Cleared for take-off: Game-based learning to prepare airline pilots for critical situations

Kuindersma, E.C.

Citation

Kuindersma, E. C. (2019, October 24). *Cleared for take-off: Game-based learning to prepare airline pilots for critical situations*. Retrieved from https://hdl.handle.net/1887/77168

Version:	Publisher's Version
License:	[Licence agreement concerning inclusion of doctoral thesis in the Institutional Repository of the University of Leiden](#)
Downloaded from:	[https://hdl.handle.net/1887/77168](#)

Note: To cite this publication please use the final published version (if applicable).

Cover Page

The following handle holds various files of this Leiden University dissertation:
http://hdl.handle.net/1887/77168

Author: Kuindersma, E.C.
Title: Cleared for take-off: Game-based learning to prepare airline pilots for critical situations
Issue Date: 2019-10-24

References

[1] Abt, C. C. (1970). *Serious games*. New York, NY: Viking Press.

[2] Adams, R. (2017). Finally time for competency-based training? *CAT Magazine*, (4), 20–23.

[3] Adkins, S. S. (2015). *2014-2019 global edugame market*. Ambient Insight. Monroe, WA.

[4] Adkins, S. S. (2017). *The 2017-2022 global game-based learning market: Serious game revenues spike to $8.1 billion by 2022*. Metaari. Monroe, WA.

[5] Adkins, S. S. (2018). *The 2018-2023 global game-based learning market: Worldwide serious game industry in a boom phase*. Metaari. Monroe, WA.

[6] Airline. (2018). Wikipedia, The Free Encyclopedia. Retrieved from https://en.wikipedia.org/w/index.php?title=Airline&oldid=843172742

[7] *Airline pilot demand outlook: 10-year view*. (2017). CAE.com. Retrieved from https://www.cae.com/media/documents/Civil_Aviation/CAE-Airline-Pilot-Demand-Outlook-Spread.pdf

[8] Allerton, D. (2009). *Principles of flight simulation*. Hoboken, NJ: John Wiley & Sons.

[9] Alvarez, J., Djaouti, D., Rampnoux, O. & Alvarez, V. (2011). *Serious games market: Some key figures*. (n.p.): LudoScience.

[10] Anderson, L. W., Krathwohl, D. R., Airasian, P., Cruikshank, K., Mayer, R., Pintrich, P., . . . Wittrock, M. (2001). *A taxonomy for learning, teaching and assessing: A revision of bloom's taxonomy*. New York, NY: Longman.

[11] Arnab, S., Lim, T., Carvalho, M. B., Bellotti, F., De Freitas, S., Louchart, S., . . . De Gloria, A. (2015). Mapping learning and game mechanics for serious games analysis. *British Journal of Educational Technology*, *46*(2), 391–411.

[12] *Aviation instructor's handbook*. (2007)(No. FAA-H-8083-9A). US Department of Transportation Federal Aviation Administration. Washington DC. Retrieved from https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/aviation_instructors_handbook/media/FAA-H-8083-9A.pdf

[13] *Aviation weather for pilots and flight operations personnel*. (1975)(No. AC 00-6A). US Department of Transportation Federal Aviation Administration. Washington DC. Retrieved from https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC%2000-6A%20Chap%207-9.pdf

[14] Bakkes, S. C. J. (2010). *Rapid adaptation of video game AI* (Doctoral dissertation, Tilburg University). Retrieved from https://pure.uvt.nl/ws/portalfiles/portal/1191720/Sander_Bakkes_-_PhD_Thesis_Camera_Ready_Copy.pdf

[15] Baldwin, T. T., Magjuka, R. J. & Loher, B. T. (1991). The perils of participation: Effects of choice of training on trainee motivation and learning. *Personnel psychology*, *44*(1), 51–65.

[16] Bates, A. W. (2015). *Teaching in a digital age*. Vancouver, Canada: Tony Bates Associates Ltd.

[17] Bates, R. (2004). A critical analysis of evaluation practice: The Kirkpatrick model and the principle of beneficence. *Evaluation and program planning*, *27*(3), 341–347.

[18] Becker, K. (2006). How much choice is too much? *SIGCSE Bull. 38*(4), 78–82.

[19] Becker, K. & Parker, J. (2014). Learning, education and games. In K. Schrier (Ed.), (Chap. An Overview of Game Design Techniques, pp. 179–198). Pittsburgh, PA: ETC Press.

[20] Bergeron, B. (2006). *Developing serious games (Game Development Series)*. Rockland, MA: Charles River Media.

[21] Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H. & Krathwohl, D. R. (1956). *Taxonomy of educational objectives, Handbook I: The cognitive domain*. New York, NY: David McKay Co.

[22] Boyle, E. A., Hainey, T., Connolly, T. M., Gray, G., Earp, J., Ott, M., . . . Pereira, J. (2016). An update to the systematic literature review of empirical evidence of the impacts and outcomes of computer games and serious games. *Computers & Education*, *94*, 178–192.

[23] Breuer, J. S. & Bente, G. (2010). Why so serious? on the relation of serious games and learning. *Eludamos. Journal for computer game culture*, *4*(1), 7–24.

[24] Brown, J. S., Collins, A. & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, *18*(1), 32–42.

[25] Burian, B. K., Barshi, I. & Dismukes, K. (2005). *The challenge of aviation emergency and abnormal situations* (Technical Memorandum No. 2005-213462). NASA Ames Research Center. Retrieved from http://humanfactors.arc.nasa.gov/eas/download/BurianTM_final.pdf

[26] Caillois, R. (1961). *Man, play, and games*. Champaign, IL: University of Illinois Press.

