A Roadmap to Simulation in Education

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Elyssebeth Leigh, Irwyn Shepherd, Amanda Davies, and Elizabeth Tipton

Overview

A structured model for use in deciding when and how to include simulations and games in educational programs is introduced here. The model is based on extensive research into relevant educational theories underpinning simulation design and practices and is located within a macro-level analysis of factors affecting curriculum development. The intention is to illustrate the complexity as well as the benefits of using active learning strategies—especially simulations and games—to engage students in their own learning processes and encourage educators to expand their options for learning design.

Keywords

Simulation · Education · Education model · Learning design · Case studies

E. Leigh (✉)
University of Technology, Ultimo, Australia
e-mail: elyssebeth.leigh@icloud.com

I. Shepherd
Monash University, Melbourne, Australia

A. Davies
Science in Policing and Security Program, Rabdan Academy, Abu Dhabi, United Arab Emirates

E. Tipton
Eastern Washington University, Cheney, USA

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Learning Objectives

Readers of this chapter will explore how

- current and emergent changes are affecting approaches to learning;
- simulations and games as learning strategies align with locally relevant learning frameworks;
- formal education contexts are subject to a complex array of (often) conflicting forces that shape curriculum activities;
- a theoretically supported education model can apply to the choosing and using of simulations and games in their own contexts.

2.1 Introduction

This chapter explores the impact of the significant interruptions generated by the COVID-19 worldwide pandemic[1] that began in late 2019. Its rapid spread across the globe in early 2020 and beyond generated major resettings in design, delivery, evaluation, and assessment of conventional education at local, national, and international levels. Shifting societal demands and an array of disruptions to education services have caused the need for significant transitions in education delivery. The chapter focuses on how the appropriate use of simulations and games aligns with the application of emerging technologies, changing student demographics and learning attributes. A brief review of current uses of simulation in education is combined with an identification of other domains that are embracing and embedding simulation and games into their work fabric and business models, thus providing potential opportunities for emulation by the education sector.

While most feedback activities, such as effective feedback characteristics and tips, and the use of digital portfolios provide room to progress professionally,[2] there is also feedback that may cause teachers to believe that student successes and failures in learning are directly linked to their teaching styles. How to counteract such feedback requires understanding about and application of a number of simple, preventative measures and coping techniques in dealing with student evaluations.[3] To counteract this, increasingly, guidelines exist to assist both the teacher trainer and even the more experienced educator transition to new ways of interaction with students and learning processes in the evolving digital technology space (see footnote 2).

[1] COVID-19: The first documented coronavirus pandemic in history. Further information related to the pandemic.

[2] https://www.education.vic.gov.au/school/teachers/teachingresources/practice/Pages/insight-feedback.aspx. This site offers effective feedback characteristics and tips.

[3] https://www.insidehighered.com/blogs/gradhacker/how-deal-negative-teaching-evaluations. This site offers preventative measures and coping techniques in dealing with student evaluations.

These guidelines draw on several principles, among the most important being that they are intentionally designed to shift from being educator centric to being student centric. Indeed, in this changing education technology environment, simulations and games support redirecting educators' attention and thinking away from a belief that they are fundamentally responsible for teaching students and the sole evaluator of the students learning. Simulation and the gamification of learning increase student engagement, interaction, and assessment activities as do other emerging educational views, such as dialogic pedagogy[4] where both teachers and students are encouraged to talk and think in a way that identifies, considers, and values a range of different perspectives that can in turn lead to new understandings. This pedagogical view resonates strongly with the simulation activities of experiential learning, debriefing, and guided reflection.

These emerging sets of conditions invite educators to accept that while responsibility for learning exists, it can be facilitated by anyone in a group, such that everyone may impact the totality of learning. Where past frameworks may have led educators to believe that success and failure in student learning are about what they, as teachers or leaders, did or did not do, simulations and games take the learning environment far beyond this limited and limiting belief into the realm of shared responsibility for teaching and learning.

Simulations and games provide effective means for implementing modern learning theory, especially concepts of student-centered design, for building learner autonomy in 'safe to fail' environments, and toward achieving independent and life-long learning. Rather than a tight focus on content, simulations in the hands of expert and well-prepared facilitators focus attention on the entire learning process including the setting, the group, and the individual, as well as the multiple interactions among all of the elements, where all involved may at different times be teachers, learners, and collaborators in creating new knowledge.

This chapter ties together contemporary knowledge of theories of learning and the challenges teachers face as familiar certainties are challenged by the quickening pace of change. To help teachers map these interrelationships and learn more about how to position themselves and their influences appropriately in regard to intended learning outcomes, current applications of learning frameworks with an exploration of how simulations and games can be used to develop and apply immersive learning experiences within and across school curricula are described. All of this assists teachers to prepare for, become comfortable with, and more effectively manage the approaches of emergent learning typical of the unsettled and discomforting discontinuities of twenty-first-century life.

[4] http://21stcenturylearners.org.uk/?p=1337. An article on dialogic pedagogy.

2.2 In the Beginning

Before delving into discussions on a roadmap to simulation and games in education, a fundamental question must be asked—*why* use simulations and games in education? Such a question could be seen to imply that these formats are not used in conventional education, which is not the case. They are already being applied in many ways as reported formally and anecdotally, empirically, and through evidence-based publications. Simulation and games have also been used throughout history. One example of the use of simulation and games for learning comes from reports of how Pacific Northwest Indigenous Tribes in what is now Canada and the USA use Simulations and Games for the transmission of key skills and have done so for hundreds of years. Similarly, in Australia, Indigenous civilizations which have been in residence for thousands of years make extensive use of simulations and games to ensure knowledge is acquired by each new generation.

