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Serious Games

in

Defence Education

'A report into the potential educational benefits of the use of computer-based games technologies and techniques within the context of Higher Education delivery at the Defence College of Management and Technology'

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"The UK MOD, and the Defence Academy in particular, has a strongly-developed understanding of the utility of modelling and simulation in training. However, the effective use of games and games technologies to support education is less well understood. This report was commissioned with Caspian Learning in order to shape the Defence Academy's development in this area. It identifies the key benefits and constraints of a 'learning through games' strategy, as well as a taxonomy for types of Immersive Learning Simulations. The taxonomy also highlights the potential uses of such simulations for Defence and their related strengths and weaknesses. I commend it to you."

Lt Col JN Potts
Defence Academy Distance Learning Programme Manager

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1. Executive Summary

This report aims to demonstrate if, how, and where the emerging field of "serious games" or "immersive learning simulations (ILS)" is of interest to the Defence College of Management and Technology (DCMT) as a component of the Defence Academy within the Ministry of Defence (MOD). In doing so, it raises many points of interest that are likely to be useful to other constituent parts of the Defence Academy and individuals involved in education and training throughout the wider MOD landscape.

Ultimately, the report should enable better informed and more robust decision making on where and how to utilise a 'learning through games' strategy to deliver enhanced learning benefits.

Building on the established and evidence-based domains of simulation, modeling and wargaming, this report opens with a review of the research literature examining the effectiveness of games in education and training while providing a taxonomy of terms and definitions, to enable those involved in training and education to understand the different types of games technology in existence, their merits and appropriate use cases. The report then focuses on an analysis of the applicability of this type of technology to the DCMT landscape and provides some conclusions on the barriers and opportunities for exploitation across the MOD.

This report describes the significant benefits to be gained by utilising games within education and training, not the least of which is improved learner motivation. Some of the principal demographics and traits of the learners surveyed by the report, such as age, technology use patterns, engagement with sport, competitiveness of learners and desire for practical hands on learning, offer a powerful argument for the use of games based learning technologies.

This report also highlights some of the cultural, system and process barriers to adoption evident within the DCMT, and noted in the wider MOD landscape, which may limit speed of take-up of ILS technologies and approaches. This report identifies issues that include military stigmas associated with key words such as "games" and "failure" and a consistent learner focus on hierarchical promotion and thus avoidance of anything that could affect the pace of promotion.

This report concludes by suggesting some ideal use cases and ways forward and provides some decision making support for those considering a "learning through games" approach within the UK MOD.

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2. Key Findings

This report has started the process of exploring the synergy between the DCMT and the wider military context and the use of Immersive Learning Simulations (ILS). It has found many compelling reasons and a growing evidence that justify a "learning through games strategy" within this landscape, including:

- learner demographics
- learner motivation
- competition
- enriched subject matter
- opportunities for safe failure
- opportunities for enhanced skills practice
- retention and recruitment
- familiarity with simulations.

Within the military and beyond, the evidence bank is becoming very persuasive, with Return on Investment (ROI) measures in specific ILS case studies showing:

- reduced training costs
- reduced training time
- increased learner engagement
- improved learning outcomes

An existing and expanding body of case studies, researched arguments and well thought through intuitions are pointing towards embracing this approach. However, this report also reveals a number of barriers that may exist in the military context and that should be considered when looking at many forms of online learning, but which are specifically appropriate to the use of ILS. These barriers are both cultural and structural. Some of these issues are specific to the military and often work against the acceptance of new technology solutions such as ILS.

These barriers include:

- Command and control, hierarchical culture
- Terminology issues (games vs ILS)
- Fear of failure, within hierarchy and among peers
- Strong culture of didactic, instructor-led learning
- Linear training and promotion pipeline with no side-feeds
- Generation gap in awareness and skills
- Policies that focus on management of teaching, not learners
- Privatisation leads to commissioning of old instructor model
- Subject Matter Experts (SME) block change as they don't want to give up power

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Therefore whilst the synergy between technology and landscape is strong, the likely benefits far-reaching and the desire inherent, the need for collation of evidence and strong leadership to overcome some ingrained cultural barriers is just as evident.

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3. Background

Military training and learning has a long history of utilising immersive 3D technologies and gaming methods to improve learning outcomes. In many ways, the use of video game technologies and methods would appear to be a natural extension of this.

Modeling and simulation

The UK MOD in general, and the Defence Academy in particular, has a strongly-developed understanding of the utility of *modeling* and *simulation* in training[1,2]. Flight simulation, for example, has been a mainstay in military training for decades; this has been supplemented by vehicle, weapon and other forms of equipment simulators. Learning through experience can be long-winded, expensive and dangerous. Simulations, by contrast, can be quick, cheap and safe, as can modeling systems and behaviours. Simulations, although difficult to design, have some significant advantages over other methods of delivering learning that are well understood and accepted in the military, including:

- Elimination of risks and danger
- Reduction of the requirement for costly sites and equipment
- Lower environmental impact
- The ability to do things that are impossible in the real world
- Increase in learner motivation
- Ability to learn through repeated failure
- Acceleration of experience
- Integration of knowledge and skills

[1] Model: 'a logically rigorous representation of a system in which only the properties believed to be relevant to the problem being examined are represented explicitly'.
Simulation: 'an experimental technique used to study the operation of systems conditioned by human decisions or probabilistic influences by imitating within a model the relevant aspects of the behaviour of the system under study'
CU AMOR Group

[2] Constructive Model or Simulation:'Models and simulations that involve simulated people operating simulated systems'. Virtual Simulation: 'a simulation involving real people operating simulated systems'.
MOD Directorate of Analysis, Experimentation and Simulation (DAES) definition used in Simulation Capability Investigation, April 2008

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- Improved transfer of learning to real-world
- Anytime, anywhere access to learning content
- Improved opportunities for assessment through actual performance

It is no accident that simulations are widely used by the military, where decisions and actions can have life-or-death outcomes. Beyond the risk of injury or loss of life, tragic as they are (and as much a factor for trainees, in the case of flying, as for innocents on the ground) there is also the element of cost. The ability to train people in live environments, theatres of war, hospital theatres and actual vehicles, ships and aircraft comes at a high and increasing cost.

Wargaming

In addition to the well trodden track of modeling and simulation, "*wargaming*" goes back thousands of years, and has been used consistently over the centuries as a training tool. The military has long used games and games techniques in learning. War simulations go back to the 19th century, when Helmuth von Moltke the Elder, Chief of the Prussian General Staff, developed a board game called 'Kriegspiel'[3], in which model soldiers were used to rehearse possible battle outcomes.

It is the explosive growth of electronic gaming in the last thirty years that has led to the development of a whole raft of wargames applications in military training. Advances in gaming technologies have enabled the creation of realistic Virtual Environments in which combatants can train skills that are costly, dangerous or even impossible to practice in 'real life'.

Wargames are now a well accepted and evidence based training medium. In his paper "*The long history of training for military training",* Roger Smith[4] points out that the history of wargames has been fraught with definition problems but that it is, nonetheless, a fruitful and productive term. In other words, there has been a long history of simulation, modeling and wargaming in the military, making computer gaming a natural extension of past training activities.