[27] Cain, J. & Piascik, P. (2015). Are serious games a good strategy for pharmacy education? *American journal of pharmaceutical education*, *79*(4).

[28] Calvillo-Gámez, E. H. (2009). *On the core elements of the experience of playing video games* (Doctoral dissertation, University College London). Retrieved from http://discovery.ucl.ac.uk/18510/1/18510.pdf

[29] Calvillo-Gámez, E. H., Cairns, P. & Cox, A. L. (2010). Assessing the core elements of the gaming experience. In *Evaluating user experience in games* (pp. 47–71). London, England: Springer-Verlag.

[30] Cazden, C. B. (1997). Performance before competence: Assistance to child discourse in the zone of proximal development. *Mind, culture, and activity: Seminal papers from the Laboratory of Comparative Human Cognition*, 303–310.

[31] Churches, A. (2001). *Bloom's digital taxonomy*. Retrieved from http://burtonslifelearning.pbworks.com/f/BloomDigitalTaxonomy2001.pdf

[32] Ciavarro, C., Dobson, M. & Goodman, D. (2008). Implicit learning as a design strategy for learning games: Alert Hockey. *Computers in Human Behavior*, *24*(6), 2862–2872.

[33] Çiftci, S. (2018). Trends of serious games research from 2007 to 2017: A bibliometric analysis. *Journal of Education and Training Studies*, *6*(2), 18–27.

[34] Clark, C., Dobbins, G. H. & Ladd, R. T. (1993). Exploratory field study of training motivation: Influence of involvement, credibility, and transfer climate. *Group & Organization Management*, *18*(3), 292–307.

[35] Coelho, P. S. & Esteves, S. P. (2007). The choice between a five-point and a ten-point scale in the framework of customer satisfaction measurement. *International Journal of Market Research*, *49*(3), 313.

[36] Collins, A., Brown, J. S. & Newman, S. E. (1989). Cognitive apprenticeship: Teaching the crafts of reading, writing, and mathematics. *Knowing, learning, and instruction: Essays in honor of Robert Glaser*, *18*, 32–42.

[37] Competent. (n.d.), In *Oxford Living Dictionaries*. Retrieved from https://en.oxforddictionaries.com/definition/competent

[38] Connolly, T. M., Boyle, E. A., MacArthur, E., Hainey, T. & Boyle, J. M. (2012). A systematic literature review of empirical evidence on computer games and serious games. *Computers & Education*, *59*(2), 661–686.

[39] Convention on International Civil Aviation, Annexes 1 to 18. (1974). International Civil Aviation Organization. Montreal, Canada. Retrieved from https://www.icao.int/safety/airnavigation/NationalityMarks/annexes_booklet_en.pdf

[40] Coulthard, G. J. (2009). *A review of the educational use and learning effectiveness of simulations and games* (Doctoral dissertation, Purdue University). Retrieved from http://www.coulthard.com/%5C%5Clibrary/paper-simulation.html

[41] Crompton, H. (2013). A historical overview of M-Learning: Toward learner-centered education. In Z. L. Berge & L. Muilenburg (Eds.), *Handbook of mobile learning* (pp. 41–52). New York, NY: Routledge.

[42] Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience*. New York, NY: Harper-Row.

[43] Csikszentmihalyi, M. (1997). *Finding flow: The psychology of engagement with everyday life*. New York, NY: Basic Books.

[44] Curado, C., Henriques, P. L. & Ribeiro, S. (2015). Voluntary or mandatory enrollment in training and the motivation to transfer training. *International Journal of Training and Development*, *19*(2), 98–109.

[45] Curley, R. (2011). *The complete history of aviation: From ballooning to supersonic flight*. London, England: Britannica Educational Publishing.

[46] Dankbaar, M. (2017). Serious games and blended learning; effects on performance and motivation in medical education. *Perspectives on medical education*, *6*(1), 58–60.

[47] Deci, E. L., Koestner, R. & Ryan, R. M. (1999). A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. *Psychological Bulletin*, *125*, 627–668.

[48] Deci, E. L., Koestner, R. & Ryan, R. M. (2001). Extrinsic rewards and intrinsic motivation in education: Reconsidered once again. *Review of Educational Research*, *71*, 1–27.

[49] Desurvire, H. & El-Nasr, M. S. (2013). Methods for game user research: Studying player behavior to enhance game design. *IEEE computer graphics and applications*, *33*(4), 82–87.

[50] Desurvire, H. & Wiberg, C. (2009). Game usability heuristics (PLAY) for evaluating and designing better games: The next iteration. In A. A. Ozok & P. Zaphiris (Eds.), *International conference on online communities and social computing* (pp. 557–566). Heidelberg, Germany: Springer.

[51] Djaouti, D., Alvarez, J., Jessel, J. P. & Rampnoux, O. (2011). Origins of serious games. In *Serious games and edutainment applications* (pp. 25–43). London, England: Springer-Verlag.

[52] Dondlinger, M. J. (2007). Educational video game design: A review of the literature. *Journal of applied educational technology*, *4*(1), 21–31.

[53] Dreyfus, S. E. (2004). The five-stage model of adult skill acquisition. *Bulletin of science, technology & society*, *24*(3), 177–181.

[54] Dubois, D. D. & Rothwell, W. J. (2000). *The competency toolkit*. Amherst, MA: HRD Press.

