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Digital Game-Based Learning and Serious Games in Physician Assistant Education

Agnes M. Compagnone, MS, PA-C

University of Lynchburg

College of Health Sciences

School of Physician Assistant Medicine

Doctor of Medical Science Program

Laura Witte, Ph.D., PA-C

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INTRODUCTION

Physician assistant (PA) educators are on a continuous quest to engage, motivate, and enhance knowledge retention while fostering deep-learning, self-improving, life-long learner attributes. Digital game-based learning (DGBL) and serious games (SG) are novel pedagogical approaches and active learning tools that can be integrated into PA education curriculums to complement traditional teaching methodologies and achieve instruction aligned with program competencies and learning outcomes.¹ DGBL and SG are one way PA faculty can enhance teaching practices, promote adult learning principles, and appeal to digital native learners while preparing PA students for entry into clinical practice. In this paper, we will evaluate the case for the inclusion of DGBL and SG as teaching practices in PA medical education.

This article provides an overview of DGBL, reviews associated educational benefits and challenges, and shares resources to assist PA educators with integrating this innovative approach into PA curricula. This paper also seeks to initiate dialogue regarding the exploration of DGBL and SG research, as effective educational tools, specifically in PA education.

OVERVIEW

Digital game-based learning is a learning activity where learners are players within a game of familiarity, delivered via an electronic medium.² A well-known example of a DGBL resource is Kahoot!; a DGBL platform that provides a collaborative environment to enhance knowledge and foster collaborative learning.³ Serious games (a form of game-based learning) are defined as digital interactive games designed for training and educating purposes, and more simply defined as "(digital) games used for purposes other than mere entertainment."⁴⁻⁶ Wang and colleagues maintain learning activities must have an engaging game design, scoring, and challenging goals to be categorized as serious games.⁷ Virtual simulations can be classified as

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serious games if they contain the game elements argued by Wang. Serious games in medical education can explore "interpersonal development, diplomacy, organization, health, education, management, and leadership"⁴ and are considered well-suited for knowledge acquisition and skill development.^{1,8} In fact, Van Eck argues DGBL is most useful when educators are teaching skills such as "critical thinking, problem-solving, collaboration, communication, and motivation."^{1,8} Because serious games effectively reinforce concepts learned via traditional teaching approaches; they are particularly prominent in fields of study characterized by rigorous, intensive, high-volume learning demands and, therefore, compatible with PA education.^{9,10}

Various DGBL and SG curricula integration investigations conclude educational advantages when DGBL and SG are assimilated into medical, allied health, and science-related higher education.^{11,12} Yet, limited information is available related to DGBL and SG in PA education. A PubMed literature search conducted between January 1, 2015, and September 7, 2020, with the keyword search terms 'serious games' and 'medical education,' retrieved a total of 192 results. However, a PubMed literature search utilizing the same timeframes and keywords 'serious games' and 'PA education' only identified two research publications. Of these two articles retrieved, only one included physician assistant students.

Several research studies reveal DGBL and SG as more engaging, motivating, and interactive approaches than conventional teaching methodologies.¹³⁻¹⁷ Serving as complementary resources to reinforce and supplement traditional teaching concepts, but not as a stand alone teaching practice.¹¹ In addition to the positive findings mentioned, SG DGBL offers a plethora of further benefits.

INTEGRATION: BENEFITS AND CHALLENGES

When PA educators integrate creative techniques to deliver content aligned with student needs and learning outcomes, it is a win-win for all. Digital game-based learning and serious

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games uphold andragogical principles by offering learners independent access to educational resources and controlled-learning environments, accompanied by abilities to self-pace and obtain real-time feedback.¹⁸ In addition to delivering instruction congruent to adult learning, DGBL and SG appeal to the technologically sophisticated students entering higher education, resulting in increased learner satisfaction.¹⁸⁻²⁰