However, the effective use of games and games technologies to support education and training is less well understood, even if the arguments in favour of the motivational and pedagogical advantages of games are strong.

[3] http://en.wikipedia.org/wiki/Kriegspiel_(wargame)
[4] http://www.modelbenders.com/papers/Papers.html

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Games for training and learning

While much work has gone into defining taxonomies in simulations, less has been done on games. The definition of games is just as varied and we are at an inflection point in games in training with the rise of 'Serious Games' as a force in learning (see section 5 for definitions).

A wide range of games options is now available, from simple board games, through casual gaming, dozens of genres of console and PC games, to massive multiplayer online environments. Games culture also has a military skew; military themes have long been the mainstay of gaming culture and remain a popular driver in that market.

Massively successful global titles such as Command and Conquer, Call of Duty, Halo, Battlefield 2, Ghost Recon, Rainbow Six, Counterstrike, Splinter Cell, Metal Gear Solid, Haze, Resistance, Stalker and so on have been the mainstay of the games charts for many years.

Flight simulators such as Microsoft Flight Simulator, IL-2 Sturmovik, X-plane and Lock On: Modern Air Combat provide a wide range of flight games, many based on real aircraft and real instrumentation. Naval games such as Aegis, Age of Sail, Battleship, Dangerous Waters, Destroyer Command, Naval Ops, Harpoon and Fleet Command, North Atlantic, include ship simulation and submarine games. Military history is also well covered, from ancient civilisations in Age of Empires, through medieval battles to both World Wars.

The options are bewildering and, despite the widespread interest in simulations and games in training and the obvious fit between games and the military, decision making is often held back by a lack of knowledge, research and experience of matching appropriate learning tasks with game techniques.

It is claimed that using games brings gains, potentially across the entire MOD structure and in line with Military Ethos, including: encouraging recruitment, motivation, complementing existing teaching strategies and blends of learning, recruit retention, reducing failure rate, teaching higher learning goals, decreasing learning time, lower costs and better preparation for operational performance.

In summary, there is an embedded culture of excellence in modeling, simulation and wargaming within the military that has already begun to benefit from advances in video game technologies and methods. Using video game technologies more widely in learning and training within the military feels like a natural extension of this culture. The purpose of this report is to examine this proposition in detail. The following section describes the specific aims and objectives of the report.

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4. Aims and Objectives of the report:

The overarching aim of the report is to deliver a comprehensive, evidence-based report to the DCMT that provides navigation through the subject of "serious games".

The purpose of the report is to enable the DCMT and wider parts of both the Defence Academy and the MOD at large to start to capture, build and then share an evidence base for games technologies and methodologies within education and training. This report should be used to support and guide any future investment decisions into this sector. In summary, it seeks to demystify the sector and the terminology and to provide a practical and researched way forward.

Five clearly defined aims were identified at proposal stage:

4.1. Aim 1 – Capture and assess existing evidence for games in education and training

This aim encompasses a review of literature and other sources such as conference reports (see sections 3,5,7,8 & 9). Research and Case Studies identified throughout the report include meta-studies from outside and within the military and data from the latest industry conferences.

Source references are presented throughout the report (as opposed to a single summary document at the end), to provide a continuous linking to the research background and literature review and to support results and conclusions as they occur in the report narrative. Clear conclusions and recommendations are drawn from this research and from formal interviews (see 4.4 below).

4.2. Aim 2 – Identify Options in Games

The purpose here is to explain the practical range of options available along with their features, benefits and appropriate use cases. This element of the report demystifies the term "serious games" and provides a focus on the learning benefits of the various technologies that are often grouped under this terminology. Also included is an introduction of the more encompassing and emergent term Immersive Learning Simulation (ILS).

This includes:

1. A practical distinction between play, games, virtual worlds and different simulations

2. A taxonomy of ILS.

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4.3. Aim 3 – Match learning tasks to an ILS taxonomy

To aid decision making, areas of learning (illustrated with military training examples) are matched against the ILS/ serious games taxonomy, and used as a device to determine optimal use of games approaches in real projects.

Games in learning are not new. What is new is the sheer range of possibilities brought about by the explosion of consumer electronics and the internet. However, like any other method of training delivery, we must decide, through selected criteria, how these delivery channels might be used in optimal ways to meet military training goals. These criteria should include learning outcomes, learners, culture, learning resources, electronic infrastructure, scalability and maintainability of the proposed solution.

4.4. Aim 4 – Assess the DCMT learning landscape

This stage of the report aims to provide a clear understanding of the types and breadth of activities of the DCMT[5], through a series of face to face qualitative interviews with key personnel representing aspects of the DCMT.

The interviews, based on the structured questionnaire at Appendix 1 to the report, provided insight into broad demographics, learner traits and skills, educational activities and cultural considerations. The report documents these different educational areas and, by overlaying the games taxonomy, is able to offer an evidence based and clear route to decision making. The evidence gathered through interview is further supplemented by a limited learner survey based on the structured questionnaire at Appendix 2 to the report.

4.5. Aim 5 – Recommend optimal projects

As the report is to provide evidence to deliver action, the final task is to recommend a specified number of projects or use cases. These may be use cases that have been identified during interviews as starting points within the DCMT or they may be wider training and educational areas within the MOD that have risen to the surface during both the literature review and the formal evidence gathering at DCMT.

[5] This report is centred on the DCMT capability at Shrivenham

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5. Approach

The report outlines specific features of games in terms of competitive elements, risk/reward strategies, feedback and goals that make them different from simulations. It also identifies several pedagogic features that are strong in games, yet weak in traditional education and training.

Conversely, the report seeks to balance the evidence, by looking at how it is possible that games *inhibit* learning[6]. The negative side of gaming is a dimension to the 'games in learning' debate that is often ignored by the games evangelists. At one extreme, games are expensive to design and produce, have no educational value and, even worse, distract, disappoint or even destroy learning. To take games seriously in learning and place them in context, any arguments against must be considered objectively, before recommendations for a 'learning through games' strategy can be offered as credible, balanced and considered. Arguments presented by academics, papers and practitioners against the use of games in learning include:

- Learning is a serious business and need not be/is not always 'fun'
- Games can distract from true learning
- Poor games can disappoint
- Games are expensive.

Only after providing insights into the balance between the two world views does this report examine how games can enhance learning. Games are certainly not a universal panacea. There are educational and training situations within which the use of games is appropriate and it is apparent that games could be effective in many more contexts than those in which, typically, they are applied currently. This is especially so in the context of younger age groups and audiences where intrinsic motivation is absent; children and young adults have a taste for games and play that tends to get blunted as they get older. Even with this older audience, however, computer game playing is not unusual; adults retain their competitive streak, are becoming increasingly digitally connected and are equally de-motivated by poor learning experiences.