[55] Dyer-Witheford, N. (2004). Mapping the Canadian video and computer game industry. A talk for the "Digital Poetics and Politics" Summer Institute. Queen's University Ontario. Retrieved from http://publish.uwo.ca/%5C~%7B%7D%20ncdyerwi/Mapping-Queens.pdf

[56] *ECA position paper on Multi-Crew Pilot License (MPL)*. (2013). European Cockpit Association. Brussels, Belgium. Retrieved from https://www.eurocockpit.be/positions-publications/eca-position-paper-multi-crew-pilot-license

[57] Effectiveness. (n.d.), In *Oxford Living Dictionaries*. Retrieved from https://en.oxforddictionaries.com/definition/effectiveness

[58] Eißfeldt, H., Grasshoff, D., Hasse, C., Hoermann, H. J., Schulze Kissing, D., Stern, C., . . . Zierke, O. (2009). *Aviator 2030: Ability requirements in future ATM systems II; simulations and experiments*. Hamburg, Germany: Deutsches Zentrum für Luft- und Raumfahrt (DLR).

[59] Emergency or Abnormal Situation. (n.d.). Skybrary. Retrieved from https://www.skybrary.aero/index.php/Emergency_or_Abnormal_Situation

[60] Enfield, J. (2012). *Designing an educational game with ten steps to complex learning* (Doctoral dissertation, Indiana University, Bloomington, IN). Retrieved from https://www.indiana.edu/~tedfrick/JakeEnfieldDissertation.pdf

[61] *Evidence-based training implementation guide*. (2013). International Air Transport Association. Montreal, Canada.

[62] Flight Envelope. (n.d.). Skybrary. Retrieved from https://www.skybrary.aero/index.php/Flight_Envelope

[63] *Flight instructor's guide*. (2003). Civil Aviation Authority of New Zealand. Wellington, New Zealand. Retrieved from http://www.caa.co.za/Flight%20Instructor%20Guides/New%20Zealand%20Flight%20Instructor%27s%20Guide.pdf

[64] *Flight-crew human factors handbook: CAP 737*. (2014). Central Aviation Authority. London, England. Retrieved from https://publicapps.caa.co.uk/docs/33/CAP%5C%20737%5C%20DEC16.pdf

[65] Franzwa, C., Tang, Y., Johnson, A. & Bielefeldt, T. (2014). Balancing fun and learning in a serious game design. *International Journal of Game-Based Learning*, *4*(4), 37–57.

[66] Fullerton, T. (2008). *Game design workshop: A playcentric approach to creating innovative games (2nd edition)*. Burlington, MA: Morgan Kaufmann Publishers.

[67] Fulton, S. & Schweitzer, D. (2011). Impact of giving students a choice of homework assignments in an introductory computer science class. *International Journal for the Scholarship of Teaching and Learning*, *5*(1), 20.

[68] Gagné, R. M. & Briggs, L. J. (1974). *Principles of instructional design*. New York, NY: Holt, Rinehart & Winston.

[69] Garris, R., Ahlers, R. & Driskell, J. E. (2002). Games, motivation, and learning: A research and practice model. *Simulation & gaming*, *33*(4), 441–467.

[70] Gee, J. P. (2005). Learning by design: Good video games as learning machines. *E-learning and Digital Media*, *2*(1), 5–16.

[71] Gee, J. P. (2008). Learning and games. In K. Salen (Ed.), *The ecology of games: Connecting youth, games, and learning* (Vol. 3, pp. 21–40). Cambridge, MA: MIT Press.

[72] Gee, J. P. (2009). Deep learning properties of good digital games: How far can they go? In U. Ritterfeld, M. Cody & P. Vorderer (Eds.), *Serious games: Mechanisms and effects* (pp. 67–82). New York, NY: Routledge.

[73] Girard, C., Ecalle, J. & Magnan, A. (2013). Serious games as new educational tools: How effective are they? A meta-analysis of recent studies. *Journal of Computer Assisted Learning*, *29*(3), 207–219.

[74] Glaser, B. G. & Strauss, A. L. (1967). *Discovery of grounded theory: Strategies for qualitative research*. Aldine.

[75] Global MPL Course Tracker. (2016, September 1). International Air Transport Association. Retrieved from http://www.iata.org/whatwedo/ops-infra/training-licensing/Documents/MPL%20documents/mpl-courses-global-tracker.xls

[76] Gog, S. J. & Seet, J. F. (2017). *The Kirkpatrick model: The end is the beginning*. SkillsFuture. Retrieved from https://www.ial.edu.sg/content/ialeads/pdfs/The__Kirkpatrick__Model.pdf

[77] Graafland, M., Schraagen, J. M. & Schijven, M. P. (2012). Systematic review of serious games for medical education and surgical skills training. *British journal of surgery*, *99*(10), 1322–1330.

[78] *Guidance material and best practices for pilot aptitude testing*. (2015). International Air Transport Association. Montreal, Canada. Retrieved from https://www.skybrary.aero/bookshelf/books/3178.pdf

[79] *Guidance material for improving flight crew monitoring*. (2016). International Air Transport Association. Montreal, Canada. Retrieved from https://www.iata.org/whatwedo/ops-infra/training-licensing/Documents/Guidance-Material-for-Improving-Flight-Crew-Monitoring.pdf

[80] Gunter, G. A., Kenny, R. F. & Vick, E. H. (2008). Taking educational games seriously: Using the RETAIN model to design endogenous fantasy into standalone educational games. *Educational Technology Research and Development*, *56*(5-6), 511–537.