As early examples, the development of teachers for the education profession has seen the use of simulation for the preparation of teacher students. De Jong et al. (2012) comment on the value and relevance of simulation as an educational pedagogy in the preparation of student teachers by providing strategies on how to normalize their emotions in the classroom. Whereas Adams et al. (2008) in a two-part presentation on a study of educational simulations explore the impact of educational simulations, acknowledging issues around engagement and learning and interface design, and report that evidence indicates simulation must flow intuitively or the student's attention is focused on the simulation, rather than on the topic (Adams et al., 2008).

More recently the work of Campos et al. (2020) discusses the application of simulation-based education in a selection of European universities and their connections with learning. The authors conclude the ease of integration of a simulation-based education approach within blended and online courses is a key factor in its rapidly increasing application by educational institutions signposting both efficacy and expansion in the future of educational design. At this time, the improving skills of both learners and educators are driving these increases, and there is more change ahead.

Similarly, the work of Ferguson et al. (2020) resonates with Campos et al. (2020) in agreeing that there is an expanding body of literature to support the use of simulation-based education (Ferguson et al., 2020 work refers to healthcare education). An insightful work by Chernikova et al. (2020) evaluating the varying types of scaffolding to facilitate effective learning through simulation-based education points to the positive value of simulations as a mechanism to facilitate the learning of complex skills. The literature evaluating the use of simulation in the training context for police, military, and health, to name a few (see Fischer et al., 2020; Haginoya, 2020; Chen, 2021; Davies & Heysmand, 2019; Davies, 2015), has been increasing exponentially, supported in part by training simulations scaffolding on the affordances of technology drawn from the entertainment and gaming fields.

At the 2021 Asia-Pacific Games for Change (G4C) conference, the innovative Australian Centre for the Moving Image (2021) unveiled its extensive program of games-based classroom materials, an indicator of the span of resources available for any teacher to use. Also in a recent literature search using 'Game-based learning in Europe', the key search term drew together 1.4 million references. An analysis of all that data is beyond the scope of this chapter—but two things were quickly evident. First, many of the articles concerned the design of games for learning with less attention on helping educators make the necessary shift in thinking required to successfully use the resulting designs. Second, there were very few indicators of where educators can go to learn about how to make that shift in thinking or what it actually involves.

From a curriculum perspective, Fig. 2.1 provides an insight into the array of academic, student, and educator demographic, social, cultural, and community forces seeking to shape and influence the design and delivery of formal education. Based on the work of Wilson (2020), this introduces eleven types of curriculum arranged in five clusters according to the driving forces for each specific curriculum. While a common reading of 'curriculum' appears to refer only to what is called here the *overt, explicit, or written curriculum*, Wilson's work highlights the complexity of those forces that attempt to influence what is taught and how it is provided. To understand the intentions of such tools as 'learning frameworks' requires some prior knowledge of these forces and their interactions (Fig. 2.2).

Within their own teaching space, educators have a degree of autonomy as to how they operate but this is inevitably constrained by such things as their own view of how to enact their role (Wilson's 'curriculum-in-use') and how this is received and internalized by their students. Outside the teaching space, while these exchanges are happening inside, eight other sets of forces are straining to influence what happens inside it. At the level of institutional engagement, aside from the 'explicit' curriculum, there is the 'rhetorical' curriculum where 'learning frameworks' seem to fit most easily. While these may be described as 'ideas offered' they clearly carry political and financial weight and may have very different impacts in differing contexts.

Less easy to discern, and therefore harder to address explicitly—unless some additional effort is applied—are the 'invisible' sources of curriculum content. It is important to note that this is the largest group of curricula, implying that there is much we do not yet know nor fully understand about how educational practices and content are actually shaped on a daily basis. The 'covert' curriculum is often absorbed by all participants in education contexts without conscious cognition of its existence. The 'null' curriculum by its very name appears not even to exist—except that what is not included may be even more powerful than what is addressed.

The power of the 'phantom' and 'electronic' curricula is only slowly being revealed as educational processes that examine more closely their boundaries and intersections with learning which occurs outside formally constituted 'education'

(Source is) INSTITUTIONAL	
Overt, explicit, or written curriculum	Written /produced documents chosen to support an institution's intentional instructional agenda. This term is usually confined to those written understandings and directions formally designated and reviewed by administrators / curriculum / directors / teachers.
Rhetorical curriculum	Ideas offered by policymakers, school officials, administrators, or politicians.
(Source is) - TEACHER	
Curriculum-in-use	The actual curriculum as delivered and presented by each teacher
(Source is) - STUDENT	
Received curriculum	Those things that students actually take out of the classroom
Internal curriculum	Processes, content, knowledge combined with the experiences and realities of the learner to create new knowledge. While educators should be aware of this curriculum, they have little control over the internal curriculum since it is unique to each student. NB *It may be enlightening and surprising to find what has meaning for learners and what does not*
(Source is) - INVISIBLE	
The hidden or covert curriculum	This includes such things as emphasis on sequential room arrangements; cellular, timed segments of formal instruction; expectations about classroom behaviour. It may include both positive or negative messages, depending on models enacted and learner perspectives. It is derived from the very nature and organizational design of the public school, as well as from the behaviours and attitudes of teachers and administrators.
The null curriculum	All that is **not** taught, thus conveying the message that these elements are not important in their educational experiences or in our society. There are consequences not only by virtue of what [is taught], but also by virtue of what [is neglected]. What students cannot consider … they are unable to use, [and this has] consequences for the kinds of lives they lead.
Phantom curriculum	The messages prevalent in and through exposure to any type of media can play a major part in enculturation of students into a predominant meta-culture, or narrower or generational subcultures.