In summary: whilst *simulation*, *modeling* and even *wargaming* are already tried and tested learning technologies for the MOD, the same cannot be said about what are often termed *serious games*. This report is intended to enable the DCMT business to begin to understand the potential benefits of the technologies and techniques associated with serious games and how these might be applied to greatest effect, in line with the DCMT mission:

[6] Marc Prensky in *Digital Game-Based Learning* (2001) set the benchmark on this debate on games and learning.

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Develop and deliver high quality education, training, research and advice in technology, management and leadership, together with relevant aspects of security and resilience, in order to enhance the delivery of defence capability.

Whilst the term "serious games" might cause some debate and split opinions as to its appeal and usefulness, the DCMT required a report that was able to demystify what is meant by the term and to provide evidence-based insight into its benefits. There was also a clear desire to understand some of the key procurement considerations when commissioning this type of training and education application; it was understood that some of these considerations maybe technological but others may be systemic and cultural.

This report seeks to make sense of the different genres and technologies in existence and to assess their relevance to different learning types and outcomes. The report is intended to ensure that DCMT is left with a sound understanding of the benefits of the approaches and is able to assess how appropriate these approaches are to the specific learning environment of the DCMT. There is also a clear identification of implications and considerations into the wider MOD landscape.

Caspian Learning are leaders in the use of simulations and games within education and training and were commissioned to develop this report. The authors have over 40 years experience between them of using and developing games based learning applications, a number of which have been within a military context both in the UK and US. Caspian have utilised this vast amount of experience and their post graduate cognitive psychology research to help achieve the aims of the report.

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6. What's in a name?

Confusion often arises around the use of terms such as "serious games" and associated terms such as:

- Play
- Games
- Computer games
- Virtual Worlds
- Serious games
- Immersive Learning Simulations

This is normal for any area of innovation and science that is still developing. Many self-professed experts hold firm beliefs and drive definitions in line with these beliefs. What follows is a simple outline of some of the more common definitions for various technologies and a consistent terminology that should be useful and acceptable to the majority of military audiences.

When searching for definitions, it becomes clear that these terms are still evolving and are sometimes confused and overlapping. Rather than attempt precision definitions, it is more useful to look at the general literature placing these terms in their cultural context.

6.1. Play

Johan Huizinga's *Homo Ludens* (1938)[7] was the first in a long line of serious academic analyses of play, taking a broad look at 'man at play' and its role in civilization. According to Huizinga, play is a major cultural phenomenon, deeply embedded in our social behaviour and language. Not only is play part of all cultures, it is, in itself, a civilizing force. Huizinga looks at play in knowledge, war, poetry, philosophy and art, seeing the play-element everywhere in our culture. Indeed play is older than culture. For Huizinga, all play has meaning. Even in the observation of animals at play, there seems to be an element of 'training' or preparation for what we will and do encounter in real life. Play is fun, but preparation for the serious business of life itself; it has a primordial quality, arousing passions (from extreme joy to intense anger), interest, devotion, even addiction. Play cannot be denied, its imagined reality, 'the primeval soil of play', gives rise to myth and ritual, law and order, commerce and profit, craft and art, poetry, wisdom and science. Play is not the basis of all culture, but is an important formative force behind the

[7] Huizinga, J (1938)
Homo Ludens: a study of the play element in culture. Boston, MA: Beacon Press

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emergence and reinforcement of culture. Huizinga defined 'play' as a free activity, standing quite consciously outside 'ordinary' life, absorbing the player intensely and utterly. It proceeds within its own proper boundaries of time and space, according to fixed rules and in an orderly manner.

Caillois, R *Man, Play and Games* (1958)[8] is much more focused on the definition and classification of games. He criticizes Huizinga for bringing in too much unfounded mysticism and ignoring the 'material' side of play, especially in gambling. Gambling, he claims, has almost no place in Huizinga's analysis, whereas for Caillois it is fundamental. Caillois also notes that play has its own places.

Brian Sutton-Smith has written a detailed study of theories of play, *The Ambiguity of Play* (1997)[9], which starts with the statement

"*We all play occasionally, and we all know what playing feels like. But when it comes to making theoretical statements about what play is, we fall into silliness*."

More recently, play has been seen as a source of pleasure and fun, with qualities that make it suitable for motivation, attention and therefore learning (Prensky 2001)[10].

The gamers and game cultural theorists have not had the entire playing field of debate to themselves. There has been a lively counter-play culture in print. Christopher Lasch in *The Culture of Narcissism* (1979)[11], and many others since, have lambasted the culture of 'play' with its obsessive parenting, celebrity culture, consumerism and self-gratification, all aligned with narcissistic tendencies. A more recent addition to the scene has been *The Cult of the Amateur: How today's Internet is killing our culture* by Andrew Keen (2007)[12]. This is more of a case against Web 2.0[13], but is illustrative of a long line of sceptics who see new technology as having more negatives than positives.

[8]Caillois, R (1958) - Man, Play and Games. Urbana and Chicago: University of Illinois Press, 2001 edition
[9] Sutton-Smith, B (1997) - The Ambiguity of Play. Cambridge, MA and London: Harvard University Press
[10] Prensky M (2001). - Digital game-based learning. New York: McGraw-Hill.
[11] Lasch, C (1979) - The Culture of Narcissism. New York, NY and London: WW Norton Company
[12] Keen A (2007) - The Cult of the Amateur: How today's Internet is killing our culture: Reed Business information
[13] Web 2.0 is a term describing the trend in the use of World Wide Web technology and web design that aims to enhance creativity, information sharing, and, most notably, collaboration among users (Wikipedia).

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6.2. Games

Wittgenstein (2001)[14] used the diversity of 'games' (the German word Spiel has a broad meaning) to show that there is no one thing that is common to all games, as games covers a family of like terms. Take ball games; some like football and tennis, have complex rules, others, such as throwing a ball in the air, have no real rules. Some games are competitive, some are not, some games have a goal, and others do not. For Wittgenstein, games, like language, are a complex network of similarities: "*games form a family the members of which have family likenesses*." Language games became a major feature of Wittgenstein's philosophy and now underlie many theories of ethics, aesthetics and other areas of philosophical enquiry.

Dempsey et al. (1996)[15] attempt to tie this down further and define a game as:

"*a set of activities involving one or more players. It has goals, constraints, payoffs and consequences. A game is rule-guided and artificial in some respects. Finally, a game involves some aspect of competition, even if that competition is with oneself*".

6.3. Computer games

Computer games are delivered on a vast array of devices including computers, consoles, mobile devices and TVs. They cover a range of genres, including action, adventure, fighting 'beat 'em up', platform, sports simulations, racing, knowledge games, simulation/modeling/role-playing games, management and strategy games, god games, puzzles, drill-and-practice games, logical games and maths games (Kaptelinin and Cole 2001[16]; Becta 2002[17]). Prensky (2001)[18] describes six key elements of computer games:

1. Rules,
2. Conflict/competition/challenge/opposition,
3. Goals and objectives,

[14] Wittgenstein L – Philosophical investigations: Third edition Blackwell Publishers
[15] Dempsey JV, et al(1996). - Instructional applications of computer games. Paper presented to the
American Educational Research Association, 8–12 April 1996, New York. ERIC Document Reproduction Service No. ED 394 500.
[16] Kaptelinin V, Cole M (2001). - Individual and collective activities in educational computer game playing. In T Koschmann and R Hall (eds) CSCL2 Carrying forward the conversation. Mahwah, NJ: Lawrence Erlbaum Associates, 303–316.
[17] Becta (2002)- Computer Games in Education project. At www.becta.org.uk/research/research.cfm?section=1&id=2826, accessed 14 April 2004.
[18]Prensky M (2001).- Digital game-based learning. New York: McGraw-Hill.

