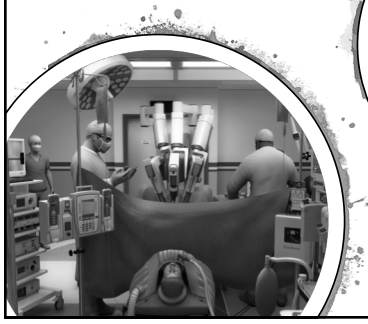
SCREEN BASED SIMULATION & MEDICAL EDUCATION



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WHAT WE WILL COVER

- Application of Simulation in medicine / healthcare
- The value of high-fidelity simulation in medical education
- Serious games / Game Based Learning
- Examples of Screen Based Simulation in Medical Education and Healthcare
- Limitations of Screen Based Simulation and alternatives (VR / AR)

CLASSIFICATION OF SIMULATION PER FIDELITY

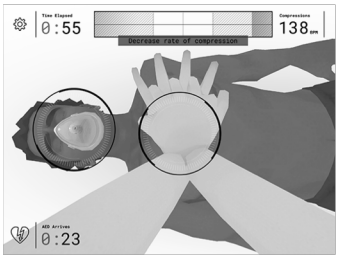
Low fidelity Screen based text simulators	Create scenarios with user selecting one of the several responses. E.g. in a scenario involving a patient with severe headache, the user may be offered options such as prescribing an analgesic or getting a CT scan of the head. Simple to construct and are less expensive but they focus on single skills and there is poor immersion
Static mannequins	Used for hands-on practice. E.g. intubation, laparoscopic training or cardio pulmonary resuscitation ('Ressusi' dolls)
Medium fidelity Screen-based graphical simulators	Suited to demonstrate physiological, pharmacological processes. Provide a more realistic representation, are portable, and relatively less costly. These help one to understand the basic concepts but do not confer actual practical skills. E.g. Computer simulation of changes in Blood pressure in response to drug administration(Ex pharm)
Mannequins with mechanical movement	Includes a mannequin and software. Computer-based pictures help confer practical skills Includes 'range of normal variation' E.g. Cardio-pulmonary resuscitation (AMBU Man)
High fidelity simulators	Combine part or whole body mannequins to carry the intervention with computers that drive them to produce physical signs. They are usually designed to resemble the reality. They can talk, breathe, blink, and respond either automatically or manually to physical and pharmacological interventions
Non-physiologic programming	Manually set parameters dependent on operator programming. Parameters need to be reset after intervention
Physiologic programming	Automatic generation of appropriate physiological responses to treatment-interventions in the mannequin allowed. E.g. human patient simulator.

Standardized Patients

Krishnan D, Keloth AV, Ubedulla S. Pros and cons of simulation in medical education: A review. *International Journal of Medical and Health Research.* 2017; 3:84-87.

APPLICATION OF SIMULATION IN MEDICAL EDUCATION

- Standardized patients / High fidelity simulations in medical and nursing student education
- Procedural training for variety of surgical specialties (from resident to attending level)
- Use of high-fidelity simulation within various residency programs for curriculum integration and reinforcement
- Use of simulations to identify and address systems issues in healthcare (in-situ simulations)
- Use in teaching and application of Crisis Resource Management
- TeamSTEPPS
- CPR: Faster skill acquisition & better skill retention
- Games For patients



Bokken L, Rethans JJ, Scherpbier AJ, van der Vleuten CP. Strengths and weaknesses of simulated and real patients in the teaching of skills to medical students: a review. Simul Healthc 2008;3(3):161Y169.

Wing-Yin Chan, Jing Qin, Yim-Pan Chui, Pheng-Ann Heng. A Serious Game for Learning Ultrasound-Guided Needle Placement Skills. IEEE Trans Inf Technol Biomed 2012;16:1032–42.

Umoren RA, Poore JA, Sweigart L, et al. TeamSTEPPS Virtual Teams: Interactive Virtual Team Training and Practice for Health Professional Learners. *Creat Nurs* 2017;23(3):184-191.

Harrington CM, Chaitanya V, Dicker P, Traynor O, Kavanagh DO. Playing to your skills: a randomised controlled trial evaluating a dedicated video game for minimally invasive surgery. Surg Endosc 2018;32:3813–21.