Fig. 2.1 Types of curricula influencing learning (based on Wilson, 2020)

The electronic curriculum	Those lessons learned through searching the Internet for information, or through using e-forms of communication.
(Source is) - COMMUNITY	
Societal curriculum (or social curricula)	The massive, ongoing, informal curriculum of family, peer groups, neighbourhoods, churches, organizations, occupations, mass media, and other socializing forces that "educate" all of us throughout our lives.
Concomitant curriculum	What is taught, or emphasized at home - may be received at church, in the context of religious expression, lessons on values, ethics or morals, etc. based on the family's preferences.

Fig. 2.1 (continued)

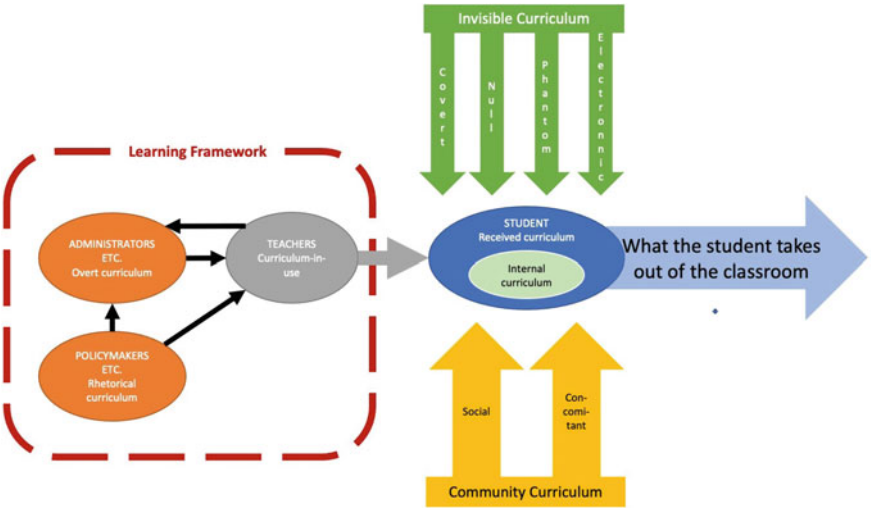

Fig. 2.2 A visual representation of Wilson's 11 types of curricula. The 11 curricula types are arranged in one particular format in this image. In different contexts we can imagine the weighting of items and their relationships might alter dramatically (Based on Wilson, 2020)

settings. 'Societal' and 'concomitant' curricula are clearly visible, and often noisy influencers in shaping how curricula are selected and applied, while seldom formally being identified as such.

2.3 Learning Frameworks

The emerging emphasis on 'learning frameworks' such as the Early Years Learning Framework for Australia and the Framework for School Age Care in Australia attests to the potential for educators to consider simulation[5,6] Such frameworks claim to provide a high level set of operating principles intended to guide educators in aligning their curricula with changing conditions and trends in learning theory and practice. In Australia, a learning framework is defined as a document based on research and with a purpose. The purpose of the national Australian learning frameworks—operational toolkits developed from overarching institutional curricula—is to provide professional educators with a foundation for creating a successful learning environment for children. Such learning frameworks—reflecting institutional (overt, explicit, and rhetorical) curricula—are essentially designed to allow for a range of interpretations and use.

As such they guide the design, development, and delivery of the teacher's 'curriculum-in-use' as developed and delivered to the students. The Australian learning frameworks refer to 'play' and 'games' as viable strategies while not specifically extending this concept to include what we understand simulation-based education to be. Appreciatively, it may be included in practice, but what appears to be missing from the literature is evidence of an educationally focused strategic approach to their use. Thus, there is no assurance that simulations are included in curricula documents nor that their use is supported or encouraged at an operational level.

As simulation and game design, delivery, and assessment are complex and highly detailed processes, the evidence, or lack thereof, indicates that educators using simulations and games for learning are not yet supported by accepted evidence-based education frameworks and models. This chapter, therefore, provides guidance to help readers understand how to integrate the use of play-based simulations and games into the strategic concepts set out in 'learning frameworks'. It is valuable to explain what we mean by 'play', 'simulations', and 'games' and consider the various contexts where these assist learning processes.

2.4 Play and Games

For millennia, play has been a core means of human learning. However, this chapter is not delving into the deep past in effort to support such a statement. Instead, in a more contemporary context, in the early 1960s, Holt (1972) explored the role of play in children's learning, and well before that Johan Huizinga (1949) had

[5] *BELONGING, BEING & BECOMING*. https://www.acecqa.gov.au/sites/default/files/2020-05/belonging_being_and_becoming_the_early_years_learning_framework_for_australia.pdf. This links to the Early Years Learning Framework for Australia document.

[6] Framework for School Age Care in Australia https://www.google.com/url?q=https://www.acecqa.gov.au/sites/default/files/2020-05/my_time_our_place_framework_for_school_age_care_in_australia.pdf.

embedded 'Homo Ludens' (the play element of human culture) as a sociological concept relevant to all human societies.

For Huizinga, play preceded human culture; since animals of all kinds are also adept at play, in its human form, play is free and not real. It is separate from the 'ordinary' aspects of life and creates order while being separated from any intent to gain a benefit or profit—it is 'for its own sake'. So this may be why conventional education finds it so hard to include play as a 'teaching' component in contexts where a benefit of some kind is supposedly central to the purpose of action. Formal education is about acquiring knowledge for the personal advantage of some kind—so playing with knowledge may seem antithetical to such proposes.