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4. Interaction,
5. Outcomes and feedback,
6. Representation or story,

There is a steady stream of texts defining and describing computer games, along with their impact on society, including:

- Herz, J.C. (1997) *Joystick Nation: How Videogames Ate Our Quarters, Won Our Hearts, and Rewired Our Minds,*
- Little Brown & Company, Poole, Steven (2000) *Trigger Happy: Videogames and the Entertainment Revolution,* Arcade Publishing,
- Kent, Steven L. (2001) *The Ultimate History of Video Games: From Pong to Pokemon - The Story Behind the Craze That Touched Our Lives and Changed the World,* Prima Publishing,
- Wolf, Mark J. P. Editor); Baer, Ralph H. (2002) *The Medium of the Video Game,* University of Texas Press.

There are further problems in separating games from simulations. Games often involve or are conducted within simulated environments and themselves simulate environments, events, acts, processes, and procedures. However, games tend to have extra facets in terms of the elements stated in Prensky's list. These additional assets can be used by learning designers in achieving performance outcomes. For example, adding elements of reward and recognition can drive learner motivation. It is when these additional elements start to be introduced that we move beyond either a "computer game" or a "pure simulation". This is where the terms "serious games" or "immersive learning simulation" start to play a role.

6.4. Virtual worlds

Virtual Worlds are places where one can interact with other real human beings but in a virtual environment. The most common format of interaction is through 3D avatars in 3D environments. However, it is fair to say that there are virtual worlds that are primarily textual or even audio. These worlds are usually missing the majority of Prensky's descriptions of games, with the exception of "*interaction*". This means they must be considered as a separate technology and providing quite different use cases and benefits to games based applications (see section 9 for further examples and use cases).

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Image 1: Screenshot of Habbo Hotel an online world aimed at teenagers. Habbo features 3D chat rooms in the form of virtual hotel rooms. As of June 2008, over 100 million avatars have been created worldwide and there are over 8 million unique visitors to the Habbo websites around the world every month[19].

[19] http://www.sulake.com/press/releases/2008-06-25-100_million_Habbos.html

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Image 2: A screenshot from Second Life an online multiplayer virtual world. As at July 15th 2008 over 14 million user accounts were registered[20].

There is also a distinction between virtual worlds, such as Second Life, and virtual world games, such as World of War craft. Games in virtual worlds tend to be MMOGs (Massive Multiplayer Online Games). These do have both game elements, such as ultimate goals and narrative, but also occur in virtual 3D worlds. It has to be noted that ultimate goals tend to be linked to alliance or clan building for the purpose of conflict. Whilst it can be and has been argued that informal learning can occur in these virtual world games, it is extremely hard to ever pinpoint, measure or assess this.

6.5. Serious games

The learning and games world came together in 2002 when the Serious Games Initiative[21] was founded at the Woodrow Wilson Center for International Scholars in Washington DC. There are now many serious games conferences, web sites and organisations. However, despite serious games being a commonly used marketing term within the learning sector, it has received much criticism.

In an interesting precursor to the serious games debate, Huizinga (1938) says,

> "*To our way of thinking play is the direct opposite of seriousness.*"

He then shows how games transcend the simple distinction of serious/non-serious. Play is neither 'folly' nor just 'fun'. It can be serious and non-serious. Play is no laughing matter. It may be fun but it is an issue of serious cultural purpose and concern. He wrote of play as a transcending, aesthetic phenomenon. It lifts you and imparts meaning as a sort of enhanced mimicry of life, within a code of rules, expectations, time and space it binds us socially into a ritual of observation, discussion and participation. Within these defined second worlds we suspend reason and normal rules of life to take part in an intense, condensed experience. One plays to win, but honor in defeat is also prized.

However, the term has become one of the most "sticky" of descriptions and for many is seen to mean "the use of computer games technology for purposes other than pure entertainment". Whilst the primary use case within serious games is learning and development, there are other use cases for serious games, such as health and wellbeing, marketing, advertising and internal communication programmes. For these reasons, along with the clash in terminology outlined by Huizinga, we must seek a broad, encompassing but acceptable terminology for the use of games technologies and methodologies

[20] http://secondlife.com/whatis/economy_stats.php Accessed 15th July 2008
[21] www.seriousgames.com

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within military education and training. In achieving this we can focus on the benefits of the technology to those involved in learning and development, rather than endless and unproductive definition discussions.

6.6. Immersive Learning Simulation

One term that is increasing in popularity and seems to fit the bill is Immersive Learning Simulations (ILS). ILS was proposed as a term in a major report from the eLearning Guild in the US in March 2008[22]. The eLearning Guild report opens by describing ILS as the "*corporate friendly synonym for serious games*". The authors go on to share evidence of cultural resistance to the term serious games and suggest that the term ILS might be used as a "Trojan Horse" to gain acceptance and overcome semantic barriers.

Whilst this does partly deal with some of the negative connotations of the word "game", and is in our experience more acceptable, it does not bring out the fact that serious games cover many other areas beyond and outside learning and development.

If we ignore the mistaken interchangeability between the terms serious games and ILS used in the eLearning Guild report, we do get a productive and sensible definition from the Guild of what an ILS is:

"An Immersive Learning Simulation is an optimized blend of simulation, game element and pedagogy that leads to the student being motivated by, and immersed into, the purpose and goals of a learning interaction"

The report goes on to discuss where simulations, 3D virtual worlds and other technological approaches fit. The authors correctly point out that whilst these terms instantly conjure up visions of highly immersive 3D worlds and experiences, genres like quizzes, mini games and 2D puzzles are also relevant to the ILS space. One of the authors, Clark Quinn, shares his views on the differences between simulations and serious games; however, we feel he is wrong in his generalized conclusion that the latter are more useful than the former. Another author, Clark Aldrich, takes a slightly more useful and balanced approach and proposes a Venn diagram model for how pedagogy, games and simulations fit together.

Below is a similar conceptual Venn diagram developed by Caspian Learning. Unlike Aldrich's model, in which he identifies pedagogy as a separate part of the equation, we identify the key pedagogical elements within each of the technologies often classified as ILS; this can provide military decision makers with a framework for selecting an appropriate ILS (see section 9).

[22] www.eLearningGuild.com - eLearning Guild (2008) Immersive Learning Simulations - the demand for, and demands of, simulations, scenarios, and serious games.