Digital game-based learning and serious games afford PA educators a platform to promote deep learning by engaging students in critical thinking, clinical reasoning, problem-solving, collaborative, and self-directed learning activities. "EMERGE," a virtual simulation serious game, delivers electronic clinical scenarios in the context of an emergency department, enabling players/learners to navigate through situations, manage consequences, and develop clinical reasoning skills.¹² In a prospective study of 112 medical students, comparing students trained with EMERGE (n=78) to students trained with small-group problem-based cases (n=34), the EMERGE group attained superior clinical reasoning final outcomes for all four clinical cases assessed.¹² The serious game trained group excelled in four of the seven defined clinical reasoning skills including, correct final diagnoses, accurate therapeutic interventions, physical and diagnostic interpretations. EMERGE, and other serious games can better equip PA students for real-world challenges. With benefits come challenges.

Currently, the digital game-based learning and serious game industries lack standardized gaming frameworks and best practices, which affects the quality, diversity, and comparability of peer-reviewed publications.^{5,7,21,22} Recent systematic reviews of SG and DGBL interventions for medical education and health professionals training reveal heterogeneous study methodologies with reviewers proposing considerations for policy related to the development, evaluation, and usage of these technological resources into medical education.^{5,7,13} Research assessments and

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systematic reviews of DGBL and SG have employed various education effectiveness models such as MERSQI and BEME. Yet, the overall effectiveness of these educational resources remains somewhat unclear due to industry regulation limitations.^{23,24}

Faculty digital literacy, pedagogical training, limited time, and financial resources are additional barriers PA programs and educators might encounter when integrating DGBL and SG into curricula.^{5, 7, 11,21,22}

The below section offers readers viable and applicable resources to assist with future learnings and foreseeable obstacles associated with DGBL and SG curriculum integration.

RESOURCES

Peer-Reviewed Literature

Scholarly works continue to increase as it relates to DGBL and SG in medical education. PA educators can reference an assortment of peer-reviewed journals to assist with identifying games, implementing new practices, generating research thoughts, and obtaining grant proposal ideas. See Table 1. for a brief overview of scholarly publications related to this subject matter.

Organizations

An assortment of professional gaming organizations produce resources to help with professional development, implementation strategies, research, and gaming design. To learn more about organizations that support gamification in higher education, refer to Table 2.

Digital Medical Education Games

Educators can turn to various sources to identify medical education and health professional based SG and DGBL resources for curricular integration consideration. Review articles and systematic review titles citing gamification, serious gaming, serious games, digital game-based learning, digital games, or games in medical education/health professions frequently

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list or reference DGBL resources and serious games. A sample of digital education games targeted for medical education is available in Table 3.

CONCLUSION

With proper planning, time allocation, and resources, PA educators can successfully integrate digital game-based learning and serious games into course curricula. Once efficacy is better established, serious games and digital game-based learning can play a vital role in PA education because this delivery of instruction appeals to the adult/digital native learners they serve, complements traditional teaching methodologies, fosters self-directed, self-improving, life-long, deep-learning attributes, and enhances student engagement, motivation, and knowledge acquisition.

In recent years, there has been a significant uptake in digital game-based learning and serious games in medical education, allied health professions, and across higher education science disciplines.^{11,23,24} However, current scholarly research related to DGBL and SG effectiveness in medical education, PA education, and allied health professions remain insufficient.^{11,23} These deficiencies are opportunities for PA educators to further research and develop appropriate resources for PA education. The PA education community lacks research regarding the effectiveness, value, and impact digital game-based learning has on PA education. Therefore, further investigations are warranted. The PA education community should also carefully consider formal explorations related to accessing resources, exchanging knowledge, and offering professional development to facilitate integrating these emerging technologies into PA curricula.

PA educators are responsible for preparing PA students for entry into clinical practice with abilities to address and creatively handle challenges they will encounter in real-world

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medicine. Supporting innovative advancements associated with this novel pedagogy can enhance PA educators' abilities to carry out these responsibilities both now and for years to come.