[81] Guthrie, H. (2009). *Competence and competency-based training: What the literature says*. National Centre for Vocational Education Research (NCVER). Adelaide, Australia.

[82] *Hainan Airlines standard flight operations manual: SOP 737-800*. (2009). Hainan Airlines Company Limited. Haikou, China.

[83] Hartley, D. E. (2000). *On-demand learning: Training in the new millennium*. Amherst, MA: HRD Press.

[84] Heeter, C., Lee, Y. H., Magerko, B. & Medler, B. (2011). Impacts of forced serious game play on vulnerable subgroups. *International Journal of Gaming and Computer-Mediated Simulations*, *3*, 34–53.

[85] Helmreich, R. L., Merritt, A. C. & Wilhelm, J. A. (1999). The evolution of crew resource management training in commercial aviation. *The International Journal of Aviation Psychology*, *9*(1), 19–32.

[86] Hernon, P. & Whitman, J. R. (2001). *Delivering satisfaction and service quality: A customer-based approach for libraries*. Chicago, IL: American Library Association.

[87] Hodge, S. (2007). The origins of competency-based training. *Australian journal of adult learning*, *47*(2), 179–209.

[88] Huang, W. D. & Johnson, T. (2009). Instructional game design using cognitive load theory. In R. E. Ferdig (Ed.), *Handbook of research on effective electronic gaming in education* (pp. 1143–1165). Hershey, PA: IGI Global.

[89]   Huizinga, J. (1955). *Homo Ludens: A study of the play element in culture*. Boston, MA: Beacon Press.

[90]   Hwang, G. & Wu, P. (2012). Advancements and trends in digital game-based learning research: A review of publications in selected journals from 2001 to 2010. *British Journal of Educational Technology*, *43*(1), E6–E10.

[91]   *Intrinsic Motivation Inventory (IMI) scale description*. (n.d.). Selfdeterminationtheory.org. Retrieved from http://selfdeterminationtheory.org/intrinsic-motivation-inventory

[92]   *IPTS IFALPA pilot training standards - guide for best practices*. (2012). International Federation of Airline Pilots Associations. Montreal, Canada. Retrieved from http://www.ifalpa.org/store/IPTS.pdf

[93]   Jamieson, D. (2017a). The four elements of game design - part 1. Blogpost. Envato. Retrieved from https://gamedevelopment.tutsplus.com/articles/four-elements-of-game-design-1--cms-22720

[94]   Jamieson, D. (2017b). The four elements of game design - part 2. Blogpost. Envato. Retrieved from https://gamedevelopment.tutsplus.com/tutorials/four-elements-of-game-design-2--cms-25628

[95]   Johnson, C. I. & Mayer, R. E. (2010). Applying the self-explanation principle to multimedia learning in a computer-based game-like environment. *Computers in Human Behavior*, *26*(6), 1246–1252.

[96]   Jonassen, D. H. (1999). Designing constructivist learning environments. In C. Reigeluth (Ed.), *Instructional design theories and models: A new paradigm of instructional theory* (Vol. 2, pp. 215–239). Hillsdale, NJ: Lawrence Erlbaum Associates.

[97]   Juul, J. (2003). The game, the player, the world: Looking for a heart of gameness. In M. Copier & J. Raessens (Eds.), *Level up: Digital games research conference proceedings* (pp. 30–45).

[98]   Kahn, K. M. (2004). Emergency exit: How to handle non-normal events. Blogpost. AOPA Flight Training Online. Retrieved from https://www.aopa.org/news-and-media/all-news/2004/december/flight-training-magazine/emergency-exit

[99]   Kapp, K. M. (2012). *The gamification of learning and instruction: Game-based methods and strategies for training and education*. San Francisco, CA: John Wiley & Sons.

[100] Ke, F. (2009). A qualitative meta-analysis of computer games as learning tools. In R. E. Ferdig (Ed.), *Handbook of research on effective electronic gaming in education* (Vol. 1, pp. 1–32).

[101] Kearns, S. K., Mavin, T. J. & Hodge, S. (2017). *Competency-based education in aviation: Exploring alternate training pathways*. Abingdon, England: Routledge.

[102] Keller, J. M. (1983). Motivational design of instruction. *Instructional design theories and models: An overview of their current status*, *1*(1983), 383–434.

[103] Keller, J., Leiden, K., Small, R., Goodman, A. & Hooey, B. (2003). Cognitive task analysis of commercial jet aircraft pilots during instrument approaches for baseline and synthetic vision displays. In D. C. Foyle, A. Goodman & B. L. Hooey (Eds.), *NASA aviation safety program conference on human performance modeling of approach and landing with augmented displays* (p. 15).

[104] Kemp, J. E. & Dayton, D. K. (1985). *Planning and producing instructional media*. New York, NY: Harper & Row.

[105] Kirkpatrick, D. L. (1975). *Evaluating training programs*. New York, NY: Tata McGraw-Hill Education.

[106] Kirkpatrick, J. D. & Kirkpatrick, W. K. (2016). *Kirkpatrick's four levels of training evaluation*. Alexandria, VA: Association for Talent Development.

[107] Kirschner, P. A. & van Merriënboer, J. J. G. (2009). Ten steps to complex learning: A new approach to instruction and instructional design. In T. L. Good (Ed.), *21st century education: A reference handbook* (pp. 244–253). Thousand Oaks, CA: Sage.