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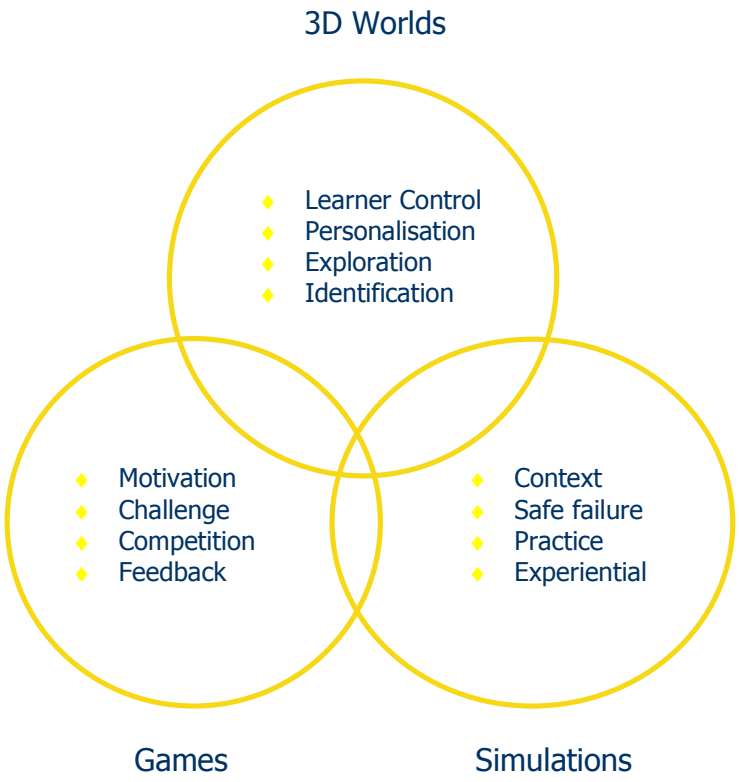

Fig 1: Caspian Learning Conceptual Model of Pedagogic Benefits from Immersive Learning Simulations

For the remainder of this report, and for the benefit of focusing on the learning benefits of the technologies and not the definitions of the technologies themselves, we have opted to use ILS as the most appropriate global term.

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7. The Defence Academy Landscape

The Defence Academy provides education to Defence personnel at many different stages of their career development. Education can start at sixth-form level and continue right through to preparation for the most senior command positions.

In the words of the Defence Academy website[23]:

The Defence Academy is the UK Defence's Higher Educational Institution - and a key component of operational capability.

The Academy comprises the Royal College of Defence Studies, the Joint Services Command and Staff College, the Defence College of Management and Technology, the Advanced Research and Assessment Group and the Armed Forces Chaplaincy Centre. The Academy has three strategic partners – King's College London, Serco Defence and Aerospace, and Cranfield University – who provide our academic and facilities support and who are vital to our success.

The Defence Academy is the institution responsible for post-graduate education and the majority of command, staff, leadership, defence management, acquisition and technology training for members of the UK Armed Forces and MOD Civil Servants. It is also responsible for the provision of non-technical research and assessment in support of the Department, and for establishing and maintaining itself as the MOD's primary link with UK universities and with international military educational institutions. By operating under unified direction and with a single budget, it capitalises on the combined strengths of its Colleges, enables the flexible and cost-effective use of staff, facilities and money and maximises influence nationally and internationally.

The Defence Academy Mission is to deliver:

"…high quality education and training, research and advice, in order to sustain and enhance operational capability and advance the defence and security interests of the UK".

The two largest components of the Defence Academy in terms of student numbers and throughput, are the Joint Services Command and Staff College (JSCSC) and the Defence College of Management & Technology (DCMT). Across these two functions there were approximately 325 MOD staff[24] and well over double that in support staff numbers including those from Cranfield University. The JSCSC has an approximate student throughput of over 1900

[23] http://www.da.mod.uk/our-work
[24] Presentation to study team - 29 Mar 08 at DCMT – figures represent Sep 07

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each year and is based at Shrivenham. The DCMT, which is the principal focus of this report, is also headquartered at Shrivenham but is spread over many more sites, and had up to 5650 military personnel through its various courses in 2005-6.

The DCMT landscape is broad and deals with training of Defence personnel in subjects as diverse as technology, leadership, acquisition and business acumen. It provides sixth form college courses, undergraduate technical courses and post-graduate education (see figure 2). Over 600 courses are available[25], ranging from short symposia through to full scale post graduate courses spanning several years.

The DCMT mission is:

"To develop and deliver high quality education, training research and advice in technology, management and leadership, together with relevant aspects of security and resilience, in order to enhance the delivery of defence capability"

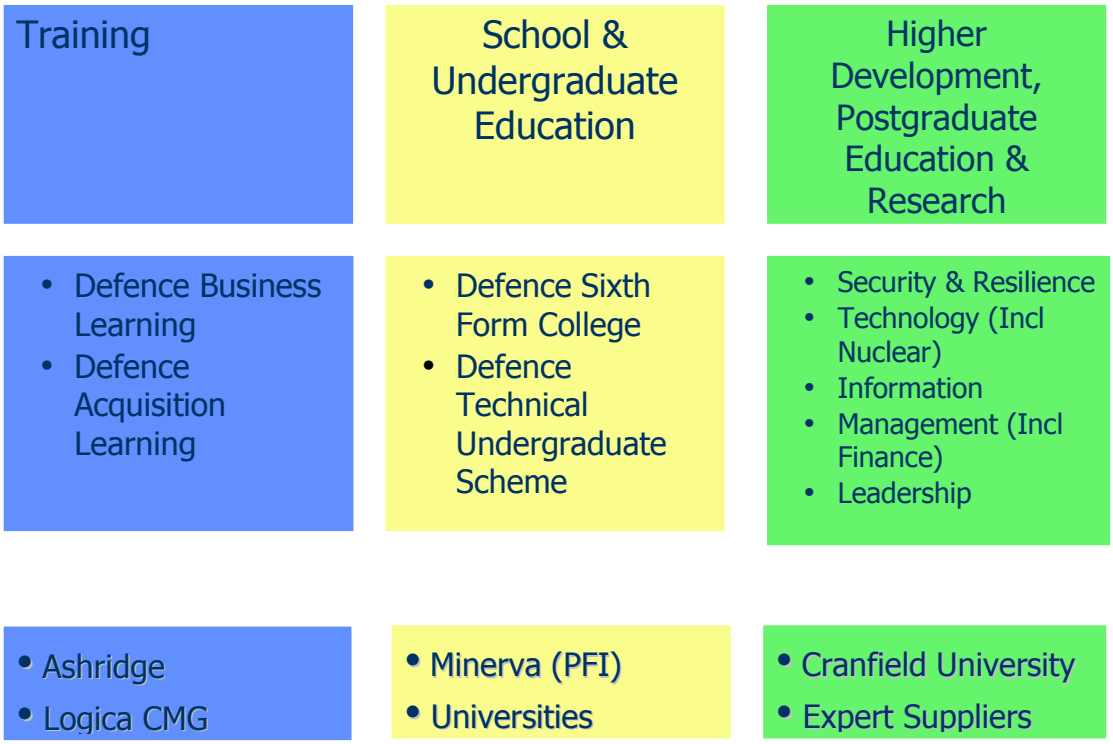

Figure 2 – DCMT Landscape at a glance:

This report focuses on the DCMT capability at the Shrivenham campus. However, it is fair to say many of the observations, conclusions and recommendations hold good for other sites and general military training and education. The report focuses principally on "military learners", although it

[25] More than 650 courses in 2008

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was noted that many courses had civilian students from industry and public sector bodies.