Creutzfeldt J, Hedman L, Felländer-Tsai L. Effects of pre-training using serious game technology on CPR performance—an exploratory quasi-experimental transfer study. Scand J Trauma Resusc Emerg Med 2012;20:79.

Ilgosse WM, Goor H van, Luursema J-M. Saving robots improves laparoscopic performance: transfer of skills from a serious game to a virtual reality simulator. Surg Endosc 2018;32:3192–9.

HIGH-FIDELITY SIMULATION (HFS) IN MEDICAL EDUCATION: IT'S VALUE

- Ability to provide standardized practice
- Ability to provide repetition
- High-fidelity environments for participant buy-in
- Useful to teach / learn about rare and critical events
- Feedback to participants during debrief
- Stress-related positive learning / retention
- Acquisition of knowledge and skills / patient outcomes

Issenberg S, McGaghie WC, Petrusa ER, Lee Gordon D, Scalese RJ. Features and uses of high-fidelity medical simulations that lead to effective learning: a BEME systematic review. *Med Teach* 2005;27(1):10-28.

Demaria S, Silverman ER, Lapidus KA, et al. The impact of simulated patient death on medical students' stress response and learning of ACLS. *Med Teach* 2016;38(7):730-7.

Cook DA, Hatala R, Brydges R, et al. Technology-enhanced simulation for health professions education: a systematic review and meta-analysis. *JAMA* 2011;306(9):978-988.

McGaghie WC, Issenberg SB, Cohen ER, Barsuk JH, Wayne DB. Does simulation-based medical education with deliberate practice yield better results than traditional clinical education? A meta-analytic comparative review of the evidence. *Acad Med* 2011;86(6):706-711.

Cook DA, Hamstra SJ, Brydges R, et al. Comparative effectiveness of instructional design features in simulation-based education: systematic review and meta-analysis. *Med Teach* 2013;35(1):e867-e898.

BUT, HIGH-FIDELITY SIMULATION IS NOT ALWAYS FEASIBLE OR PRACTICAL…

High-fidelity simulation (HFS), using standardized patients or advanced technologically-driven mannequin-based simulators, aren't cheap

- Startup and maintenance cost of simulation lab / center
- Initial price and lifelong maintenance of simulators (including the advanced, physiologically-responsive mannequins vs. task trainers)
- Personnel (time + pay for being away from clinical duties)
- Ancillary equipment for simulation center to increase the fidelity of environment (i.e., anesthesia machine, OR bed, anesthesia carts, supplies for the carts, etc)

HFS has limitations

- Requires physical presence of participants
- Limits amount of participants that can undergo simulation (simultaneously, or serially)
- Not every department in an institution, or even the institution itself, has easy or affordable access to use / learn from simulation
- Limited realistic human interactions

VIRTUAL ENVIRONMENTS / GAMES-BASED LEARNING

What is a serious game?

- A game with a primary purpose other than pure entertainment
- They can be specifically designed for a particular field
  - Military - MACS
  - Healthcare
  - Emergency management

They can be commercially designed and applied for a different purpose

- The SIMS – for Hospitality Management OR gateway to architecture

VIRTUAL ENVIRONMENTS / GAMES-BASED LEARNING

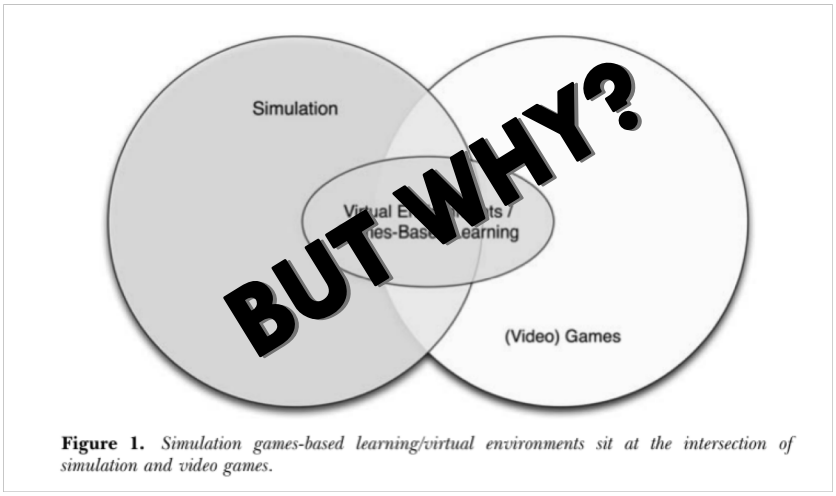


Figure 1. *Simulation games-based learning/virtual environments sit at the intersection of simulation and video games.*