Regardless of this, play is still part of every formal educational context—albeit less often in the classroom than it could be. The playground and other non-formal social spaces are the areas where play is more readily accepted—and often where much life-learning occurs. For our purposes, we are using the terms simulations and games to address a multitude of play-based learning forms. In brief, a simulation is a means of replicating/representing some single or cluster of aspects of real life. It *'enrolls'* participants for the duration of the action to provide participants with a low-to-no threat experience of real life in order to rehearse expected behaviors, explore possible rationales for known actions, or develop predictive indicators for future actions.

Its structure is framed within a scenario made known to participants, which may also have unexpected elements creating uncertainties to be resolved through action. Games have rules and time-bound frameworks and may include roles. They are less 'real life' like and the focus is on solving problems or 'playing' with artefacts. However, both simulations and games easily incorporate learning goals and provide fictional realism for the adventurous exploration of many serious learning topics. So now we turn to an exploration of places where simulations and games are currently used and can potentially operate in education.

2.5 Simulation in Other Domains

A roadmap has a beginning and it would be remiss not to provide a brief summary of the emergence of simulation in the education [and training] fields. In 1988, Hays and Singer (1988) in referring to simulation as the replication of reality suggested rudimentary simulation was utilized as early as the middle ages, particularly in battle training and birthing. Forward to the work of Salas and Cannon-Bowes (2001), in reporting on the development of simulation in education and training, with the authors referring to the development of sophisticated, technological advances producing ever-increasing realism in simulation-based learning environments. The military, such as the Australian Defence College,[7] and the aviation

[7] Home: Wargaming and Simulation Centre. This is a link to the Australian Defence College website.

industry for example QANTAS airlines[8] are early adopters of the advances in simulation design for their cost effectiveness and efficiency of training and shone the light on this form of learning approach for other professions, such as policing, healthcare (Victoria Department of Healthcare Workforce Education and Training platform),[9] and engineering, to name a few. While the early twenty-first-century emergence of simulation-based learning design was varied in design and application, the common goal was to provide opportunity for learners to apply knowledge and skills and test themselves and others in a 'practice environment'.

As we move to 2022 and beyond, the plethora of literature on the design and application of simulation-based learning in a myriad of professions, medicine, dentistry, aviation, military, policing, engineering, business, and healthcare (and this is not an exhaustive list), is valuable for the insight it brings to the education community on what didn't work and what works such as what is described from a simulation-based medical teaching and learning perspective.[10]

It is important not to lose sight in the twenty-first-century technology-connected world that not all simulation-based learning requires sophisticated and often expensive technology. The key is about fit for purpose and following your roadmap as an educator to enhance the experience of your learners.

Exemplars

As identified earlier in this chapter, many organizations, businesses, and industries that need to ensure they remain functional and safe have embedded simulation strategies and activities within their very fabric. This is especially evident in high stakes environments where organizational and human safety is paramount such as mining,[11] engineering,[12] aeronautical,[13] seafaring,[14] nuclear[15] plus petroleum, space, environmental, defence, policing, and many more. All of these footnote links offer a range of different perspectives due to their areas of activity, but the core focus is using simulation to mitigate risk and reduce losses (such as life, infrastructure, productivity, outcomes, revenue, and support).

Indeed, as an example close to the discipline of education, simulation in healthcare education has blossomed over the last 30 years from a 'market garden' approach to what is now a discipline-specific, interdisciplinary, and multidisciplinary national and international movement. A fundamental goal was and is to improve knowledge, practice, and attitude in the workforce so as to improve patient

[8] Flight training. This is a link to the Qantas training website as an example of the use of flight simulation.
[9] Simulation program. This is a link to the Victoria Department of Healthcare Workforce Education and Training platform website.
[10] Simulation-based medical teaching and learning. This is a discussion article on clinical skills, medical education, medical simulation, and simulators.
[11] Mining Training Simulators.
[12] Engineering simulation.
[13] Ansett Aviation Training: Home.
[14] Simulation studies for maritime operations.
[15] Nuclear Reactor Simulators for Education and Training|IAEA.

safety and outcomes. Many collaborations, local and cross-boundary investigative and translational research, significant infrastructure and human capital investment, and evolving communities of practice now demonstrate levels of maturation in design and delivery, broadening of scope, and a collective desire to aim for even more translational impacts where translational simulation is used to help improve patient care. Educationally designed and evidence-based simulation activities can facilitate a review of healthcare teams and system performance that in turn helps design and test improvements (Brazil, 2017) through simulation.[16]

However, this development has not come about in a vacuum. It has had its fair share of detractors and pushback, especially from an economics and management perspective. In early developments management was asked to spend—but a return on investment was not easily forthcoming. Direction and momentum changed when consistently emerging evidence demonstrated that simulation positively impacted clinical practice and indirectly impacted patient outcomes. Also, a return on investment could be more effectively demonstrated, along with improvements in a number of sociocultural domains and human factors such as communication skills, teamwork, leadership, crisis resource management, and metacognitive processing (Bukhari et al., 2017).

In unison with this development was the increasing understanding that to demonstrate meaningful outcomes, the need to use educational modeling to guide the design, build, delivery, and measurements of simulation interventions became more evident. While the literature demonstrates this growth in awareness and application, this journey has been spasmodic initially. There is now a broader recognition, acknowledgment, and acceptance that education philosophies, education frameworks, and education models are important prerequisites in simulation development, delivery, and evaluation.

