.
AR	**Utility**: Can bring anything to you	Utility: Performance support in the real world	It will take several years to reach mass market.

Immersive learning is typically more *expensive upfront*; 3D art assets need to be hand crafted; interactivity need to be programmed. However, it's a malleable asset that can be leveraged in multiple ways over a long time, using multiple platforms. Unlike video that needs to be reshot every time something needs to be updated and live instructor-led training which doesn't scale, 3D immersive learning is infinitely *scalable* and *reusable*. Applying it in developing countries requires adequate funding, supported by a sustainable business model that includes cost-recovery models over multiple years, platforms and applications.

How to get started?

How does one get started to introduce game and simulation-based learning? Below is a step-by-step guide.

- **Identify use case and goals**: Select an area of knowledge or skill with high pay-off that game and simulation-based approaches are uniquely suited to solve.
- **Pilot: Start with a pilot** which will meet smaller learning objectives as opposed to a full-blown immersive learning program.
- **Vendor selection and costs -** select a team of professional game developers, including artists and programmers and instructional designers who are experienced in the immersive learning design and development process.
- **Learning and Experience Design:** With the objective(s) identified, it is time to ideate a simulation design. Storyboard out the experiences.

- **Prototyping and Iterating: Next, prototype and iterate the solution.** This service requires a team of artists, programmers and game/instructional designers and can also be outsourced. A new generation real-time game engine helps developers manage logic, rules, physics, real-time visuals, sound, artificial intelligence and more. These engines allow developers to focus on the creative aspect of development. Two market leading game engines, Unreal (https://www.unrealengine.com/) and Unity (**https://unity.com/**), power most entertainment and learning games developed by independent studios. These game engines are multi-platform, deployable on everything from phones to VR and AR headsets. They are also license free for educational purposes. The game engines are great tools for an agile team to prototype early and iterates fast.The client can test design iterations on a weekly basis and end-users can be involved to play-test every stage of development.

- **Quality Assurance Testing**: Track and resolve bugs until one has arrived at a final, deployable "*release*" version.

- **Deployment and "Hyper-care":** Provide first- or second-line support during the lifetime or the program.

- **Analytics and enterprise integration:** The impact of the program should be evaluated at all four *Kirkpatrick levels* of Reaction, Learning, Behavior, and Results. A dashboard can track every digital footprint of game play, including usage, retention, crash reports, and failure points. In-game telemetry capture actionable insights to improve game experience and other training. "Funnel analysis" a method to understand the steps required to reach an outcome, measure completion of each level and how long people stay in the game. This data can be reported to a Learning Management Systems (LMS) and Learning Record Stores (LRS) using SCPRM or xAPI.

Ideas to Take Forward

VR can take one to any place; AR can bring anything to the learner. VR offers a digital rehearsal space of such convincing verisimilitude that learners feel they are actually there. AR makes the real world the canvas of any number of simulation-based learning activities. The accessibility of mobile games on the phone provide spaced repetition, learning sustainment and mastery. Phone-based learning games are the real opportunity for the developing world, which leapfrogged PC and are primarily mobile based. Cross-platform immersive learning on platforms ranging from phones to digital reality headsets hold the promise of empowering students to play an active role, becoming the protagonists of their own learning and, in the process, dramatically boosting their performance. Games and simulations are ushering in a new era of experiential and visceral learning that promises to upend training and human performance as we know it. The benefits are enormous, what is needed is adequate funding to support the development of games that expediate capacity building to achieve the SDGs in less than ten years.

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