Taekman JM, Shelley K. Virtual environments in healthcare: immersion, disruption, and flow. *Int Anesthesiol Clin.* 2010;48(3):101-21.

VIRTUAL ENVIRONMENTS / GAMES-BASED LEARNING

Concept of **Flow**: aka "In the zone", "head in the game"

- A psychological / mental state, in which the person is fully engaged, focused, and committed to the success of an activity
- Common in game design (challenges / missions are staged - aren't too easy to bore the participants, and not so hard that they give up)
- Needs to be incorporated and strived for, in medical education, since it is a component of efficient learning, especially when developing expertise through deliberate practice.

Csikszentmihalyi MCsikszentmihalyi , IS. Optimal Experience: Psychological Studies of Flow in Consciousness. Cambridge; New York: Cambridge University Press; 1988.

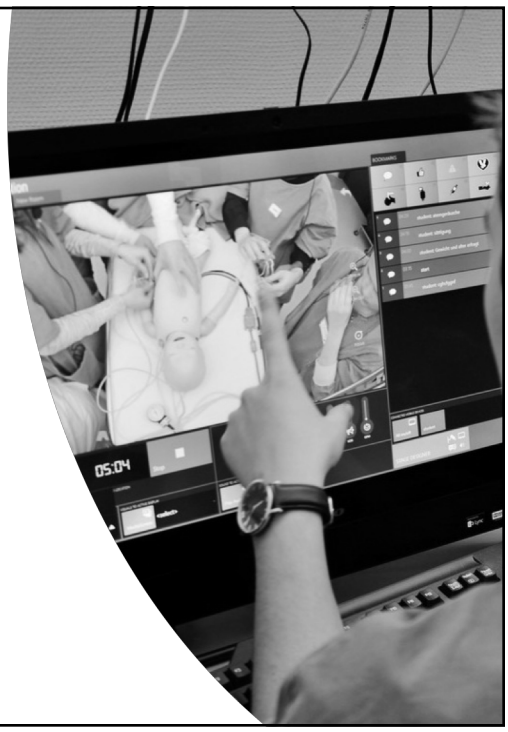
Colvin G. Talent is Overrated: What Really Separates World-class Performers From Everybody Else. London, England: Portfolio (Hardcover); 2008.

TYPES OF VIRTUAL ENVIRONMENTS FOR SIMULATION

1. Screen-based
2. Virtual Reality (VR)
3. Augmented Reality (AR)

SCREEN BASED SIMULATION

- Multiple views and vantage points
- Easy to time constrict and dilate
- Allows for shortcuts
- May be very expensive to develop
- May be expensive to maintain
- Require additional purchases
  - Computer
  - Phone
  - Peripherals
- Require multiple outcomes or levels for replay value
- Limited real estate depending on platform
- Learning curve on gameplay mechanics (where to position hands or icons)



BENEFITS OVER MANNEQUIN-BASED LEARNING

- **Convenience and lower cost** - phone, tablet, personal computer + internet connection
- **Scalability & Distributability**
- **Repetition**
- **Tracking progress**
- **Anonymity**
- **Instant Feedback (frequent / customized)**
- **Rewards and Competition**

Taekman JM, Shelley K. Virtual environments in healthcare: immersion, disruption, and flow. *Int Anesthesiol Clin.* 2010;48(3):101-21.