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References

1. Sera L, Wheeler E. Game on: The gamification of the pharmacy classroom. *Curr Pharm Teach Learn*. 2017;9(1):155-159. doi:10.1016/j.cptl.2016.08.046
2. Bigdeli S, Kaufman D. Digital games in medical education: Key terms, concepts, and definitions. *Med J Islam Repub Iran*. 2017(September 2);31:52.https://doi.org/10.14196/mjiri.31.52
3. Kahoot! What is Kahoot!? <https://kahoot.com/what-is-kahoot/>. Accessed September 11, 2020.
4. Fonseca LM, Dias DM, Góes Fdos S, et al. Development of the e-Baby serious game with regard to the evaluation of oxygenation in preterm babies: contributions of the emotional design. *Comput Inform Nurs*. 2014;32(9):428-436. doi:10.1097/CIN.0000000000000078
5. Gentry SV, Gauthier A, L'Estrade Ehrstrom B, et al. Serious gaming and gamification education in health professions: Systematic review. *J Med Internet Res*. 2019;21(3):e12994. Published 2019 March 28. doi:10.2196/12994
6. Susi T, Johannesson M, Backlund P. Serious Games-An Overview. Technical Report. School of Humanities and Informatics. University of Skovde, Sweden. 2007:1.
7. Wang R, DeMaria S Jr, Goldberg A, Katz D. A systematic review of serious games in training health care professionals. *Simul Healthc*. 2016;11(1):41-51. doi:10.1097/SIH.0000000000000118
8. Van Eck RN. Digital game-based learning: still restless after all these years. *EDUCAUSE Rev*. 2015:13–28.
9. Tan JW, Zary N. Diagnostic markers of user experience, play, and learning for digital serious games: A conceptual framework study. *JMIR Serious Games*. 2019;7(3):e14620. Published 2019 July 16. doi:10.2196/14620
10. Dobrovsky A, Borghoff UM, Hofmann M. An approach to interactive deep reinforcement learning for serious games. *IEEE*; Oct 16-18, 2016; Wroclaw, Poland. 2016:85.
11. Brown. CL, Comunale MA, Wigdahl B, Urdaneta-Hartmann S. Current climate for digital game-based learning of science in further and higher education. *FEMS Microbiol Lett*. 2018;365(21):fny237. doi:10.1093/femsle/fny237
12. Middeke A, Anders S, Schuelper M, Raupach T, Schuelper N. Training of clinical reasoning with a serious game versus small-group problem-based learning: A prospective study. *PLoS One*. 2018;13(9):e0203851. Published 2018 September 11. doi:10.1371/journal.pone.0203851
13. Dankbaar ME, Roozeboom MB, Oprins EA, et al. Preparing residents effectively in emergency skills training with a serious Game. *Simul Healthc*. 2017;12(1):9-16. doi:10.1097/SIH.0000000000000194