Another valuable lesson learnt early on was identifying the who, what, why, when, where, and how simulation might be of value. While initial simulations focused on repeating scenarios based on challenging issues—in health education this might be the 'deteriorating patient' or advanced life support—it became increasingly obvious that the curriculum needed to be revisited. Identification of areas of complex learning and practice that would be better suited to the use of simulation were identified and interventions were built around these. The goal here was to proactively introduce learners to these diverse activities in a safe and quarantined environment, where mistakes could be made without external ramifications, and the entire process could be discussed and reflected on as an educational process, rather than a reactionary process to a clinical problem. This approach has gained high levels of maturity.

[16] Translational Simulation Collaborative. All of the above links provide evidence of the use of simulation in their respective industries.

2.6 Transitioning to Mainstream Education

While there may well be many areas where educational theory and models will be driving simulation in mainstream education, it could be argued that a similar approach to that of healthcare could be advocated as an example of best practice and governance. This then becomes a starting point for those entering the discipline of education, those already in the education industry who are looking for a different or novel approach to their existing teaching and learning armory, and those managers who are keen to pivot how their curricula are delivered. This is particularly relevant in the face of emerging hardware and software technologies, the changing education workforce, societal and cultural changes in a highly linked technology world, along with political, parental, student, and employer/business expectations (Pang et al., 2019).

2.7 Simulation as a Change Agent

This transition to include a simulation-based learning approach helps address the need and necessity for a fundamental planned shift away from the more traditional approaches to teaching and learning and in parallel address the expectations of the new generation of student-centered and digitally connected learners. A significant change in student and parent demographics and expectations requires almost a forensic approach to what is being provided—and what can now be provided. An international pandemic disrupting the delivery of education worldwide has triggered the rapid transition from predominantly classroom-based to online digital education, using a plethora of web-based learning platforms, live streaming, and video connectivity.

Learning management systems have been quickly repositioned to deliver via digital devices (e.g. computer and smartphone) that which the teacher historically controlled in the school environment. Hybrid learning has become the catchphrase. Almost without exclusion all education organizations, in order to remain relevant and continue education delivery, have had to embrace and work through this rapid change challenge. This change process, which transcends national and international borders and cultures, with advantages and disadvantages provides an opportunity to reflect on the transition and capture ideas, suggestions, guidance, and processes—for embedding simulation-based learning into the new normal for education delivery.

Simulations support many aspects of modern learning theory, across the existing educational paradigms of pedagogy, andragogy, and now with heutagogy (Blaschke, 2012) which drives the use of student-centered learning design with the goal of building learner autonomy toward independent and life-long learning in this technology era. It encourages adaptive learning[17] where the delivery of education or

[17] Adaptive Learning: What is It, What are its Benefits and How Does it Work? Adaptive learning enables the learner to individualize and self-pace their learning. It can be monitored and provided feedback.

training is using digital technology to provide a more individual student-oriented, customized learning program that intelligently adapts to their learning needs. A personalized learning path can be provided for each student, which encourages increased engagement—as it allows for frequent practice while providing immediate feedback. This also reduces educator workloads.

2.8 Those Early Years

It is well recognized that teacher-led simulations in early childhood encourage students to absorb what is being presented and to use their developing imaginations to make sense of an activity. In Storytelling, the use of learning materials (paper, pencils, pens, and paints) linked to stories generates individual and collective responses (ideally). As the children progress from pre-school into primary school, these learning-based narratives become more complex and focused, in keeping with the appropriate curriculum and the cognitive and sociocultural development of the students. This continues into the senior school years, the vocational space, and the higher education arena—the tools of delivery and engagement becoming increasingly more sophisticated with the maturation of the learners' competencies. The question remains—is there an overarching learning framework or a set of frameworks and models that will guide development and encourage deeper learning using simulation?

2.9 Simulation

To enable an understanding of 'why simulation', it is valuable to first offer a response to the question 'what is simulation?' Simply put, simulation is a teaching and learning method (Beyea & Kobokovich, 2004; Binstadt et al., 2007) that can be designed, delivered, and measured more effectively if potential users (educators) have acquired a comprehensive understanding of the underpinning education philosophy theories, frameworks, and models that support simulation (Bordage, 2009; Shepherd, 2017). Armed with this important knowledge, educators can be more confident in its strategic use as part of their teaching toolbox and be able to engage students in innovative ways, especially as simulation affords the opportunity for safe learning activities to occur, where mistakes can be made, where a failure is an option, and feedback provides the learning (of note, simulation-based activities in a number of high-risk professions, military, policing, and aviation, are also designed where the participant may experience failure and a level of insecurity/lack of safety and these are fundamental to the learning design, preparing and testing the participant for the reality of the real world of their working environment).

2.10 Education Philosophy and Simulation

Cognitive and social constructivism (Shepherd, 2017) is identified as being a strong contender as an underpinning education philosophy for simulation-based education. Beginning from our earliest formative learning years, on almost a daily basis, as enquiring humans we have been exposed to new information, from both a cognitive and social perspective. This may be new knowledge or additional knowledge that challenges current understanding and makes you critically review what you understood to be valid. Any social dimensions presented may also encourage a 'deconstructing' of thought and beliefs and allow you to review, reflect, and accept these new views—to 'reconstruct' your knowledge and position.

There are a number of educational theories that facilitate the development of responses to the 'what, where, when, why, and how' questions supporting simulation as a tool to benefit learning and teaching. These include adult learning theory or andragogy, self-determined learning or heutagogy, theory associated with tacit knowledge, theories associated with learning styles, characteristics or preferences, experiential learning theory, critical thinking theory or metacognition, theories related to the reflective learner such as guided reflection, theories attributed to skill development and competence, theory on deliberate practice and expert performance, and theory related to self-efficacy (conceptual framework web link).

