

WHITE PAPER



TIME



POWER



Serious Games: Improving Medical Education

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INVIVO[®]



Executive Summary

Games can be created to mimic any type of healthcare environment, from the emergency department to the surgical suite. **Serious games** are educational tools to help physicians master clinical skills. Medical education games have been shown in clinical studies to improve healthcare professionals knowledge, skills and confidence in various medical procedures (e.g., surgical procedures, diabetes management, and patient interactions) leading to improved patient outcomes. Studies support the theory that simulative and immersive experiences may lead to faster diagnoses, fewer surgical errors, and overall improved patient management.



29%

improvement in
mean knowledge and
skills using serious
games compared to
traditional education.¹

By learning through
simulation and immersion,
knowledge gained
becomes knowledge
integrated and applied.

Introduction

Education is more challenging in a fast-paced, delivery-oriented world. Creating a single solution for educating adults provides challenges, as **we each bring our own unique experiences to help address the problems, questions and challenges we are facing.**² Nonetheless, ongoing learning is particularly important for healthcare professionals, as it assists them with acquiring new skills and developing the thought processes that are needed to respond appropriately in a variety of situations, particularly under pressure.³

The adult learner is primarily a self-directed learner, who is most interested in information and ideas that can be applied immediately to solve problems or address challenges.² A further complication of adult learning is a lack of time, necessitating that education take place in bite-sized chunks accessible without limitations of scheduling or location. With competing constraints on our time and attention, it is imperative that teaching tools grab the learner's attention from the outset. This can be achieved through the use of visually compelling graphics and imagery that keep users engaged with an array of media (audio, reading, visual) in order to deliver information in a clear and concise manner.⁴

Creating multimedia experiences is essential in adult learning to maximize engagement and assist with the visualization of concepts. Research suggests that time spent in the classroom offers less benefit in how to learn, think, and perform in the face of real-world challenges than do interactive experiences which motivate the learner and simulate a person's reality.³



Screenshot from "The Enlightened League of Bone Builders" on HTC Vive, INVIVO Communications.

...it is imperative that teaching tools grab the learner's attention from the outset.

Gamification, particularly simulation-enabled games, improves not only the quality of learning but also the confidence of the learner, by engaging them in real-world problem solving.⁵ This method has been shown to help the learner better understand the connection between their learning experience and their real-life work as they pursue a specific goal. Game-based learning and simulations allow the learner to make errors and experiment in a risk-free setting, encouraging them to learn, practice and discover new ways to achieve success. This approach keeps the learner actively engaged in different techniques and thought processes that can be transferred from a game or simulation to real life.³

Gaming and Education

Serious games are educational tools that encompass a spectrum of activities, including defined objectives, a set of rules and a feedback system that allows the player to assess how close they are to achieving their goals. Gaming should also offer the player a concrete experience, time for reflection and conceptualization and application of learning/experimentation.

Serious games are increasingly being considered for medical education as they have been shown to employ game-thinking and mechanics that improve medical knowledge and skills.⁶

Digital games have become more commonly used as tools for medical education given they are now a well-accepted part of our everyday life. They promote experiential (active) learning and encourage self-directed learning.⁷⁻¹⁰ It is important, however, that medical education games facilitate stealth learning. That is, delivering knowledge and skills within a safe framework that is perceived as a personal and community journey of growth. To allow for the sentiment of empowerment and control, which is key for gaming, the learner should drive the game, determining their route and speed.⁶

Several surveys and studies support that digital games and active learning offer educational value in science and healthcare learning, particularly if the game realistically replicates the experience of laboratory or clinical practice.^{8,12,13} In a study using Labster, a gamified laboratory simulation, a 76% increase in learning outcomes compared to traditional teaching was observed, with a 101% increase when the simulation was used in combination with traditional teaching.¹³

The benefits of active learning are further supported by a meta-analysis of 225 studies that compared student performance in undergraduate science, technology, engineering, and mathematics (STEM) courses under traditional lecturing versus active learning (e.g., group problem solving, worksheets, workshops). The outcome indicated that the average exam score improved in active learners by about 6%, while learners in traditional lectures were 1.5 times more likely to fail than their active-learner colleagues.¹²

Some tips for creating a 'serious' medical education game include^{6,11}:

Ground game in a clear curriculum of knowledge and skills



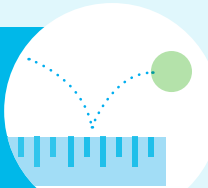
Offer rewards (self-efficacy and/or reputation)

Allow for a trainee-player model, where the learning guides the experience



Provide opportunity for in-game collaboration with colleagues.