EXAMPLES OF SCREEN BASED SIMULATION IN HEALTHCARE

Procedural Training

- Laparoscopic Skills (**The Underground**)
  - Better skills acquisition on Lap Simulator
    - Vs Control of Standard Practice
    - Vs Control of Lap Simulator
- CPR
  - Faster Skill Acquisition
  - Better Skill Retention
- Ultrasound Needle Placement
  - Better Targeting
  - Higher Success Rate

Wing-Yin Chan, Jing Qin, Yim-Pan Chui, Pheng-Ann Heng. A Serious Game for Learning Ultrasound-Guided Needle Placement Skills. IEEE Trans Inf Technol Biomed 2012;16:1032–42.

Creutzfeldt J, Hedman L, Felländer-Tsai L. Effects of pre-training using serious game technology on CPR performance--an exploratory quasi-experimental transfer study. Scand J Trauma Resusc Emerg Med 2012;20:79.

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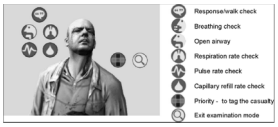
EXAMPLES OF SCREEN BASED SIMULATION IN HEALTHCARE

Knowledge Base Training

- OLT Anesthesia Trainer
  - Enhanced skill gains on rotations
- abcdeSIM
  - Improved Clinical Competencies in ER
  - abcdeSIM available for:
    - Emergency physicians
    - Emergency department nursing
    - Pre-hospital primary care
    - Severe burn victims
    - Pediatrics
- Triage Trainer
  - Higher tagging and step accuracy



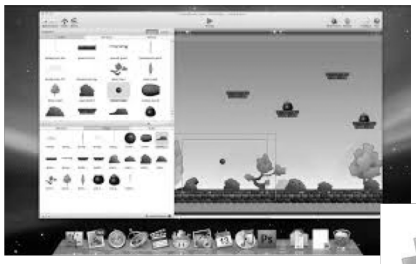
Dankbaar MEW, Roozeboom MB, Oprins EAPB, Rutten F, Merrienboer JJG van, Saase JLCM van, Schuit SCE. Preparing Residents Effectively in Emergency Skills Training With a Serious Game. Simul Healthc 2017;12:9–16.

Katz D, Zerillo J, Kim S, Hill B, Wang R, Goldberg A, DeMaria S. Serious Gaming for Orthotopic Liver Transplant Anesthesiology: A Randomized Control Trial. Liver Transplant 2017;23:430–9.

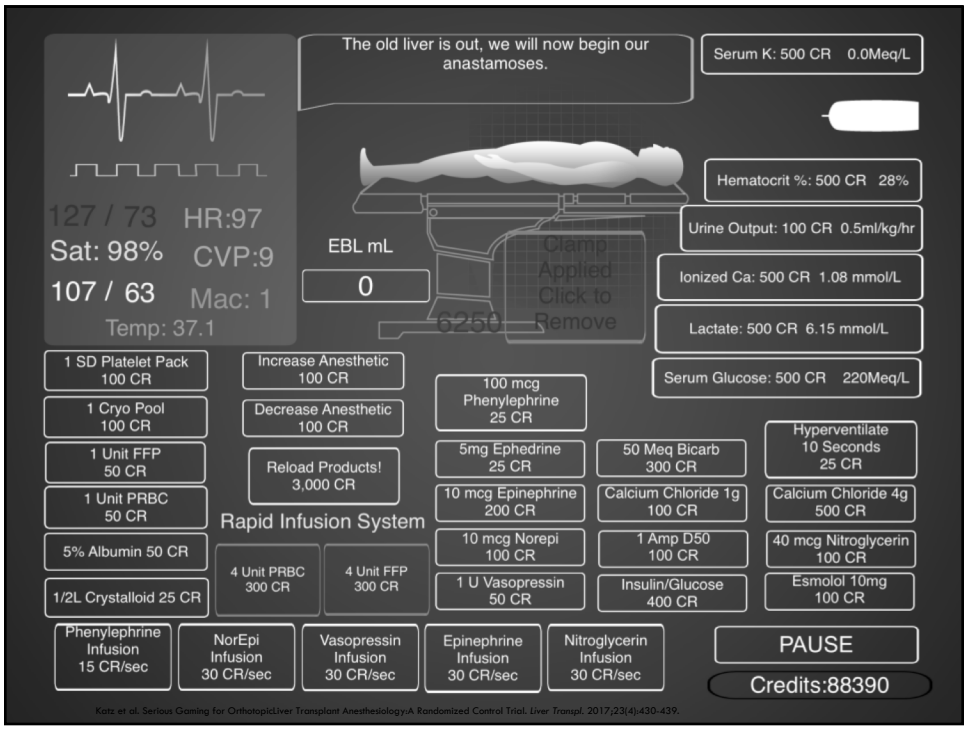
OLT ANESTHESIA TRAINER

Platform
- iPad

- Engine
  - GameSalad
    - Low Cost
    - No Coding
- Graphic Assets
  - Artist
- Content created using:
  - Basic Concepts
  - Local experts
  - Best practices
  - Guidelines