In carrying out the report we interviewed a range of military and support staff, and also surveyed a number of learners. Some key observations emerged:

- The ages of the military people on courses surveyed were grouped at the late twenties to mid-thirties.
- The gender split was heavily skewed towards the males. Up to 95% of those interviewed and surveyed were male
- The majority of learners surveyed were either junior officer level, with the maximum rank being Major (or equivalent)
- The majority of students surveyed were attending courses that lasted a minimum of two weeks and a maximum of two years
- The bulk of the teaching was done by Academic staff (most commonly from Cranfield University), however Defence staff were often present
- Much of the teaching was classroom based and the majority of the format was lecture driven

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8. Summary of Evidence behind Immersive Learning Simulations

While the literature associated with simulations and performance is well established, the empirical research of game-based / ILS learning is still in its infancy. Many of the claims made on behalf of ILS are theoretical or philosophical. They are grounded in the hypothesis that the characteristics and appeal of games can be transferred into learning and performance benefits.

As a new methodology is introduced, there is excitement and experimentation until research catches up. Much progress is based upon use cases, as eager practitioners apply new methods. Researchers then take time to design and implement studies, some of which apply to out-of-date methods as the field moves on. To some degree, this is the case with ILS development. In reviewing the evidence for the use of ILS, we will first examine the hypothesis held by many researchers and practitioners that games based technologies / methods can be beneficially applied to learning. We will then consider the evidence that exists in the research literature to support this hypothesis. Finally, we will consider a number of case studies of recently deployed and evaluated ILS.

8.1. Why ILS?

In the past decade the power of 3D games software engines and the processing power of standard hardware have markedly increased. Meanwhile, the cost and resources required for these technologies has decreased. This happy coincidence has driven rapid growth in the video games industry until it has grown to be bigger than the film industry, creating ever more interactive and visually stunning blockbusters for millions of users.

As the technology has become more powerful, cheaper and easier to use, practitioners and researchers within the learning and training domains have become more excited. The military community, in particular, is well versed in the human performance benefits to be derived from visual simulation technologies. However, the costs are usually high. The potential for ILS is to transfer these benefits into the wider training arena.

A number of the characteristics of ILS / game based learning applications offer the potential to improve learning performance. These include the following:

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1. Motivation
    - Among practitioners motivation along with 'rich skills practice' are the two most popular reasons for enthusiasm for ILS.
    - There is a motivational crisis in education and training, with massive disengagement from learning in schools and the workplace (Barber 1997)[26]. Brain imaging studies provide direct evidence of the power of video games to motivate players. In a study by Koepp et al 1998[27], subjects moved a 'tank' through a 'battlefield' on a screen using a mouse with the right hand. Subjects had to collect 'flags' with the tank while destroying 'enemy tanks'. The research showed that playing the game was associated with significant release of dopamine in the reward centres of the brain. Interestingly, the level of this increase was directly related to the players' performance. The higher the players scored the more activation in the reward centre.
    - Games clearly motivate and games designers know a lot about motivation and sustaining interest in games - they have to, or the games won't sell. There is potential, therefore in taking the motivational components in game design and using them in learning.
    - The techniques typically involve good marketing, level based design, keeping players interested through achievable goals, good feedback and high quality production values. Motivation comes through good gameplay design and high levels of interaction.

2. Learner-centricity
    - Arguably, games are the most interactive of all online experiences. They are massively interactive and rarely take control away from the learner. They are an active rather than a passive experience.
    - This 'active learning' (Bonwell & Eison 1991[28]) experience contrasts with typical eLearning and most classroom experiences, where the learner is a passive recipient of information and instruction.
    - This approach can increase learner control and the ability to explore materials with guidance; which in certain circumstances is shown to improve learning performance (Makany, Redhead & Dror 2007 [29]).

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[26] Sir Michael Barber. The Learning Game: Arguments for an Education Revolution (Indigo, 1997).
[27] M. J. Koepp, R. N. Gunn, A. D. Lawrence, V. J. Cunningham, A. Dagher, T. Jones, D. J. Brooks, C. J. Bench&P.M. Grasby. 1998. Evidence for striatal dopamine release during a video game. Letters to Nature.
[28] Bonwell, C. & Eison, J. (1991). Active Learning: Creating Excitement in the Classroom AEHE-ERIC Higher Education Report No.1. Washington, D.C.: Jossey-Bass. ISBN 1-87838-00-87.
[29] Makany, T., Redhead E., & Dror, I. E. (2007). Spatial exploration patterns determine navigation efficiency: Trade-off between memory demands and distance travelled. Quarterly Journal of Experimental Psychology, 60, 1594-1602.

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3. Personalisation
    - The use of avatars representing the learner is a strong form of personalisation, as is the customisation and manipulation of 'you as the avatar'. Beyond this, games often regard 'you the player' as reaching certain states or goals. This sense of personal progress and achievement is handled well in games. Games often allow users to earn rewards and tailor their avatar, environment or experience. This starts to deliver a "user designed" experience as well as achieving yet further engagement.
    - The location of the player within the game as an avatar, interacting with intelligent characters, can engender a strong feeling of 'presence' or of 'being there' within the player (Heeter, 1992)[30].

4. Incremental learning / Optimum challenge
    - The playability of a game centres on its ability to exploit the needs of players to push beyond their current ability to the next achievable state of expertise. Good games are always pulling you onwards to the next task, upwards to the next level. Players like to live on the edge of success and failure.
    - Studies of expert performance refer to the concept of 'optimum challenge' or 'zone of optimal development' (Ross 2006) [31] – where learners are continually set challenges that stretch their competence, but not too far, as this adversely affects skill acquisition. Good game design is built on this principle, so that players continually invest time and energy into progressing.

5. Contextualisation
    - Researchers in the fields of situated and authentic learning align student learning experiences with the world for which they are being prepared. This type of learning uses real-world problems, projects and, where possible, realistic physical contexts to enhance learner motivation and transfer (Herrington & Oliver, 2000) [32]. The replication of critical aspects of the environment leads to high functional fidelity (Jentsch & Bowers, 1998[33]).

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[30] Heeter, C. (1992). Being there: The subjective experience of presence. Presence: Teleoperators and Virtual Environments, 1(2), 262-271.
[31] Philip E. Ross. Scientific American. July 24, 2006. The Expert Mind : Studies of the mental processes of chess grandmasters have revealed clues to how people become experts in other fields as well
[32] An instructional design framework for authentic learning environments. J Herrington, R Oliver (2000) Educational Technology Research and Development
[33] Jentsch, F. & Bowers, C. A. (1998). Evidence for the validity of PC-based simulations in studying aircrew
coordination. International Journal of Aviation Psychology, 8, 243-260.

