A Model for in-Simulation Assessment

Abstract

Simulations are a relatively well-known concept in training situations. Simulations allow the player's competencies for handling specific situations in-simulation to directly benefit the player in real-world situations. We presented a study on the use of a well-known business simulation game package, MarkStrat, to investigate the pedagogical outcomes for strategic management development. The experience of using MarkStrat lead us to develop an approach model what would enable us to develop pedagogically informed in simulation assessments. We will be using this pedagogically inform framework for in-simulation assessment in the simulations we are currently developing for a number of companies.

Introduction

“Tempora mutantur, nos et mutamur in illis: the times change and we with the times” goes the old adage. Rather than just the times however, it has been more the case that the terms have changed with regards to Serious Games and Simulations. Are they one and the same? Is one the subset of the other? Or, as this study will illustrate, are they distinct yet related entities in the domain of training tools?

Simulations are a relatively well-known concept outside of E-learning circles. Many off-the-shelf games for entertainment follow a simulation model to varying degrees of accuracy. Sports simulators, flight simulators, driving simulators, civil engineering simulators, and life simulators are a mainstay of the industry and as games set in real world situations, albeit with fictional story lines such as the Call of Duty series (Treyarch, 2012), take a grittier and more realistic approach they too can be said to be teetering on the edge of simulation. Simulations can be therefore defined by practice as the genre of software, which seek to reflect the acknowledged reality of a real-world situation as closely as possible within technological restraints. This definition remains fundamental to the validity of any simulation as a training tool.

Simulations are of course nothing new in training, particularly in military or medical fields. The United States Army Research Laboratory, for example, identifies the need for a strict adherence to reality and user immersion and many of the simulations they produce are becoming ever more complex, particularly with regards to the inclusion of human psychological factors (Army Research Laboratory, 2010). Simulations are not above criticism however and their flaws help underpin the distinction between themselves and Serious Games.

A commonly used example of simulations is as flight simulators. In a flight simulator game the player encounters a realistic representation of flying an aeroplane. Rules of conduct and protocol, such as communication between pilot and flight control during taxiing, are observed in the artificial intelligence. Meteorological events affect the player's control of the aircraft. Flight velocity must be achieved before the simulation will allow the player to take off. A significant drop in speed will cause the aeroplane to lose height through artificially programmed lift mechanics. Even hull and wing integrity may be breached due to the actions of the player. Yet even within the construction of this realistic and immersive environment the simulation is not yet a training tool, though it would have the capability to be used as one.

The issue is that there is no distinctly inherent educational value to use such a simulator. The player could do so for pleasure alone but if the simulation were to be used to train pilots then the specifics of the training exercise would have to be enforced externally. For example the player might leave the runway without permission from the flight controller. The player may even experience a verbal reprimand from the flight controller in game yet there are still no consequences for the player's actions. It is entirely up to the player whether they regard or disregard the flight controller's wishes and unless the simulation developers have included a means to counter this behaviour then the observation of player protection made by Garris et al., (2002) stands. The next time the game is played all is forgotten and all is forgiven. Was this instance in the flight simulator a serious breach of protocol or merely a formality or, perhaps even, just a pleasantry that would ordinarily be observed? The user cannot know unless they have prior instruction or fore knowledge of a procedure. It might be perfectly possible, in simulation at least, to land a commercial jet safely yet upside down on a Heathrow runway but this, though possible, might not be considered best practice.

The aim of this paper is to examine a traditional use of a well-known simulation for learning and teaching, with the aim developing an approach that can capitalize on the benefits of simulation to make an effective computer assisted assessment tool. The paper first looks at some of the background literature in this domain, we then describe a popular simulation tool used to teach marketing students. A model is then proposed to aid the development and use of simulator not just as learning tools but effective assessment tools.

Background

Ulicsak and Wright (2010) give a definition for “Educational simulations” which goes some way to addressing this problem of requiring external direction from within a simulator by proposing simulations of specific instances with intensive detail. Through these intricate educational simulations they argue that the player's competencies for handling these specific instances in-simulation will directly benefit the player in real-world situations. If one were to return to the flight simulator example; should such a game which, for example, contain a simulation of an engine failure mid-flight for the purposes of testing a potential user's reaction to that situation and how they would make the situation safer, then there would be a case for describing it as Ulicsak and Wright do, as an educational simulation.