[108] Knulst, M. (2014). *Serious gaming & didactics: A review on game, instructional, and player variables in serious game design* (No. NLR-TR-2014-397). Netherlands Aerospace Centre (NLR). Amsterdam, The Netherlands.

[109] Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice Hall.

[110] Koster, R. (2013). *Theory of fun for game design*. Sebastopol, CA: O'Reilly Media.

[111]   Kuindersma, E. C., Field, J. & van der Pal, J. (2015). Game-based training for airline pilots. Paper presented at the Simulation-Based Training For The Digital Generation conference at the Royal Aeronautical Society. London, UK.

[112]   Kuindersma, E. C., van der Pal, J., van den Herik, H. J. & Plaat, A. (2015). Voluntary play in serious games. In A. De Gloria & R. C. Veltkamp (Eds.), *Games and Learning Alliance, 4th international conference* (pp. 131–140). Heidelberg, Germany: Springer.

[113]   Kuindersma, E. C., van der Pal, J., van den Herik, H. J. & Plaat, A. (2016a). Comparing voluntary and mandatory gameplay. *International Journal of Serious Games*, *3*, 17.

[114]   Kuindersma, E. C., van der Pal, J., van den Herik, H. J. & Plaat, A. (2016b). Shuttle to Mars: Training airline pilots for critical situations. Poster and handout presented at the Meaningful Play Conference. East Lansing, MI.

[115]   Kuindersma, E. C., van der Pal, J., van den Herik, H. J. & Plaat, A. (2017). Building a game to build competencies. In J. Dias, P. A. Santos & R. C. Veltkamp (Eds.), *Games and Learning Alliance, 6th international conference* (pp. 14–24). Heidelberg, Germany: Springer.

[116]   Kukulska-Hulme, A. (2007). Introduction. In A. Kukulska-Hulme & J. Traxler (Eds.), *Mobile learning: A handbook for educators and trainers* (pp. 17–22). Abingdon, UK: Routledge.

[117]   Laamarti, F., Eid, M. & Saddik, A. E. (2014). An overview of serious games. *International Journal of Computer Games Technology*, *2014*, 11.

[118]   Laramee, F. D. (2005). *Secrets of the game business (game development)*. Newton Center, MA: Charles River Media.

[119]   Leach, J. (2004). Why people 'freeze' in an emergency: Temporal and cognitive constraints on survival responses. *Aviation, Space, and Environmental medicine*, *75*(6), 539–542.

[120]   Learmount, D. (2010). Training: Jobs for tomorrow. *Flight International*. Retrieved from https://www.flightglobal.com/news/articles/training-jobs-for-tomorrow-337753

[121]   Liebermann, S. & Hoffmann, S. (2008). The impact of practical relevance on training transfer: Evidence from a service quality training program for German bank clerks. *International Journal of Training and Development*, *12*(2), 74–86.

[122]   Likert, R. (1932). A technique for the measurement of attitudes. *Archives of psychology*, *140*, 5–55.

[123]   Lim, T., Louchart, S., Suttie, N., Ritchie, J., Aylett, R., Stanescu, I., . . . Moreno-Ger, P. (2013). Strategies for effective digital games development and implementation. In Y. Baek & N. Whitton (Eds.), *Cases on digital game-based learning: Methods, models, and strategies* (pp. 168–198). Hershey, PA: IGI Global.

[124]   *Loss of thrust in both engines after encountering a flock of birds and subsequent ditching on the Hudson river*. (2010)(Aircraft Accident Report No. NTSB/AAR-10/03). National Transportation Safety Board. Retrieved from https://www.ntsb.gov/investigations/AccidentReports/Reports/AAR1003.pdf

[125]   Loukopoulos, L. D., Dismukes, R. K. & Barshi, I. (2016). *The multitasking myth: Handling complexity in real-world operations*. Farnham, UK: Ashgate.

[126]   Lukosch, H., van Bussel, R. & Meijer, S. A. (2013). Hybrid instructional design for serious gaming. *Journal of Communication and Computer*, *10*(1), 1–8.

[127]   Magnusson, K. & Osborne, J. (1990). The rise of competency-based education: A deconstructionist analysis. *The Journal of Educational Thought (JET)*, *24*(1), 5–13.

[128]   Malone, T. W. & Lepper, M. R. (1987). Making learning fun: A taxonomy of intrinsic motivations for learning. In R. E. Snow & M. J. Farr (Eds.), *Aptitude, learning, and instruction. Volume 3: Conative and affective process analyses* (pp. 223–253). Hillsdale, NJ: Erlbaum.

[129]   *Manual of evidence-based training*. (2013)(No. Doc 9995). International Civil Aviation Organization. Montreal, Canada.

[130]   Masek, M., Murcia, K., Morrison, J., Newhouse, C. & Hackling, M. (2012). Learning in transformational computer games: Exploring design principles for a nanotechnology game.

[131]   Mautone, T. & Spiker, A. (2006). *Conventional training versus game-based training*. Anacapa Sciences. Santa Barbara, CA.

[132]   McCowan, R. J. (1998). *Origins of competency-based training*. Center for Development of Human Services. Buffalo, NY. Retrieved from https://files.eric.ed.gov/fulltext/ED501710.pdf

[133]   McGonigal, J. (2011). *Reality is broken: Why games make us better and how they can change the world*. New York, NY: Penguin Press.

[134]   Means, B., Toyama, Y., Murphy, R. & Baki, M. (2013). The effectiveness of online and blended learning: A meta-analysis of the empirical literature. *Teachers College Record*, *115*(3), 1–47.