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- ILS and video games can generate a high degree of graphical and psychological fidelity in fully interactive 3D environments. The potential for practitioners is to develop realistic environments in which learners can engage in repeatable practice which should enhance transfer.

6. Rich media mix
   - The use of 3D avatars, 3D environments, animation, objects and audio, give games a real edge over other flat media. It is this that makes their contextual worlds appear relevant. The whole experience is one in which the player/learner can move, explore and learn without the dullness of print on a screen.
   - Games get the users to do something with the media other than just "watch" it. Multimedia is useful if we are trying to appeal to different learning styles, however it is what you get the learners to do with this media that makes the real difference. Games deliver challenges or tasks to the user and therefore "just watching" is not an option.

7. Safe failure
   - Ultimately, the user must be presented with the opportunity to keep winning in incremental steps and get positive feedback. But they must also be presented with the opportunity to fail. Catastrophic failure is a strong feature of games design, i.e. 'dying' or getting thrown out of a level back to the beginning. Instructional designers are fine on simple 'answers to questions' feedback, but often ignore the more important 'critical failure and success feedback' (see detailed discussion of 'Safe Failure' in section 10).

8. Immediate feedback
   - Instructional scaffolding methods are incorporated into good learning design to support students as they form concepts and acquire skills (Hartman 2002)[34]. Feedback mechanisms are also required to support mentoring functions.
   - Video games utilise high degrees of performance feedback. Players are always aware of how well they are doing on a battery of measures. They will also see the consequences of their actions.
   - Game players rarely need written tutorials. Good games and ILS naturally 'scaffold' the learner through training scenarios, feedback, goals and progression to enable the player to acquire the skills relevant to the game.

[34] Hartman, H. (2002). Scaffolding & Cooperative Learning. Human Learning and Instruction (pp. 23-69). New York: City College of City University of New York.

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9. Extensive practice and reinforcement
    - Games are played and replayed, sometimes for weeks and months. Their motivational pull makes it likely that the player will return for more. This is rarely the case in traditional training and education. Learning how to play a game is therefore a lesson in that most basic of principles in learning theory – reinforcement. By failing and getting put back to the start, games players not only learn quickly how to overcome failure, they get plenty of chances to reinforce their learning. This is often lacking in education and training, where the learning experience is too frequently a simple short-term memory experience without the reinforced push into long-term memory. Using a range of different challenges and tasks on the same subject matter within games enables us to avoid a major pitfall of standard e-learning, that of assuming transfer of knowledge has been achieved.
    - Standard e-learning often only gets the learner to carry out one task on a piece of knowledge, i.e. a test involving multiple choice questions. However, by reinforcing this learning with other similar level cognitive challenges, it is more likely that learners will be able to retain this knowledge and subsequently transfer this knowledge to different scenarios.

10. Collaboration and group/teamwork
    - It often comes as a surprise to those who see gamers as loners to discover that online communities of gamers are among the largest and most vibrant on the web. Game sites invariably have discussion groups, and gamers engage in rich dialogue about the games, use voice over internet (VOIP) to play with people across the globe, and share related strategies and 'cheats'.
    - From a learning point of view, this is a clear demonstration that communities work when they involve similar people with similar interests and goals. Completion of games, or the game, is the goal - and gamers genuinely seek to learn and teach each other to reach these goals. Communities need common goals, this is what stimulates mutual support.
    - Communities of practice in education and training are often sparse and can lack vibrancy, even when moderated. Game communities abhor the idea of e-tutors and moderators, yet have scale and are full of life and activity.

As new technologies and methods are adopted there is often a gap between progress on the ground, driven by eager practitioners and early adopters, and empirical research, using relatively slow traditional models. This is the case with ILS, Empirical studies are now beginning to filter into this domain. We will consider these studies and note the requirements for further progressive

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work. We will also consider the application of high profile use case studies to view progress in development and application.

8.2. Research Data

Recent literature reviews provide a mixed bag of claims as to the role of ILS and games based approaches within training and education.

Reviews focusing on commercial off the shelf games in an educational classroom setting (Kirriemuir & McFarlane, 2004[35]; Mitchell & Savill-Smith, 2004[36]) report that there are no firm conclusions about learning, although most students reported an interest in using games to learn, rather than being limited to using conventional classrooms.

We will now consider the findings of three extensive literature reviews that have principally considered learning effects within adult training environments.

A review by Alexander et al (2006)[37] identifies four constructs within ILS as being key for successful skills acquisition: fidelity, presence, immersion, and operator buy-in. In describing fidelity, Alexander distinguishes between physical, psychological and functional fidelity. High-end military simulators, such as flight simulators, can incorporate a high degree of physical fidelity, albeit at very high investment cost and management resource. Functional fidelity is defined as the degree to which the simulation acts like the operational equipment in reacting to the tasks executed by the trainee (Allen et al. 1986)[38]. Alexander's review identifies functional fidelity as a major strength of the ILS approach. For example, in a study of multiplayer Virtual Worlds (Weil et al., 2005a), evidence suggested that by incorporating appropriate military command and control hierarchies, trainees were better able to recognize the correspondences between gaming and operational reality.

Alexander suggests:

"While expensive simulators can recreate visual cues and precise instrument operation (i.e. physical fidelity), comparatively inexpensive gaming

[35] Kirriemuir, J., & McFarlane, A. (2004). Literature Review in Games and Learning (No. 8). Bristol, Canada: Nesta Futurelab.
[36] Mitchell, A., & Savill-Smith, C. (2004). The use of computer and video games for learning. London: Learning and Skills Development Agency.
[37] From Gaming to Training: A Review of Studies on Fidelity, Immersion, Presence, and Buy-in and Their Effects on Transfer in PC-Based Simulations and Games Amy L. Alexander1, Tad Brunyé, Jason Sidman, and Shawn A. Weil Aptima, Inc. Woburn, MA
[38] Allen, J. A., Hays, R. T., & Buffordi, L. C. (1986). Maintenance training, simulator fidelity, and individual differences in transfer of training. Human Factors, 28, 497-509.

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technologies are ideal for recreating interactivity (i.e., functional fidelity) across a range of users in a variety of locations (Lewis & Jacobson, 2002)[39]"

In conclusion, Alexander notes that ILS have the clear potential for enhancing learning transfer because of their ability to generate physical and functional fidelity and their impact on operator buy in. However, the review states that research into transfer was thin on the ground. In Alexander's view, for successful transfer to be achieved functional fidelity must be incorporated into the design. This point resonates with the views of Hays (2005)[40] who recommends strongly that the interactive activities (functional fidelity) in the ILS design should be clearly linked to the target learning goals. Hays's report documents a review of 48 empirical research articles on the effectiveness of instructional games. It also includes summaries of 26 other review articles and 31 theoretical articles on instructional gaming. Hays describes the research literature thus:

"empirical research on the instructional effectiveness of games is fragmented, filled with ill defined terms, and plagued with methodological flaws"

Hays reported that some games can provide effective learning for a variety of learners for several different tasks (e.g. maths, attitudes, electronics and economics). However, he cautions against applying generalizations from research on the effectiveness of one game in one learning area for one group of learners to all games in all learning areas for all learners. Hays identified a set of clear learning-based criteria that should be incorporated into ILS and the decisions of how and where to use them; a point that we shall return to below.