These parameters bring simulations tantalisingly close to Serious Games however some of the definitions for what constitutes a Serious Game can range from the academic approach of fulfilling learning outcomes using gaming technology (Yusoff, 2010) to the unhelpfully vague definitions of the use of game based methods or technology in non-entertainment situations (Corti, 2006). Corti (2001) argues that the interactivity of games and the technological opportunities are far more compelling than simply being presented with information. Serious Games, as a digital games-based medium, attempt to encapsulate those two principles and provide a compelling experience and create a learning environment of virtual opportunities, which might otherwise have been denied to the user. Such virtual opportunities might include the ability to have a symphony orchestra at hand, or create structures and buildings within architectural limits, or witness geographical effects over long periods of time.

Serious Games must go further than these simulations of environments however to compel their players to continue. Though the argument that simulations have been found lacking in tackling higher-order thinking in favour of specific skills from professional situations (de Freitas, 2006) is valid, the professional situations themselves must be tackled in a way that would be both applicable to the real-world environments and real-world practices to provide the compelling experience needed to maintain player engagement (Shaffer, 2006). In the case of Serious Games in the formal learning environments of classrooms Kirriemuir and McFarlane (2004) argue that students are more compelled when the learning is seen as relevant, because of these situations, and the game facilitates a way for them to effectively map their own progress. For many decades, however business simulations have been used in education for learning about specific aspects of a business. They provide an expansive view of the complexity of a business situation, where students have a chance to take and implement decisions and see their consequences, within a longitudinal (though time-boxed) timeframe. Although enabled via information and communication technologies (ICT), such an approach is limited in the sense that nothing can replicate true responsibility and accountability than active business experience in the real world. Clearly an abstracted synthetic reality still limits and distorts the reality of actual business contexts – notwithstanding the logistics of implementing, supporting and maintaining such sophisticated environments for learning. Hence, probably the best learning effects are achieved when these three methods are flexibly combined. The use of all these methods, at different stages of the teaching process, allow the students to achieve a multi-dimensional vision of the real-life business process, and of the challenges raised by decision-making and implementation in a high-risk, unpredictable environment. Used in combination, the advantages of these methods complement each other, enriching students' experience and facilitating understanding. Simulations such as these, however do not offer virtual environments and immersive situations. They provide linear decision making rounds and results, with participants attempting to achieve good return on investments, profitability and brand dominance within a marketspace in competition with other teams.

An example of Simulation in use: MarkStrat

This study focuses on the application of a well-known business simulation game package, MarkStrat, to investigate the pedagogical outcomes for strategic management development in this light. MarkStrat, has been in use for over 25 years and continues to be the worldwide leader of interactive marketing simulations in education, having been used at more than 500 educational institutions across a wide range of undergraduate and postgraduate courses throughout the world (Markstrat, 1997). The simulation software itself arose out of a pedagogic desire to increase and improve the efficiency and reflectivity of understanding strategic decision-making behaviour within the focal area of marketing; also addressing the need to apply theoretical strategic concepts (portfolio mix, market analysis, corporate strategy, market research, forecasting, team planning and inter-team dynamics) in a "safe" simulated environment (Larreche and Gatignon, 1990).

The philosophy and rules for the system are quite straightforward and involve teams of (students) competing against each other under semi-realistic synthetic business conditions, to design, innovate, brand and market a set of products across two markets in an artificial world with a given budget and a target to maximise shareholder returns (Burns, 1997; Gatignon, 1987). As such, MarkStrat requires participants to consider not only a simulated market but also real, human competitors who are interacting and setting business strategies, enabled through the MarkStrat interface. In doing so, the platform itself essentially provides a suite of decision-making and forecasting tools available as a suite of "management dashboards" such that each team attempts to meet the needs of five different (virtual) consumer groups. Thus, performance depends not only on the quality of internal company decisions but also on the market behaviour of competitors, annualised returns – and indirectly, the dynamics and harmonics of inter- and intra-team competition.