Katz et al. Serious Gaming for OrthotopicLiver Transplant Anesthesiology:A Randomized Control Trial. *Liver Transpl.* 2017;23(4):430-439.



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FINDINGS FROM A PROSCPECTIVE RANDOMIZED CONTROL TRIAL

Score Differences Between Groups			
Stage of Game	Score Difference Gaming Group	Score Difference Control Group	Statistical Significance
Pre-Operative Assessment	2.67 (2.09)	1.17 (1.43)	p=0.01
Induction and Monitoring	1.57 (1.49)	1.00 (1.41)	p=0.22
Dissection Phase	0.75 (0.61)	0.92 (0.83)	p=0.45
Pre-Anhepatic and Anhepatic Phase	1.62 (1.01)	0.75 (1.28)	p=0.02
Reperfusion Phase	1.32 (1.07)	0.97 (0.80)	p=0.25
Total Score	7.95 (3.65)	4.8 (4.48)	p=0.02
Numbers Reported as Mean (SD), GG (Gaming Group), CG (Control Group)			

Katz et al. Serious Gaming for OrthotopicLiver Transplant Anesthesiology:A Randomized Control Trial. *Liver Transpl*. 2017;23(4):430-439.

EXAMPLES OF SCREEN BASED SIMULATION IN HEALTHCARE

Graafland M, Bemelman WA, Schijven MP. Game-based training improves the surgeon's situational awareness in the operation room: a randomized controlled trial. Surg Endosc 2017;31:4093–101.

Non-Technical Skills

- Improved Situational Awareness
  - After 1 hour of gaming (Surgeon Trouble)
    - Enhanced response to equipment failure
- Better Adherence to Standardized Protocols
  - Central Line Placement

Katz D, Goldberg A, Khanal P, Kahol K, DeMaria S. Using Serious Gaming to Improve the Safety of Central Venous Catheter Placement: A Post-Mortem Analysis. Gaming Comput Mediat Simulations 2015;6:34–45.

Step of CVC Placement	Control Group (% Missed Step)	Gaming Group (% Missed Step)	Chi Square
Hands Washed Pre-Patient Introduction	81%	72%	0.61
Patient Introduction/Consent Verification*	54%	9%	0.02
Placement of Patient in Trendelenberg*	72%	9%	0.002
Primary Scrub*	81%	9%	0.003
Gown and Glove	9%	0%	0.3
Skin Preparation	0%	0%	-
Patient Draping	0%	0%	-
US Probe properly covered	0%	0%	-
Application of US gel	0%	0%	-
Verification of Compressibility of IJ Vein	0%	0%	-
Time Out Verification	100%	90%	0.3
Skin Localization	0%	9%	0.3
Insertion of syringe with back pressure*	81%	9%	0.0006
Confirmation of venipuncture via manometry*	72%	9%	0.002
Insertion of guidewire	0%	0%	-
Removal of puncture needle	0%	0%	-
Insertion/removal of dilator	0%	0%	-
Catheter insertion	0%	0%	-
Removal of guidewire	0%	0%	-
Catheter flush	9%	0%	0.3
Use of clipper to secure catheter	36%	9%	0.12
Sterile dressing placement	9%	0%	0.3
Pt. repositioned	81%	72%	0.61
Proper disposal of items	81%	90%	0.5
Hands washed after procedure	100%	100%	-

EXAMPLES OF SCREEN BASED SIMULATION IN HEALTHCARE

Online Simulation	
Description	Online simulation that realistically replicates clinical scenarios that participants can work through using computer technology. These options are approved: • ASA Anesthesia SimSTAT (up to 5 points per module) • VHA DAARC (up to 6 points)
Point Value	1 point per hour spent on the activity, up to 25 points.
Reporting Mechanism	The ASA will report completion to us for Anesthesia SimSTAT. Self-report completion for VHA DAARC based on time spent on the activity.