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14. Dankbaar M, Alsma J, Jansen E, van Merriënboer J, van Saase L, Schuit S. An experimental study on the effects of a simulation game on students' clinical cognitive skills and motivation. In: *Advances in Health Sciences Education*. Netherlands: Springer; 2015;21:505–521
15. Kaczmarczyk J, Davidson R, Bryden D, Haselden S, Vivekananda-Schmidt P. Learning decision making through serious games. *Clin Teach*. 2015; 13:277–82. doi.org/10.1111/tct.12426
16. Bryce D, King N, Graebner C, Myers J. Evaluation of a diagnostic reasoning program (DxR): Exploring student perceptions and addressing faculty concerns. *J Interact Media Educ*. 1998; 98: 451–455.
17. Dankbaar MEW, Richters O, Kalkman CJ, Prins G, ten Cate OTJ, van Merriënboer JJG, et al. Comparative effectiveness of a serious game and an e-module to support patient safety knowledge and awareness. *BMC Med Educ*. 2017; 17: 30. doi.org/10.1186/s12909-016-0836-5 P
18. Olszewski AE, Wolbrink TA. Serious Gaming in Medical Education: A proposed structured framework for game development. *Simul Healthc*. 2017;12(4):240-253. doi:10.1097/SIH.0000000000000212
19. Davids MR, Chikte UM, Halperin ML. Development and evaluation of a multimedia e-learning resource for electrolyte and acid-base disorders. *Adv Physiol Educ* 2011;35(3):295–306.
20. Gleason AW. RELM: developing a serious game to teach evidence-based medicine in an academic health sciences setting. *Med Ref Serv Q* 2015; 34(1):17–28.
21. Comunale MA. Getting Into the Game: An Explanatory Case Study to Examine the Experiences of Faculty Incorporating Digital Game-Based Learning in Higher Education volume Dissertation/Thesis. ProQuest Dissertations Publishing, 2017
22. De Freitas S, Ott M, Popescu M et al. Game-Enhanced Learning: Preliminary Thoughts on Curriculum Integration. *New pedagogical approaches in game enhanced learning: Curriculum Integration*, Hershey, PA. 2013 doi:10.4018/978-1-4666-3950-8
23. Gorbanev I, Agudelo-Londoño S, González RA, et al. A systematic review of serious games in medical education: quality of evidence and pedagogical strategy. *Med Educ Online*. 2018;23(1):1438718. doi:10.1080/10872981.2018.1438718
24. Akl E, Pretorius R, Sackett K, et al. The effect of educational games on medical students' learning outcomes: a systematic review: BEME Guide No 14. *J Med Teacher*. 2010;32(1):16–27.
25. Kapralos B, Fisher S, Clarkson J, et al. A course on serious game design and development using an online problem-based learning approach. *Interactive Technol Smart Educ*. 2015;12(2):116–136.

Appendix 1: Tables

Table 1. Peer-Reviewed Literature

<u>Journal</u>	<u>Web URL</u>
International Journal of Game-Based Learning	https://www.igi-global.com/journal/international-journal-game-based-learning/41019
Journal of Medical Internet Research Serious Games	https://games.jmir.org/
Medical Education Online	https://www.tandfonline.com/toc/zmeo20/current
Journal of the Society of Simulation in Health Care	https://journals.lww.com/simulationinhealthcare
Journal of Medical Internet Research	https://www.jmir.org/
Interactive Technology and Smart Education	https://www.emerald.com/insight/publication/issn/1741-5659
Games for Health	https://home.liebertpub.com/publications/games-for-health-journal/588/overview
International Journal of Serious Games	http://journal.seriousgamessociety.org/index.php/IJSG

Table 2. DGBL and Serious Games Organizations and Associations

<u>Organization/Association Name</u>	<u>Web URL</u>
Center for Digital Games Research	https://www.cdgr.ucsb.edu/
Digital Games Research Association	http://www.digra.org/
Games for Health Foundation	https://gamesfor.health/foundation/
International Society for Technology in Education	https://www.iste.org/
North America Gaming and Simulation Association	https://nasaga.org/
Serious Game Society	https://seriousgamessociety.org/
Society of Simulation in Health Care	https://www.ssih.org/

Table 3. Digital Games for Medical Education

Game Name	Genre/Type	Topic	Web URL
abcedeSim	High Fidelity Simulation Game	Emergency Med Primary Care Pediatrics	https://virtualmedschool.com/abcdesim/
Septris	Game	Infectious Disease	https://med.stanford.edu/septris/
Virtual Emergency TeleMedicine	Serious Game-Simulation	Emergency Med.	https://stremble.com/virtual-telemedicine/
Geriatric	Simulation/Clinical Reasoning	Emergency Primary Care Pediatrics	https://seriousgaming.nl/portfolio/game-projects/clinical-reasoning/
Underground	Serious Game	Surgical Training	https://www.undergroundthegame.com/
Vital Signs	Serious Game/Decision Making	Emergency Medicine	https://www.breakawaygames.com/vitalsigns/