The game progresses through a series of up to 9 – 15 virtual "rounds" over a period of 3 – 4 days, whereby each team – hence company – have to make strategic decisions on product R&D, production, market research, HR costs, distribution and so forth. A server in Paris collect all decisions from all groups on a periodic basis, and uses them as inputs to the simulation process. After the simulation is run for a relevant period of time by the tutor and the results transferred to the teams, the game management site transfers the output to all groups whereby an overall set of management reports is made available to all to track competitive performance drivers (including shareholder price, rate of inflation, product drift, consumer satisfaction and other indices). The simulation output consists of a marketing budget for the next period and the result of marketing studies purchased by each group in the last period. Hence the main task of each group is to realise a qualified decision making process that enables a smooth balance between the offer of prospected products and the demand of the market. Only by considering all relevant market conditions it is possible to achieve a high net marketing contribution. The key steps are shown in Table 1. Lecturers also tutor teams and loans can also be arranged.

Table 1 A typical MarkStrat business simulation game session

Phase	Tutors	Students
Preliminary setup	▪ Organise and setup teams and "worlds" ▪ Define objectives and duties of students ▪ Release simulation access to students ▪ Briefing on marketing issues and strategy topics	▪ Familiarisation with MarkStrat
Simulation Round	▪ Release previous or current team/world results ▪ Brief and cover key marketing or strategy topics of use to students to enable decision-making ▪ Formative Feedback is given on progress ▪ Support and answer general or specific queries ▪ Offer loans to weakly performing teams	▪ Review released team / world results ▪ Organise and take team decisions ▪ Input team decisions into MarkStrat and upload ▪ Use the feedback and lessons learnt into the next task
Post-simulation	▪ Feedback and analysis of results (identify winning team) ▪ Highlight learning outcomes for marketing and strategy topics	▪ Preparation and submission of either a group or individual assignment on the performance of the team based on the simulation and module objectives

Within MarkStrat, the participating students are effectively "learning-by-playing", and are goal-seeking in terms of analysing a complex decision-making process through breaking down their overall objective into a series of marketing strategy sub-tasks and targets – successful branding, marketing, consumer satisfaction, lean inventory management and the like (Lant and Montgomery, 1992). Furthermore, they are learning to work within a team and to react quickly to an unpredictable evolution of the pseudo-market driven by a combination of other team interactions within the simulation – as well as "God"-like interventions presaged by the MarkStrat tutors (such as arbitrarily adjusting the inflation rate and / or introducing new product and market varieties). These interventions are possible through differing scenarios; on the other hand a tutor may just use a standard option where extraneous variables follow a predetermined path.

Table 2 Range of learning styles and behaviours arising from MarkStrat (Sharif and Ranchhod, 2008)

<table>
<tr><th>Experiential learning
aspect
(Wolf and Kolb, 1984)</th><th>Knowledge aspect
(Nonaka and Takeuchi, 1995)</th><th>Learner behaviour
(Honey and Mumford, 2000)</th><th>MarkStrat session components</th><th>Identifiable Component</th></tr>
<tr><td>Abstract Conceptualisation and Active Experimentation</td><td>Socialisation</td><td>Activist</td><td>Practical application of marketing strategy within the game</td><td>Process</td></tr>
<tr><td>Concrete Experience and Reflective Observation</td><td>Combination</td><td>Thinker</td><td>Development of product and market strategies to aid decisions</td><td>Learning Opportunity</td></tr>
<tr><td>Abstract Conceptualisation and Reflective Observation</td><td>Internalisation</td><td>Reflective</td><td>Making decisions to address product, market, and macro-economic results</td><td rowspan="2">Implementation</td></tr>
<tr><td>Concrete Experience and Active Experimentation</td><td>Externalisation</td><td>Pragmatist</td><td>Implementing decisions, and assessing competitor team response in each simulation round</td></tr>
</table>

A such, this type of environment approximates to the well-known Kolb Learning Cycle (Kolb, 1984; Fry *et al*, 2000), fitting into the spectrum of work-based learning, teaching laboratory and practical work, action-learning, role-playing, and many associated types of small group teaching (Fry *et al*., 2000). Information Systems-based business simulation games such as MarkStrat can then be defined as experiential learning tools, whereupon concepts, theories and constructs to be learnt are not fixed but are formed and re-formed through the 'experience' and knowledge of individual participation (Race, 1996). It is interesting to note that upon engaging in a MarkStrat simulation session, the key stages of the experiential learning process are addressed and achieved, albeit through a range of different learning styles, as Wolf and Kolb (1984) note. Further, and as shown in Table 2, such business simulation games provide a range of learning aspects which can assist in understanding personal development (Tonks, 2002) and can then also be related to the transfer of knowledge (Nonaka and Takeuchi, 1995) and associated behavioural learning styles (Honey and Mumford, 2000).