[135]   Michael, D. R. & Chen, S. L. (2006). *Serious games: Games that educate, train, and inform*. Boston, MA: Thomson.

[136]   Millennials. (2018). Wikipedia, The Free Encyclopedia. Retrieved from https://en.wikipedia.org/w/index.php?title=Millennials&oldid=843721425

[137]   Miller, A. (2012). Game-based learning to teach and assess 21st century skills. Blogpost. Edutopia. Retrieved from https://www.edutopia.org/blog/game-learning-21st-century-skills-andrew-miller

[138]   Mollick, E. R. & Rothbard, N. (2014). *Mandatory fun: Consent, gamification and the impact of games at work*.

[139]   Moroney, W. F. & Moroney, B. W. (2009). Flight simulation. In J. Wise, V. Hopkin & D. Garland (Eds.), *Handbook of aviation human factors (2nd edition)* (pp. 19-1–19-36). Boca Raton, FL: CRC Press.

[140]   Multi-Crew Pilot Licence Symposium. (2013). Online. International Civil Aviation Organization. Retrieved from https://www.icao.int/meetings/mpl/Pages/default.aspx

[141]   Multi-Crew Pilot License (4). (n.d.). AviationKnowledge Wiki. Retrieved from http://aviationknowledge.wikidot.com/aviation:multi-crew-pilot-license-4

[142]   Nabben, A., Maij, A. & Justen, P. (2013). *Future maintenance training* (No. NLR-TR-2012-481). Netherlands Aerospace Centre (NLR). Amsterdam, The Netherlands.

[143]   Nacke, L. E., Drachen, A. & Göbel, S. (2010). Methods for evaluating gameplay experience in a serious gaming context. *International Journal of Computer Science in Sport*, *9*(2), 1–12.

[144]   Nacke, L. E. (2014). The formal systems of games and game design atoms. Blogpost. The Acagemic. Retrieved from http://www.acagamic.com/courses/infr1330-2014/the-formal-systems-of-games-and-game-design-atoms

[145]   Nielsen, J. (2000). Why you only need to test with 5 users. Blogpost. Nielsen Norman Group. Retrieved from https://www.nngroup.com/articles/why-you-only-need-to-test-with-5-users

[146]   Nishikawa, K. A. & Jaeger, J. (2011). A computer simulation comparing the incentive structures of dictatorships and democracies. *Journal of Political Science Education*, *7*(2), 135–142.

[147]   O'Brien, D., Lawless, K. A. & Schrader, P. G. (2010). A taxonomy of educational games. In Y. K. Baek (Ed.), *Gaming for classroom-based learning: Digital role playing as a motivator of study* (pp. 1–23). Hershey, PA: IGI Global.

[148]   Owens, B. (n.d.). Handling an aircraft emergency. Blogpost. I Fly blog. Retrieved from http://iflyblog.com/handling-an-emergency

[149]   Oxford Aviation Academy. (2018). Wikipedia, The Free Encyclopedia. Retrieved from https://en.wikipedia.org/w/index.php?title=Oxford_Aviation_Academy&oldid=843928224

[150]   Page, R. L. (2000). Brief history of flight simulation. In *SimTecT 2000 proceedings* (pp. 11–17). Sydney, Australia.

[151]   Paras, B. S. & Bizzocchi, J. (2005). Game, motivation, and effective learning: An integrated model for educational game design. In *Proceedings of the 2005 digra international conference: Changing views: Worlds in play*. Retrieved from http://www.digra.org/wp-content/uploads/digital-library/06276.18065.pdf

[152]   Parry, S. B. (1996). The quest for competencies. *Training*, *33*(7), 48.

[153]   Peng, W., Lee, M. & Heeter, C. (2010). The effects of a serious game on role-taking and willingness to help. *Journal of Communication*, *60*(4), 723–742.

[154]   Personnel Licensing. (n.d.). Skybrary. Retrieved from https://www.skybrary.aero/index.php/Personnel_Licensing

[155]   Piaget, J. (1952). *Play, dreams and imitation in childhood*. New York, NY: WW Norton & Co.

[156]   Pilkington, E. (2009). Miracle on the Hudson: 155 survive crash as jet hits river in New York. *The Guardian*. Retrieved from https://www.theguardian.com/world/2009/jan/16/us-airways-plane-crash-lands-on-hudson

[157]   Pilot Flying (PF) and Pilot Monitoring (PM). (n.d.). Skybrary. Retrieved from https://www.skybrary.aero/index.php/Pilot_Flying_and_Pilot_Not_Flying

[158]   Prensky, M. (2001a). *Digital game-based learning*. New York, NY: McGraw-Hill.

[159]   Prensky, M. (2001b). Digital natives, digital immigrants - part 1. *On the horizon*, *9*(5), 1–6.

[160]   Prensky, M. (2005). Computer games and learning: Digital game-based learning. In J. Raessens & J. Goldstein (Eds.), *Handbook of computer game studies* (pp. 97–122). Cambridge, MA: MIT Press.

[161]   *Principles and methods of instruction (archived)*. (2012)(No. CAAP5.14-2(0), Appendix D). Civil Aviation Safety Authority. Woden Valley, Australia. Retrieved from https://www.casa.gov.au/file/104951/download?token=4mEQxK6S

[162]   *Procedures for air navigation services — training*. (2013)(No. Doc 9868). International Civil Aviation Organization. Montreal, Canada. Retrieved from https://www.icao.int/SAM/Documents/2018-UPRT2/9868%5C%20PANS-TRG%5C%20Training_en.pdf

[163]   Rankin, A., Woltjer, R., Field, J. & Woods, D. (2013). 'Staying ahead of the aircraft' and managing surprise in modern airliners. In I. Herrera, J. M. Schraagen, J. van der Vorm & D. Woods (Eds.), *Proceedings of the 5th Resilience Engineering Symposium*. Resilience Engineering Association.