EXAMPLES OF SCREEN BASED SIMULATION IN HEALTHCARE

Acquired Brain Injury

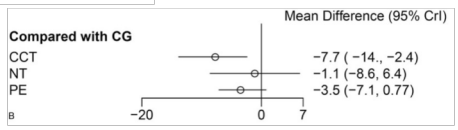
- Supplement to cognitive/physical rehabilitation
  - Programs lasting months
  - Repetitive exercises
  - Home-based therapies

Alzheimer's Disease and Related Disorders and Frailty

- Exergames
  - Enhanced balance
  - Timed up and go (TUG)

Huisman MG, Leeuwen BL van, Ugolini G, Montroni I, Spiliotis J, Stabilini C, de'Liguori Carino N, Farinella E, Bock GH de, Audisio RA. "Timed Up & Go": a screening tool for predicting 30-day morbidity in onco-geriatric surgical patients? A multicenter cohort study. PLoS One 2014;9:e86863.

- Cognitive Games
  - Enhanced Cognition
    - As good or better than medication
  - Less Neuropsychiatric Symptoms
    - As good or better than medication



Liang J-H, Xu Y, Lin L, Jia R-X, Zhang H-B, Hang L. Comparison of multiple interventions for older adults with Alzheimer disease or mild cognitive impairment: A PRISMA-compliant network meta-analysis. Medicine (Baltimore) 2018;97:e10744.

Férnandez-Calvo, B., Rodriguez-Pérez, R., Contador, I., Rubio-Santorum, A., and Ramos, F. (2011). Efficacy of cognitive training programs based on new software technologies in patients with Alzheimer- Type dementia. *Psicothema* 23, 44–50.

Padala KP, Padala PR, Malloy TR, Geske JA, Dubbert PM, Dennis RA, Garner KK, Bopp MM, Burke WJ, Sullivan DH. Wii-fit for improving gait and balance in an assisted living facility: a pilot study. J Aging Res 2012;2012:597573.

TEAMSTEPPS VIRTUAL TEAMS

EXAMPLES OF SCREEN BASED SIMULATION IN HEALTHCARE

- Novel multiplayer game created to teach learners about the management of Post-Partum Hemorrhage

Variable	Pre	Post	p
Affective	7.70 ± 1.75	9.00 ± 1.46	<0.0001
Cognitive	7.46 ± 1.89	8.73 ± 1.51	<0.0001
Psychomotor	8.31 ± 1.72	9.11 ± 1.51	<0.0001
Ave. combined	7.83 ± 1.58	8.95 ± 1.42	<0.0001

Questions were categorized into one of three domains of Bloom's Taxonomy. Pre and post survey consisted of four psychomotor questions, six cognitive questions, and five affective questions. Following the screen-based simulation experience, significant gains in confidence were seen in each of the domains as well as the combined overall confidence score.

Toekman JM, Foureman MF, Bulamba F, et al. A Novel Multiplayer Screen-Based Simulation Experience for African Learners Improved Confidence in Management of Postpartum Hemorrhage. *Front Public Health*. 2017 26;5:248.

LIMITATIONS OF GAME BASED LEARNING – KNOW WHEN IT WON'T WORK

- Culture / traditions of medicine
- Familiarity with computers / virtual environments
- Nonverbal communication
- Level of fidelity
- Educational objective
- Cost

Race the unexpected and leave the real world in the dust!

Battle your friends online via PlayStation Network or in the same room using the split-screen mode, complete challenges or dive into the community to discover new player-created courses. No two tracks are ever the same, so you will never run out of new places to do battle.

IN SUMMARY

Screen based simulation is a form of serious gaming that fosters learning in medical education and healthcare, in a manner that is:

- more feasible
- more scalable
- low maintenance costs
- drives to induce "Flow" in participants

However, currently, initial development costs can be high.

Coding knowledge is not always a necessity.

THANK YOU!