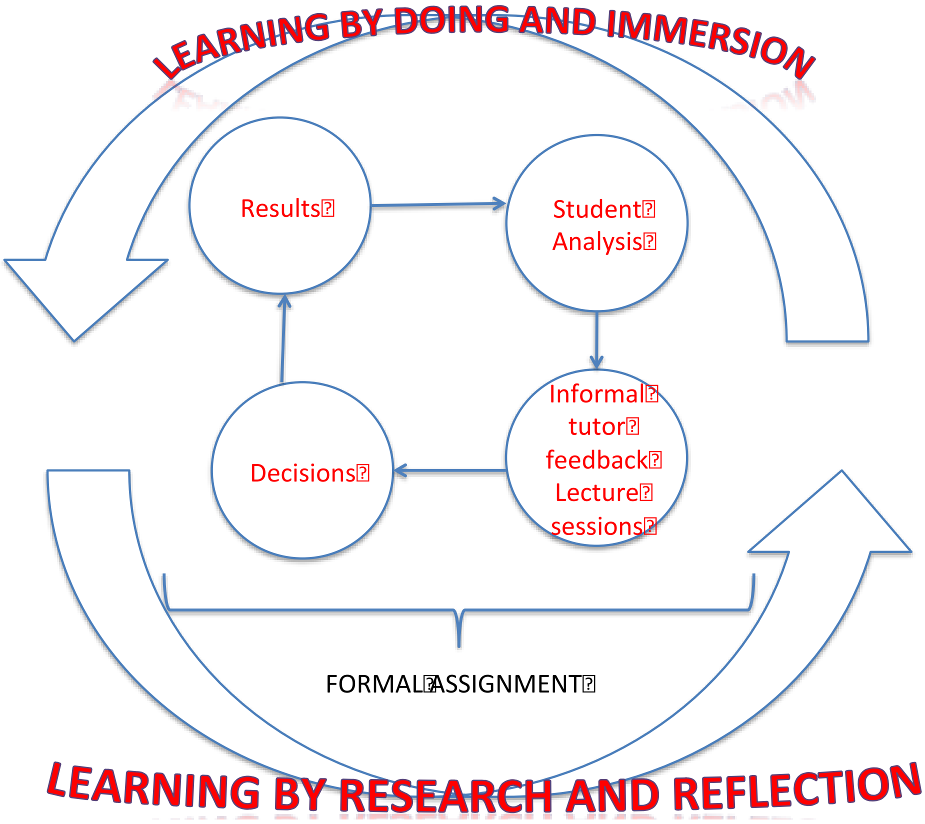

Figure 1 a simulation learning cycle

In order to gauge the learning impact of such a simulation, students were formally assessed after undertaking the simulation exercise. They had full access to the simulation, once the formal decision making periods were completed and results announced. This meant that they could look at data for any of the years for which they made their decisions and analyse them in detail.

The assessment was a non-computer based assessment in the form of a report. Students were asked to undertake the assignment and offer detailed analysis and screenshots where appropriate. Students generally performed well, found insights from the simulation and wove in useful theory where necessary. It is important to note that throughout the simulation, tutors were on hand to provide formal feedback and ideas for future strategies to the students, so informal feedback took place during the simulation.

Figure 1 illustrates the two cycles that students go through in order to learn from an immersive simulation. The tutor is important in helping the student to reach certain goals. In the end however the results are largely because of the decisions students make about markets, consumers, research and development, positioning, competitor analysis and brand positioning. Upon completion, the students can look at the archive of the effects their decisions had on progressing their companies and mine them for useful information, reflecting on it and doing the assignment with relevant academic theory input.

In using a traditional paper-based assessment for the learning activity using MarkStrat, we failed to make the most of the affordance of simulation. Magee (2006) pointed out traditional assessment approaches do not demonstrate the pedagogical benefits of using the simulators in learning and teaching. Magee goes on to suggest that the more forms of effective assessment will occur as computer based assessment from inside the simulation environment itself.

Wrongness Framework

In-simulation assessments must be tackled in a way that is both non-trivial but also in a way which is not jarring to the immersion of the user of the simulation. In our reasoning we have deduced that to simply try to account for every possible situation that the simulation users might find themselves is unreasonable and unviable. This would fail as it would take a monumental amount of design time to consider all possibilities and, even if such an event were accomplished, it would prove to be even more arduous to test the reception of the simulation to those possibilities. The risk of error is far too great. Likewise, and even if such things were feasible on a small scale, it would provide a very linear experience for the user (an educational simulation) and the danger would be that they would eventually qualify from the instance by dogged determination rather than a true aptitude for the subject matter.