It is not the intent of this chapter to provide extensive information about all these different theories as there is significant available literature. In the context of simulation-based learning, the work of Shepherd (2017) and Shepherd and Burton (2019) and more recently Ross (2021) offers a valuable review of a number of learning theories and their application in simulation.

Gaining further insight through such an overview will potentially arm the educator with a broader and deeper understanding about these interrelated theories and their relationship to simulation design, development, delivery, and evaluation. A further activity is to develop the ability to critically consider how the underpinning constructivism approach and each of the educational theories intersect and decide where they have a role or not in the overall simulation.

2.11 Next Steps

Ideally, simulations should not be designed and developed in an 'educational vacuum' or in an 'atheoretical' sense. Application of an iterative instructional design-based model and process that guides the educator to identify the necessary information and tools to develop a best-practice set of activities results in a simulation event that has educational fidelity (Shepherd, 2017; Shepherd et al., 2019). Developed using a range of educational and instructional design principles, the ADELIS model (Shepherd et al., 2019) offers the educator a roadmap to simulation design (see Fig. 2.3).

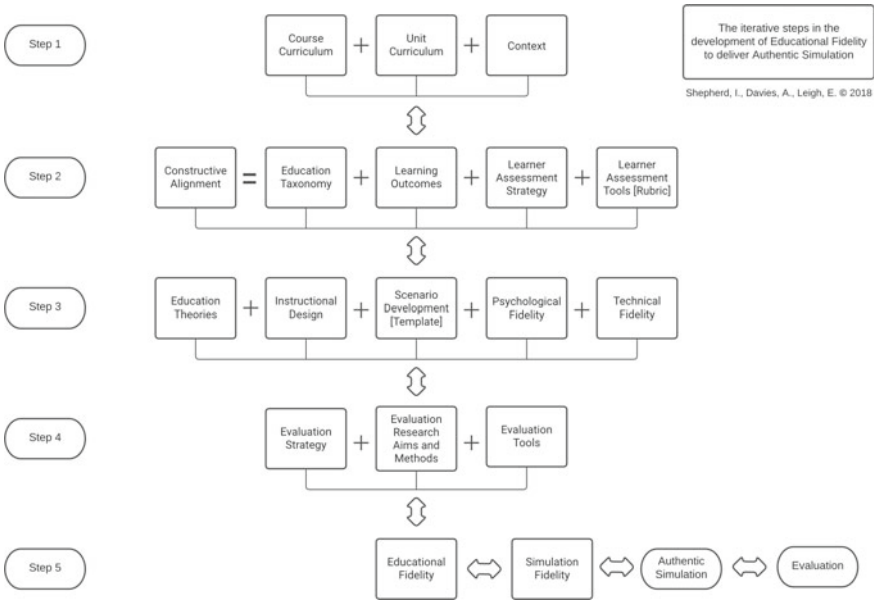

Fig. 2.3 The ADELIS model (Shepherd et al., 2019)

At the highest level in Step 1, the relevance for the use of simulation is assessed through a needs analysis process. Single simulation interventions for either a unit of study that would supplement or even replace a current education delivery activity (such as text, lecture, PowerPoint, or video) or a series of scaffolded simulations that cover key elements across a course need to be identified. Importantly, the context of the simulation(s) needs to be clearly articulated. This provides the initial 'why' parameters that will need further development.

In Step 2, the process of constructive alignment is considered first. With guidance from an education taxonomy, such as Bloom's Taxonomy (Adams, 2015), the most appropriate action verbs are identified that the educator/s considers best represents the area of learning being developed. The action verbs are subsequently embedded into the specific learning outcomes for the topic, course, and program in which the simulation will be a part of the learning experience. Assessment of the extent to which a learner achieves the learning outcomes requires consideration of the form of measurement, be it either formative or summative, and the associated assessment tool, for example, an assessment rubric.

Step 3 requires consideration of the how, what, when, and where of the simulation. Simulations require various levels of immersion, activity, and interactivity coupled with post-simulation reflections. An understanding of the educational theories that support this becomes relevant here as not all simulation activities require a host of supporting theories. There are, however, a number of theories essential for successful simulation design—keeping in mind that there are many instructional design models such as ADDIE (Analysis, Design, Development,

Implementation, and Evaluation) that help organize and streamline the production of course content. This is important for simulation as it provides educational integrity to the build.[18] Access to a simulation scenario template that embraces constructive alignment principles is a valuable tool to enable the educator to consider how and to what degree the levels of psychological and technical fidelity need to be addressed within the simulation.

Step 3 is both critically and pivotally important as it is here that the credibility of the simulation activity needs to be clearly deliberated. A simulation is a learning outcomes-guided approximation of a real-world event or process, which implies there are a number of considerations to address. These include, with the constructive alignment step in mind, the briefing, orientation to the scenario, and carefully selected cues and clues that will capture the imagination of the learner and allow them to 'engage' with or 'buy into' the simulation as if it was the real world.

This aspect, from a psychological fidelity perspective, is often referred to as 'suspension of disbelief' or the 'fiction contract' (Shepherd, 2017). The learners begin to encounter a shared understanding—a shared mental model[19] that the educator is attempting to establish. In identifying this engagement goal and process, it is important to acknowledge here that all this activity needs to include consideration of the overall psychological safety[20] of the learner—they need to feel comfortable that the simulation will be of value and not cause undue stress or anxiety (unless these are key attributes of the simulation design in specific learning contexts, e.g. policing, military, aviation, and medicine).