Ensure actions/learnings from the game have a clear, measurable real-world impact



Allow for infinite play (continuous deliberate practice) until expert level is achieved

Looking at real-world clinical examples, two studies, one in diabetes and one in hypertension, found that gamification improved knowledge and skills in medical students/residents. Notably, gamification of hypertension best practices led to improved patient outcomes in the hypertension study by highlighting the underlying need and importance of therapy for the patient.^{1,14-16} InsuOnline was developed to improve physician knowledge about insulin and glycemic control in adults with diabetes mellitus. The pilot study with medical students and residents demonstrated an improvement in their mean knowledge/skill with a score of 21% in the traditional education group (lecture, case discussion; n=23; p<0.001), and a 29% improvement in the game group (player assumes role of physician in primary healthcare unit evaluating increasingly complex patients; n=18; p<0.001).

The gamification of hypertension best practices involved developing game mechanics for an evidence-based for online education.* The goal was to improve treatment intensification in hypertensive patients not at BP target in clinical practice. This real-world study was a 2-arm randomized trial conducted over 52 weeks among primary care clinicians (n=111) at 8 hospitals with 14 336 patients. The game improved clinicians' long-term knowledge of best practices, and was significantly more effective than providing the identical content as an online posting with e-mail reminders. Gamification led to a large gain in clinicians' knowledge of hypertension management and generated a modest but significant improvement in time to BP target (117 days versus 125 days, P=0.022) as well as leading to improved health measures in the treated patients. The study concluded that, while significant, the modest success highlights the fact that substantial challenges remain in translating improvements in clinician knowledge to changes in patient outcomes.¹⁷

Simulation games such as Septris and SICKO have been applied to hospital risk management. These simulations use real-life patient cases recreated as virtual interactive patients to allow clinicians to identify a practical approach to early symptom identification and application of evidence-based management (best practice) and evidence-based guidelines. The simulations are used by risk managers to assess healthcare professional performance on past or potential cases as well as allowing clinical decisions made within the scenario to be deconstructed and analyzed, leading to **improved patient outcomes, with reduced mortality and liability.**^{18, 19}



*Game mechanics included competition among participants, adaptive content reinforcement based on performance, an appointment dynamic (one must engage at predefined times to take some action), and a progression dynamic (progress is displayed and measured by completing itemized tasks).



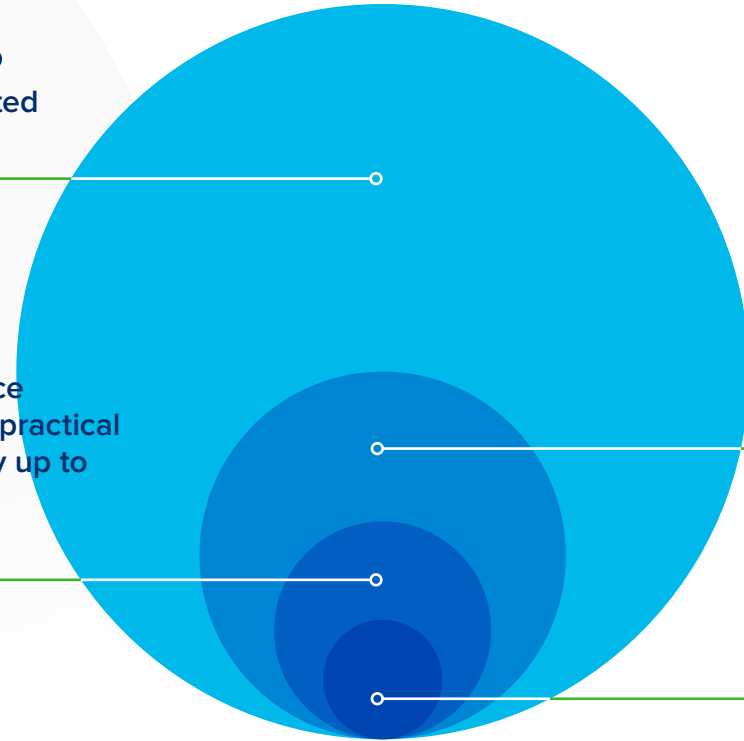
Evidence is growing that games are an effective way to learn. Compared with traditional learning, game-based learning may:

Generate up to
300%
more completed
tasks

Increase
self-confidence
and enhance practical
knowledge by up to
20%


Improve
retention
of learned
content by
90%

Improve
conceptual
knowledge by
11%



Sitzmann T. A Meta-analytical examination of the instructional effectiveness of computer-based simulation games. *Pers Psychol.* 2011;64:489-528.

Rewards and competition are an integral part of any game. In medical education, multiplayer online games can help physicians collaborate or compete with their peers in clinical environments with the goal of improving a skill. People, particularly healthcare professionals, like being good at tasks and enjoy learning and demonstrating their improvements.

An infographic featuring a central green circle with white text. Surrounding it are several circular icons containing different types of data visualizations: two donut charts, a line graph with a peak, a bar chart with five bars, a hand pointing at a bar chart, a pie chart, a checklist, and another line graph. The background is white with light gray circles.

Analytics help
identify common
mistakes and guide
improvements to
clinical practice.

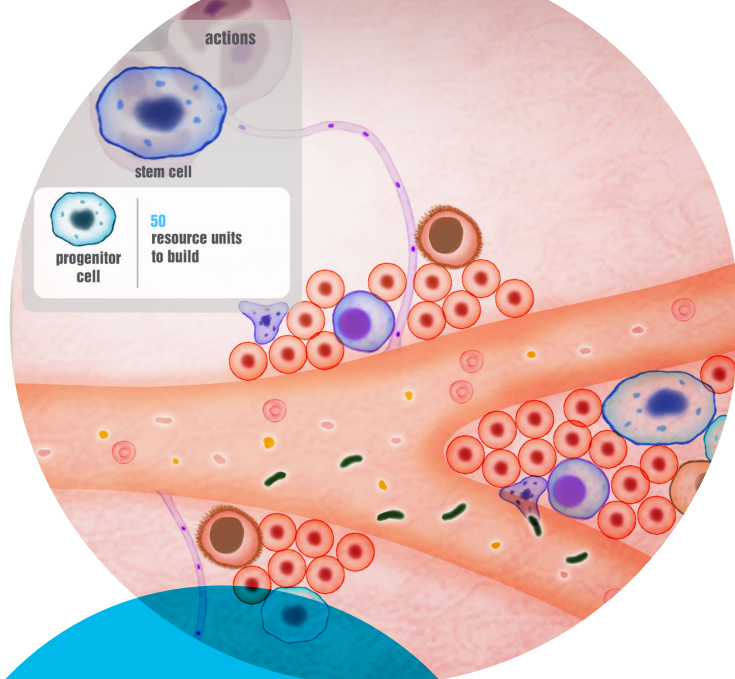
Analytics

It is estimated that over 24 million mixed reality devices will be sold in 2018. It is also expected that gamification will have significant adoption by 2020, particularly in light of the inexpensive nature of mixed reality devices like the Google Cardboard.²¹

The data support that gamification can be used to help keep healthcare professionals current on medical best practices, ultimately improving patient care. Gamification allows complex information and training to be learned in a safe environment.