True in-simulation assessment must test for wrongness and wrongness alone as simple logic tables will tell us what is not wrong must invariably be right. This way if the user has not triggered any “wrongness” flags then there approach must have succeeded. This however is not a process to be undertaken alone, reducing cut and fast rules about wrongness into statements of predicate logic is merely the first step. The refinement of best practice will occur only if the framework allows for the subtleties of intelligent leveling.

The Wrongness Framework provides an overview of how in-simulation assessment is possible without the constrictions and linearity of educational simulations or the immersion breaking trends of edutainment based rewards and foci. The framework itself is balanced on a simple premise that that practice, which is not bad must, invariably, be good. In this way the simulation needs only to recognise when a user has performed a prohibited action and not try to second guess, or what is much worse, define what is only good practice for a given epistemological context, see Figure 2.

The first stage in building any simulation around this framework must be to define what is absolutely prohibited in the epistemological context. These rules are referred to in the framework as “Wrongness Flags”. The second stage is to define not that which is prohibited but rather what is considered bad practice. These flags are known as “Cumulative Malpractice Flags”.

In the background of the simulation the user is assigned a unseen upper limit score which, should the user trigger either a Wrongness or a Cumulative Malpractice flag, will reduce at varying rates of degradation depending on the severity of the offence. These reductions are fed directly back into the simulation along with a newly assigned “Consequence Flag” which will itself trigger an in-simulation response.

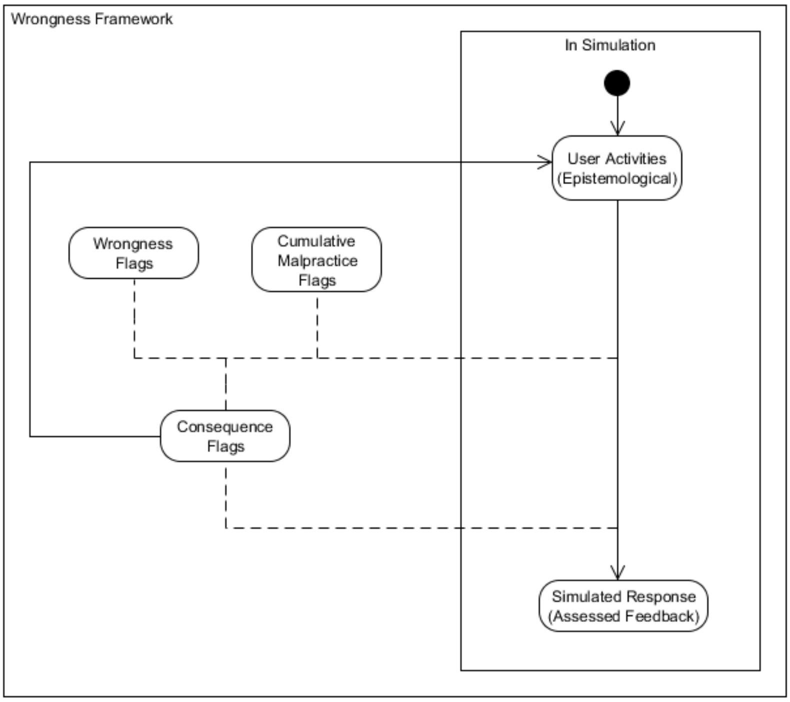

Figure 2 the Wrongness Framework

To ensure culpability the Consequence flag also feeds back into the general environment of the simulation which will affect how the user may proceed and what task they will be assigned to complete next and any artificially intelligenced guidance.

Continued bad practice will lead to a loss of responsibility, trust, or worthiness of task assignment; improved or good practice (which is to say practice which has triggered no response flags) leading to bigger and better things. Assessment in this framework accounts for user actions with simple logical constraints and does so in a continuous flow to avoid breaking immersion. No externalising is required or necessary. Any external interaction could be used for tutoring purposes post simulation. In fact the situation created is closer to a serious game.