Cues and clues will be verbal, written, photographic, or video imagery as part of establishing the context and allowing the learner to construct a visualization (a mental picture), both as a starting point in the simulation journey and to sustain the sense of immersion, presence, and co-presence. It is at this point that interactivity is facilitated if that is an expectation—as part of the learning outcome(s) is introduced. This process is seen as establishing varying levels of psychological or functional fidelity. Whereas other stimuli (cues and clues) may be set up in the physical environment (the infrastructure) the learner is exposed to and referred to as the technical (environmental, equipment) fidelity. The psychological and technical fidelities provide various levels or measures of the realism of a simulation.

These fidelities are not mutually exclusive, so it is important to consider their overall fidelity mix, so as to mitigate the opportunity for the learner to slip into a 'comfort zone' and not buy in, or be overloaded and unfocused but more likely to be the in the learning and/or performance zone (McLeod, 2017).[21] A good

[18] ADDIE: 5 Steps To Effective Training Courses. This link further describes the steps of the ADDIE instructional design framework.

[19] Shared Mental Models. This link further describes the concept of a 'shared mental model'—a process of student engagement.

[20] https://thedebriefingacademy.com/wp-content/uploads/2019/01/Kolbe_PsychSafety_BMJSTEL_2020.pdf. This link provides further information on the need to ensure debriefing is psychologically sound.

[21] Zone of Proximal Development and Scaffolding. This link further describes the work of Vygotsky and ZPD.

understanding of what an educator wants to achieve—and this takes practice—is paramount during the design and development process, to achieve an optimal combination of fidelity factors and scaffolding activities. This becomes more evident in the final aspects of the simulation where guided reflection[22] can be used to ascertain how well the learning outcomes have been achieved and, importantly, the extent to which the simulation offered the opportunity for the learner to demonstrate achievement of the learning outcomes.

This leads to Step 4 where the evaluation of the educational impact of the simulation intervention using a research-focused approach is an important phase in the roadmap as it contributes to the validation of the simulation design. As mentioned earlier in the chapter, constructive alignment requires you to ascertain how you will measure the level of achievement of the intended learning outcomes. That includes capturing and analyzing student responses, which may cover a range of measurements (knowledge, comprehension, analysis, application, and attitude).

Step 4 requires determining the type of data and data collection tools that will contribute to evaluating the achievement of the fundamental aim of the simulation. Guidance to accomplish this phase is drawn from understanding the types or methods of research to be applied—descriptive, analytical, applied, exploratory, or translational. Consideration of the type of data to be captured, i.e. quantitative, qualitative, or a mix of both will guide the data collection tools which may include pre- and post-simulation participation surveys, participant and non-participant observation, video capture, and interviews.

Step 5 allows the simulation developer to review and reflect on what has been developed. It is suggested that working through the iterative process of the ADELIS model will result in a product that will have demonstrable educational fidelity with the desired levels of simulation fidelity (Shepherd, 2017). It is at Step 5 the educator is in a position to consider the steps on the roadmap that have led to developing, from an educational perspective, an authentic simulation environment and exercise that closely represents the real-world approach, setting, or activity. Importantly, confirmation at this step offers confidence that what has been designed and delivered will demonstrate measurable levels of authenticity, validity, and reliability[23] during any subsequent student assessment and simulation evaluation. From a research perspective, this is important as it establishes a sound basis for future translational studies where the impact of the learning is measured in the real-world environment.

[22] Guided reflection procedure as a method to facilitate student teachers' perception of their teaching to support the construction of practical knowledge. This link further describes how to use guided reflection effectively to ensure learning occurs.

[23] Validity, reliability and generalisability|Health Knowledge. This link further describes the processes required to ensure that content, delivery, and measurement strategies work within and across different activities.

2.12 Case Studies

The following case studies briefly describe how the use of educational theory and the education model ADELIS benefited the developer/educator and the learners. The following may resonate with educators, whereby simulation-based learning has been embedded in the learning design for a course/subject/program and on reflection has followed the steps in the ADELIS model. This is the situation experienced in the following two cases and in part contributed to the articulated design of the ADELIS model (Table 2.1).

Table 2.1 ADELIS application in a police case study

Step 1	Step 2	Step 3	Step 4	Step 5
Course curriculum/content	Construction Alignment Education taxonomy – Learning outcomes – Learner assessment why simulation?	Education theoretical design +simulation design and fidelity (technical, psychological)	Evaluation of Simulation based learning design	Validation of inclusion of educational fidelity to create authentic learning and assessment experience
Application to case				
Investigation management—theory to practice	Learning outcome 1: Demonstrate application of 'golden hour' in investigation practices	Computer desktop scenario—a video streamed scenario supported by interjections of phone call and information updates (visual, audio stimuli)	Two pathways of evaluation applied: 1. Student assessment results indicating the scenario enabled demonstration of application of knowledge 2. Post course survey requesting feedback on the simulation design for enhancing application of knowledge and transfer to the field of practice	Post Simulation Based Learning Survey for Students and Instructor results utilized for validation of authentic simulation based learning environment and exercise and continuous improvement action

The first case is drawn from simulation-based learning applied in a police education context. In this learning event design process, the Learning Outcomes were established, the knowledge acquisition content determined, and the simulation environment and exercise necessary to enable the students to demonstrate the application of knowledge acquisition identified. The measurement tools for assessing student application of knowledge and level of competence through participation in the simulation exercise were developed—the measurement tools enabling assessment to align with the learning outcomes. Of note, in this case, the computer-based simulation scenario exercise rolled out aligned to real time the students' performance monitored by camera.