[164]   Rauschenberger, M., Schrepp, M., Cota, M. P., Olschner, S. & Thomaschewski, J. (2013). Efficient measurement of the user experience of interactive products. *International Journal of Artificial Intelligence and Interactive Multimedia*, *2*(1), 39–45.

[165]   Rick, S. & Weber, R. A. (2010). Meaningful learning and transfer of learning in games played repeatedly without feedback. *Games and Economic Behavior*, *68*(2), 716–730.

[166]   Romero, M., Usart, M. & Ott, M. (2015). Can serious games contribute to developing and sustaining 21st century skills? *Games and Culture*, *10*(2), 148–177.

[167]   Roos, C., Justen, P. & Nabben, A. (2013). *Future training in aviation - 2020 and beyond* (No. NLR-TR-2012-569). Netherlands Aerospace Centre (NLR). Amsterdam, The Netherlands.

[168]   Roszkowski, M. J. & Soven, M. (2010). Did you learn something useful today? An analysis of how perceived utility relates to perceived learning and their predictiveness of satisfaction with training. *Performance Improvement Quarterly*, *23*(2), 71–91.

[169]   Rouse III, R. (2010). *Game design: Theory and practice*. Burlington, MA: Jones & Bartlett Publishers.

[170]   Ruona, W., Leimbach, M., Holton III, E. F. & Bates, R. (2002). The relationship between learner utility reactions and predicted learning transfer among trainees. *International journal of training and development*, *6*(4), 218–228.

[171]   Ryan, M., Costello, B. & Stapleton, A. (2012). Deep learning games through the lens of the toy. In *Meaningful play 2012 conference proceedings*. East Lansing, MI: Michigan State University.

[172]   Ryan, R. M. (1982). Control and information in the intrapersonal sphere: An extension of cognitive evaluation theory. *Journal of personality and social psychology*, *43*(3), 450–461.

[173]   Salen, K. (2007). Gaming literacies: A game design study in action. *Journal of Educational Multimedia and Hypermedia*, *16*(3), 301–322.

[174]   Salen, K. & Zimmerman, E. (2004). *Rules of play: Game design fundamentals*. Cambridge, MA: MIT Press.

[175]   Sander, P. C. (2016). *Shared knowledge in complex teams: An investigation of the shared mental model construct* (Doctoral dissertation, Maastricht University).

[176]   Sanders, L. (2008). On modeling: An evolving map of design practice and design research. *Interactions*, *15*(6), 13–17

[177]   Sanghi, S. (2016). *The handbook of competency mapping: Understanding, designing and implementing competency models in organizations*. SAGE publications India.

[178]   Savage, I. (2013). Comparing the fatality risks in United States transportation across modes and over time. *Research in Transportation Economics*, *43*(1), 9–22.

[179]   Sawyer, B. & Rejeski, D. (2002). Serious games: Improving public policy through game-based learning and simulation. Whitepaper. Woodrow Wilson International Center for Scholars. Washington, DC.

[180]   Schell, J. (2008). *The art of game design: A book of lenses*. Burlington, MA: Morgan Kaufmann Publishers.

[181]   Schrepp, M. (2015). *User Experience Questionnaire handbook*. Retrieved from https://www.ueq-online.org/Material/Handbook.pdf

[182]   Smith, R. (2010). The long history of gaming in military training. *Simulation & Gaming*, *41*(1), 6–19.

[183] Spires, H. A. (2008). 21st Century skills and serious games: Preparing the N generation. *Serious Educational games*, 13–23.

[184] Squire, K. (2006). From content to context: Videogames as designed experience. *Educational Researcher*, *35*(8), 19–29.

[185] Stepniczka, I., Tomova, L., Rankin, A., Woltjer, R., Sladky, R. & Tik, M. (2015). *D3.1 Final analysis of research evaluation*. Man4Gen consortium. Vienna, Austria.

[186] Strauss, A. L. & Corbin, J. M. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. Sage Publications.

[187] Sullenberger, C. & Zaslow, J. (2009). *Highest duty: My search for what really matters*. New York, NY: Harper Collins.

[188] Susi, T., Johannesson, M. & Backlund, P. (2007). *Serious games: An overview* (No. HS-IKI-TR-07-001). University of Skövde. Retrieved from http://his.diva-portal.org/smash/get/diva2:2416/fulltext01.pdf

[189] *Taxonomy to assist in the identification of instructional methods*. (2016). International Civil Aviation Organization. Montreal, Canada. Retrieved from https://www.icao.int/training/Documents/GAT%20Training%20Taxonomy%202016.pdf

[190] Teuber, K. (1995). *The settlers of Catan: Game rules and almanac*. Stuttgart, Germany: Kosmos Verlag. Retrieved from https://www.catan.com/en/download/?SoC_rv_Rules_091907.pdf

[191] Tobias, E., Tischler, M., Berger, T. & Hagerott, S. G. (2015). Full flight-envelope simulation and piloted fidelity assessment of a business jet using a model stitching architecture. In *AIAA modeling and simulation technologies conference* (1594, pp. 625–662). American Institute for Aeronautics and Astronautics.