Analytics within a game allow instructors to determine which actions/diagnostics were most commonly used on specific patients and to identify common mistakes made by the learner. These common mistakes can then be addressed with additional feedback either built into the game or through other teaching methods. Analytics also have the potential to correlate improvements in learner knowledge and skill with improvements in patient outcomes and mortality rates.¹⁸

Interestingly, analytics also help engage the learner. One study demonstrated that the use of a leaderboard (scoreboard showing names and current scores of competitors) **led to students interacting with their project 29.61 more times**, on average, than those in a control condition.²² Competition and education are intimately related. Competition was used historically to enable people to practice their abilities, hone their skills and encourage the solution of problems (both practical and theoretical)—all key elements of learning. Competition challenges the participant to give their best and, importantly, to seek creative paths or solutions to achieve desired results. Competition has also been shown to provide motivation, as the participant is provided with feedback that may be incorporated into their learning and strategy to better accomplish the goal.²³



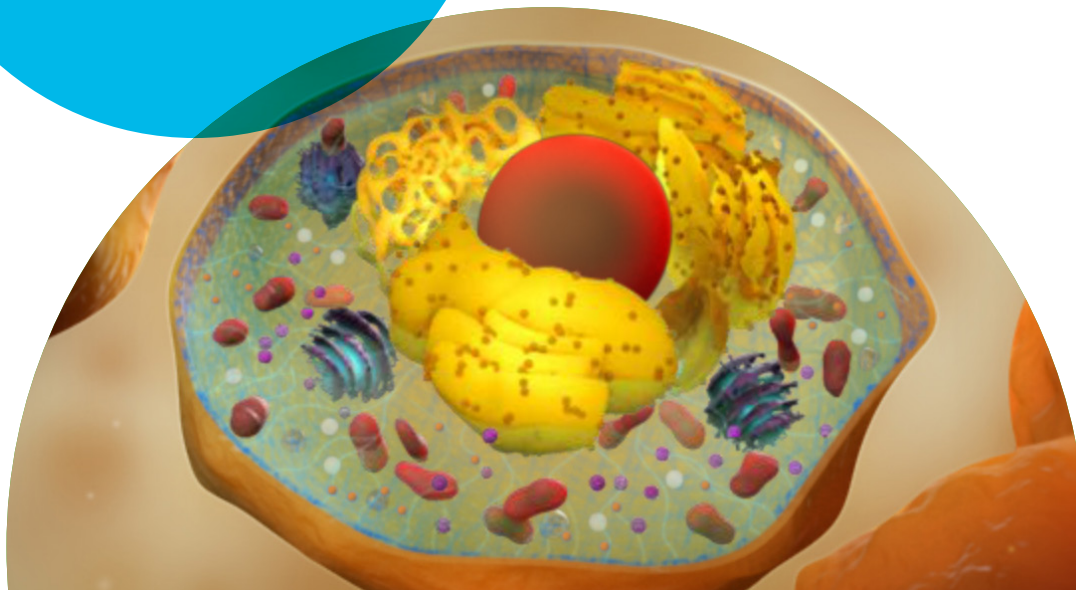
Gamification is about mastering skills to change actions and behaviours.

Summary

To develop mastery, students must acquire knowledge and component skills, practice integrating this knowledge and, most importantly, understand when to apply what they have learned.³ The demand for novel teaching methods that work in conjunction with blended learning is growing in our increasingly technical world, and it is expected that gamification, especially simulation, will be applied to more areas of knowledge.¹⁸

Gamification and simulation are about mastering skills and techniques, which develop into changed actions and behaviours.²⁴ Good game-based learning should be tailored to each learner, permitting them to advance only if they have mastered a certain task. More importantly, as the game represents an active, realistic learning environment, the focus should be on learning, through consequences, to apply suitable knowledge at the appropriate time.³ The challenge with medical games is creating an engaging, enjoyable and educational experience that allows health professionals to gain skills to solve challenging patient cases.

Medical education games are now being seen as an effective tool to engage health professionals, to boost knowledge and skills, to optimize best practices, and to improve patient outcomes.¹⁷



Screenshots (from top): "CellTropolis" and Animal Cell from "Build-a-body."

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