The second case involves the development of online games for accounting courses. When these learning designers encountered the ADELIS model, problem/learning outcomes were already known. The goal was to turn dry financial topics into an engaging learning experience contributing to their understanding and use of such tools as profit and loss statements and balance sheets.

As they worked through the process steps, the way forward became clearer and a simulation emerged. Of particular importance to them was the reminder to include assessment as an integral part of the design sequence and—emerging only later—was the vital point of psychological fidelity. Reviewing the model later helped them to identify that this had actually been an implicit factor in their considerations, and they could in retrospect see how they had done so, and importantly for the future, they expressed pleasure in being able to add this more consciously to their future design work.

Their simulation was intended for accounting and finance students and has also been used for introducing healthcare staff to profit and loss and balance sheet accounting procedures in health contexts. One of the creative design decisions was to situate the scenario in a holiday resort on an island, thus making it a familiar kind of context but one of which most players would have little, if any, first-hand knowledge (visit at https://kilgors.com).

2.13 Summary

While simulation and games may be used in mainstream education to some degree, their strategic use and integration into education curricula remain suboptimal. While traditional teaching and learning strategies have changed marginally, it has taken a major international upheaval concerned with public health to swiftly and dramatically challenge the status quo in education delivery. Rapid, almost exponential transitions, to various modes of online learning, supported by an array of digital software platforms, have swept the education domain worldwide. Change for the survival of education services and the welfare of students and educators across the learning spectrum has been of a magnitude as yet unmeasurable. The circumstances were a catalyst for identifying where simulation and games could be of benefit in the new dynamic.

Educational processes which are beginning to encourage the use of simulation as a legitimate alternate teaching and learning method in the digital space have been explored here. Identification of uptake in the past by other industries and organizations has been presented with a closer look at an exemplar that offers insight for educators to better understand—and guide their uptake of simulation and games in education. Importantly, a review of the educational theories underpinning simulation is described, using an education model that provides an iterative instructional design approach to developing simulation activities to deliver high levels of educational fidelity and authenticity.

The stage is set to encourage educators to look at this approach and, through the information provided, step forward to embrace and develop educationally valid games and simulations that will spark student interest and engagement. The very experiential nature, the potential for repetitive and adaptive learning plus the guided reflective nature of simulations and games increase the potential for more effective learning, memory retention, and improvements in self-confidence and self-efficacy. The value-add is that the student has the opportunity to approach the real world at all levels of education with a more comprehensive skill set and ability to contextualize to different settings.

Questions for Further Discussion

To help consolidate your thinking on the content, focus, and intent of this chapter, the following questions are provided to facilitate—through a needs analysis approach—a novel strategy that may be of value to both you and your learners:

- What remains a problematic teaching and learning subject or activity for you?
- What are the recurring issues from a student perspective (engagement, understanding, analysis, and application) that might warrant a different approach?
- Where in the curriculum do the issues arise?
- Why?
- From your reading what type of simulation do you feel might be worthwhile exploring?
- Where might you seek further evidence to support your idea?
- Who might you engage in any future design activities?
- What resources do you believe would be crucial for a successful development?
- How might you go about delivering and evaluating your project?

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Elyssebeth Leigh is a professional educator working with adult learners in business and academic contexts and has provided simulation-based educational programs in many countries. Overtime her career has shifted from Practitioner to Researcher and she is now focusing on how simulation is used for education and for research about education. She has designed simulations of complex adaptive systems, and is currently exploring the skills, attitudes and knowledge required for effective application of adult learning principles and constructivist approaches to academic education. She is a Visiting Academic at UTS (Sydney) and is on the Board of Simulation Australia. She has published numerous books and articles on educational uses of simulation.

Irwyn Shepherd Experienced Principal Consultant with a demonstrated history of working in the hospital & health care industry- and academia. Skilled in Analytical Skills, Healthcare Education, Lecturing, Educational Technology, and Instructional Design. Strong education professional with a Doctor of Education (EdD) focused in Healthcare simulation education, plus: Master of Education (MEd), B.App.Sci., PGC ICU, Cert IV TAA. Currently supporting development of a VR /AR platform across whole of University.

Amanda Davies has more than 20 years of experience in police education and training in Australia and the United Arab Emirates at Police Academy training level, University and Vocational program level A Doctoral thesis in 2013 exploring the impact of simulation-based learning for novice and advanced police practitioners has been followed by a continuous production of a wide collection of publications and conference papers in this education domain. Dr. Davies is internationally recognised for her research work, specifically in evaluation of police training and education programs and associated policing operational training initiatives with simulation-based learning as a central tenant. More recently, Dr. Davies simulation research work has concentrated on the role of educational fidelity as a fundamental principle in simulation design for education purposes.

Elizabeth Tipton earned her Ph.D. MSIS business statistics from the University of Texas at Austin and hired at Eastern Washington University as an assistant professor of decision science in 2001, promoted to full professor in 2010, awarded the trustees medal in 2020, and retired emeritus in 2021. She was the primary faculty member involved in the development of the widely recognized, innovative partnership between Eastern's analytics program and Microsoft. Tipton's reputation and relationships in the community lead to the development of collaborative projects where students work with local, national and international organizations to solve real-world problems, gaining valuable experience to help them succeed in a competitive marketplace. Tipton has served in many roles during her career at Eastern, including department chair, interim associate dean, and interim dean. Tipton has also made significant professional contributions at the national and international level in research and scholarship by presenting, publishing, editing, and conference hosting in the areas of simulation, pedagogical game design, data visualization, and dental hygiene. Her undergraduate data analytics students were mistaken for ABDs at a professional data analytics conference in Bellevue, which made her very proud of them and the EWU Data Analytics faculty.