[192] Toups, Z. O., Kerne, A., Hamilton, W. A. & Shahzad, N. (2011). Zero-fidelity simulation of fire emergency response: Improving team coordination learning. In *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 1959–1968). New York, NY: ACM.

[193] Toups, Z. O., Kerne, A., Hamilton, W. & Blevins, A. (2009). Emergent team coordination: From fire emergency response practice to a non-mimetic simulation game. In *Proceedings of the acm 2009 international conference on supporting group work* (pp. 341–350). New York, NY, USA: ACM.

[194] Trespalacios, J. H. & Chamberlin, B. (2012). 21st Century learning: The role of serious games. In M. M. Cruz-Cunha (Ed.), *Handbook of research on serious games as educational, business and research tools* (pp. 782–799). Hershey, PA: IGI Global.

[195] Twenge, J. M. (2017). *IGen: Why today's super-connected kids are growing up less rebellious, more tolerant, less happy –and completely unprepared for adulthood– and what that means for the rest of us*. New York, NY: Simon and Schuster.

[196] Van Bussel, R., Lukosch, H. & Meijer, S. A. (2014). Effects of a game-facilitated curriculum on technical knowledge and skill development. In S. A. Meijer & R. Smeds (Eds.), *Frontiers in gaming simulation* (pp. 93–101). Cham, Switzerland: Springer.

[197] Van der Pal, J., Roos, C. & Sewnath, G. K. (2017). *Acceptance and validation of the apache assessment game* (tech. rep. No. NLR-CR-2016-538). Netherlands Aerospace Centre (NLR). Amsterdam, The Netherlands.

[198] Van Merriënboer, J. J. G. (1997). *Training complex cognitive skills: A four-component instructional design model for technical training*. Englewood Cliffs, NJ: Educational Technology Publications.

[199] Van Merriënboer, J. J. G., Clark, R. E. & De Croock, M. B. M. (2002). Blueprints for complex learning: The 4C/ID-model. *Educational technology research and development*, *50*(2), 39–61.

[200] Van Merriënboer, J. J. G. & Kester, L. (2005). The four-component instructional design model: Multimedia principles in environments for complex learning. *The Cambridge handbook of multimedia learning*, 71–93.

[201] Van Merriënboer, J. J. & Kirschner, P. A. (2013). *Ten steps to complex learning: A systematic approach to four-component instructional design (2nd edition)*. New York, NY: Routledge.

[202] Vink, R. G. D. (2017). *An exploration into the utility of a virtual reality headset for flight-crew training using the backward transfer paradigm* (Master thesis, Coventry University, Coventry, England).

[203] Vroom, V. (1964). Work and motivation. *John Willey & Sons*.

[204]   Vygotsky, L. S. (1967). Play and its role in the mental development of the child. *Soviet Psychology*, *5*(3), 6–18.

[205]   Wattanasoontorn, V., Boada, I., Garcia, R. & Sbert, M. (2013). Serious games for health. *Entertainment Computing*, *4*(4), 231–247.

[206]   What is GBL (Game Based Learning)? (n.d.). EdTech Review. Retrieved from http://edtechreview.in/dictionary/298-what-is-game-based-learning

[207]   Wikander, R. & Dahlström, N. (2014a). *The Multi Crew Pilot Licence - revolution, evolution or not even a solution?* (Bachelor thesis, Lund University - School of Aviation, Lund, Sweden). Retrieved from http://www.tfhs.lu.se/fileadmin/tfhs/doc/The_Multi-Crew_Pilot_License.pdf

[208]   Wikander, R. & Dahlström, N. (2014b). *The Multi-crew Pilot License, Part II: The MPL data - capturing the experience*. Lund University - School of Aviation. Lund, Sweden. Retrieved from http://www.tfhs.lu.se/fileadmin/tfhs/doc/The_MPL_Part_II_The_MPL_Data_-_Capturing_the_Experience.pdf

[209]   Wilkinson, P. (2016). A brief history of serious games. In R. Dörner, S. Göbel, M. Kickmeier-Rust, M. Masuch & K. A. Zweig (Eds.), *Entertainment computing and serious games* (pp. 17–41). Heidelberg, Germany: Springer.

[210]   Wolfe, J. & Crookall, D. (1998). Developing a scientific knowledge of simulation/gaming. *Simulation & Gaming*, *29*(1), 7–19.

[211]   Wood, D., Bruner, J. S. & Ross, G. (1976). The role of tutoring in problem solving. *Journal of child psychology and psychiatry*, *17*(2), 89–100.

[212]   Woodworth, R. S. & Thorndike, E. L. (1901). The influence of improvement in one mental function upon the efficiency of other functions (i). *Psychological Review*, *8*(3), 247–261.

[213]   Wouters, P., van Nimwegen, C., van Oostendorp, H. & van der Spek, E. D. (2013). A meta-analysis of the cognitive and motivational effects of serious games. *Journal of Educational Psychology*, *105*(2), 249–265.

[214]   Wu, W. H., Hsiao, H. C., Wu, P. L., Lin, C. H. & Huang, S. H. (2012). Investigating the learning-theory foundations of game-based learning: A meta-analysis. *Journal of Computer Assisted Learning*, *28*(3), 265–279.

[215]   *Yahtzee instructions*. (1996). Milton Bradley Company. Retrieved from https://www.hasbro.com/common/instruct/Yahtzee.pdf

[216]   Zyda, M. (2005). From visual simulation to virtual reality to games. *Computer*, *38*(9), 25–32.

Appendices