Summary

Simulations are a relatively well-known concept outside of E-learning circles and used quite extensively in training situations. However there has been some progress toward “Educational simulations” that allows the player's competencies for handling specific situations in-simulation to directly benefit the player in real-world situations. In this paper, we presented a study on the use of a well-known business simulation game package, MarkStrat, to investigate the pedagogical outcomes for strategic management development. The simulation package pedagogic designed to increase and improve strategic decision-making behaviour in a “safe” environment.

While the MarkStrat is an effective training tool, and has successively been used for over 25 years, it was assessed using a traditional mode of assessment and thereby not drawing on the inherent benefit of assessment in-simulation. This led us to develop an approach model that would enable us to develop pedagogically informed in-simulation assessments. We will be using this pedagogically informed framework for in-simulation assessment in the gaming simulations we are currently developing for a number of companies.

References

Army Research Laboratory, 2010, *Simulation and Training Technology* [online], accessed at: <http://www.arl.army.mil/www/default.cfm?page=540> [last accessed: 2013/04/15]

Burns, A.C. (1997). Review of MARKSTRAT3. Marketing Education Review, **7** (1) : 89-90.

Corti, K., 2001, Evidence that using Games-based eLearning (G-bel) can lead to significant benefits for learners and organisations, White Paper, PIXELearning

Corti, K. 2006, *Serious Games for eLearning; When games become serious business applications,* Presentation from seminar of Serious Games, De Montford University

de Freitas, S., 2006, Learning in Immersive Worlds: A review of games-based learning, JISC Learning Programme

Fry, H., Ketteridge, S., and Marshall, S. (2000). Understanding Student Learning. In Fry, H., Ketteridge, S., and Marshall, S, (eds.) *A Handbook for Teaching and Learning in Higher Education*, London: Kogan Page, pp.21-40.

Garris, R., Ahlers, R., and Driskell, J. E., 2002, *Games, motivation and learning: A research and practice model*, Sage Publications

Gatignon, H. (1987). Strategic Studies in Markstrat. *Journal of Business Research*, **15** (6), 469-480.

Honey, P. and Mumford, A. (2000). *The learning styles helper's guide*. Maidenhead: Peter Honey Publications Ltd

Kirriemuir, J. and McFarlane, A., 2004, Report 8: Literature Review in Games and Learning, Futurelab

Kolb, D.A. (1984). *Experiential Learning*. Englewood Cliffs: Prentice-Hall.

Lant T. K., and Montgomery D. B. (1992). *Simulation Games as a Research Method for Studying Strategic Decision Making: The Case of MARKSTRAT.* Stanford GSB: Research Papers, Available. [on-line] http://gobi.stanford.edu/researchpapers/detail1.asp?Paper_No=1242

Larreche J-C., and Gatignon H (1990). *Instructor's Manual: Markstrat - A Marketing Strategy Game*, Palo Alto: The Scientific Press.

Magee M (2006) State of the Field Review: Simulation in Education, Final Report. Alberta Online Learning Consortium, Calgary AB, May 12, 2006

Markstrat Strat*X (1997). *Simulation as a learning method*. Available. [on-line] http://cross.net/strat*x/sims.htm.

Nonaka, I., and Takeuchi, H. (1995). *The Knowledge-creating Company : How Japanese Companies Create the Dynamics of Innovation*. Oxford University Press: Oxford, UK.

Race, P. (1994). *The Open Learning Handbook*. 2nd edition. London: Kogan Page.

Shaffer, D. W., 2006, *How Computer Games Help Children Learn*, Palgrave Macmillan

Sharif, A and Ranchhod, A (2009) Using the Markstrat business simulation to develop strategic management behaviours

Proceedings of The European and Mediterranean Conference on Information Systems (EMCIS) Izmir Turkey

Tonks, D. (2002). Using Marketing Simulations for Teaching and Learning: Reflections on an Evolution. Active Learning in Higher Education, **3** (2) : 177-194.

Treyarch, 2012, *Call of Duty: Black Ops II*, computer game, PC, PS3, Xbox 360, WiiU, Activision

Ulicsak, M., and Wright, M., 2010, *Games in Education: Serious Games,* Futurelab

Yusoff, A., 2010, A Conceptual Framework for Serious Games and its Validation, PhD Thesis, University of Southampton

Wolf, D.M., and Kolb, D.A. (1984). Career development, personal growth and experiential learning. In D. Kilb, I. Rubin, and J. McIntyre (eds.), *Organisational Psychology: readings on Human Behaviour*. 4th edition. Englewood Cliffs: Prentice-Hall.