Another recent review (Mishra and Foster, 2007)[41] reports similar findings. These authors state that researchers who make claims both for and against the effectiveness of games based approaches are agreed that learning can and often does happen; but how significant is the effect, how it happens and where it happens are the issues. Mishra and Foster make very salient points that share sentiment with the other reviews covered above:

- That for instructional games to be effective they must pay much more attention to the demands of the subject matter under study

[39] Lewis, M. & Jacobson, J. (2002). Game engines in scientific research. Communications of the ACM, 45(1), 27-31.
[40] Robert T. Hays (2005). THE EFFECTIVENESS OF INSTRUCTIONAL GAMES: A LITERATURE REVIEW AND DISCUSSION. Naval Air Warfare Center Training Systems Division
[41] Mishra, P. & Foster, A. (2007). The Claims of Games: A Comprehensive Review and Directions for Future Research. In C. Crawford et al. (Eds.), Proceedings of Society for Information Technology and Teacher Education International Conference 2007 (pp. 2227-2232). Chesapeake, VA: AACE.

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- They argue strongly for a greater emphasis on the development of technological pedagogical content knowledge (TPCK) in the design of learning games.

In examining the research literature ourselves these points stand out clearly and we think it is indicative of the status of the ILS research field as it stands currently. IN our view this highlights the issue of timeline drag between the publication of research studies and the progress made by practitioners and early adopters as the field moves on at pace. It is worth noting some points on the nature of the ILS examined in these reviews:

- Technology – most reviews consider game based approaches from the 1980s and 1990s and a few look at those from earlier in the current decade. Computer processing power, internet capability, storage and graphical capabilities have advanced hugely since 2000. Older examples do not generate the high levels of physical, functional and psychological fidelity that can be captured by ILS built since 2005.
- Incidental to learning – many of the games pre-2002 were built for 'edutainment', that is, to provide motivation to the students while they completed a learning task that was unrelated to gameplay. For example, get a few maths questions correct and be rewarded by playing Tetris.
- Non-learning, commercial off-the shelf (COTS) games – studies that have considered ILS with higher graphical, physical and functional fidelity have largely examined the use of commercial entertainment games that are then used by instructors in the classroom (e.g. Teaching with Games 2006)[42]. These applications were not designed for learning; they were designed specifically for entertainment.

The recommendations inherent in the research literature reviews have been adopted by ILS developers and practitioners in more recent deployments:

- Close integration of learning objectives into the design and interactive activities with the ILS
- Design must embed the subject matter into the mechanics of the ILS – it should be a focus and not a tangential consideration
- ILS should be embedded in instructional programs that include debriefing and feedback so that learners understand what happened in the game and how these events support the instructional objectives

[42] FutureLab report. Teaching with Games.
http://www.futurelab.org.uk/projects/teaching_with_games Accessed 10th July 2008.

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- Functional, physical and psychological fidelity should be appropriate to the subject matter learning

Since 2005 hundreds of organisations around the world have developed and utilised ILS in their training. The majority of these deployments do not focus upon 'edutainment' nor do they use commercial off the shelf games. These deployments are often custom built, or product based for a specific content area. In each case, learning objectives and subject matter would be at the centre of any design. To date there has not been a large scale review of the empirical effectiveness on learning outcomes for these types of ILS deployment.

The most comprehensive recent survey of these ILS has been conducted by the e-Learning Guild in 2008[43]. The evidence from this survey focuses upon the assessments, opinions and actions of individuals who commission ILS and are responsible for learning outcomes in their organisations. This evidence does not comprise empirically controlled conditions and repeatable outcomes. Its relevance is in its timeliness, as it reflects the state of ILS development and deployment right now and predicts activity into the immediate future of 12 to 18 months. Its validity is derived from the responder population. These individuals utilise a wide array of methods and approaches to deliver learning in their organisations. Their decisions of how, when, why and how often to deploy ILS and their views going forward will inform the whole market. Some of the key findings from this research of over 1,000 e-Learning Guild members are:

- ILS development and use has moved beyond the 'fad' or 'novelty' stage, with almost 40% developing and deploying ILS.
- Over 93% of Guild members who have created an ILS report that their efforts produce results that are either somewhat or much better than other forms of rich-skill practice.
- 76% indicate they have received either a modest or a very good return on investment.
- 70% of responders intended to develop more ILS for their training.

This survey is the clearest view of ILS development and application activity today. As a barometer of validity and acceptance of ILS it is a very positive endorsement. The survey's authors suggest:

"We do see ILS getting nearer the tipping point of widespread acceptance as more and more very large, mainstream, and in fact, conservative organisations are starting to embrace game-based learning"

[43] www.eLearningGuild.com - eLearning Guild (2008) Immersive Learning Simulations - the demand for, and demands of, simulations, scenarios, and serious games.

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The research still has many questions to investigate. Empirical studies will be conducted that focus upon more recent ILS technologies and methods. These will tease out the levels of effectiveness, conditions that impact effectiveness and the types of ILS suitable for different learning issues and student abilities. This process has started already and a few examples of empirical studies have begun to appear.

Case Studies

8.3. Immersive game beats Classroom in maths

The University of Central Florida tested a hypothesis (Kebritchi et al 2008)[44]; that interactive maths games are more effective than classroom instruction.

They took 193 algebra students, control groups and then did evaluation through pre- and post-study assessments, surveys, classroom observations and interviews. On average, over 18 weeks, students in the experimental group made gains of 8.07 points (out of 25), while students in the control group made gains of 3.74 points.

The study used an immersive video game world that engages students in the instruction and learning of mathematics. Pre-algebra and algebra objectives are covered through a series of missions that bring math into a world that today's students understand. Students become so captivated in solving problems that they forget they're learning but they don't forget what they've learned. The study has many detailed findings, but the main conclusion was a significant positive effect on student mathematics achievement in a public high school setting:

Gamers do better at maths
Students who played the maths video games scored significantly higher on the district-wide math benchmark exam, and on the maths performance test generated by the publisher, than students who did not play the games. While students in both the experimental and control groups demonstrated significant gains from pre-test to post-test on the district benchmark exams, students who played the games demonstrated greater gain scores from pre-test to post-test (mean increase of 8.07) than students who did not play the games (mean increase of 3.74).

Higher achievement in standard tests
Higher achievement scores and greater gain scores on district benchmark tests by students who played the games, compared to those who did not play

[44] Mansureh Kebritchi, Atsusi Hirumi, and Haiyan Bai. The Effects of Modern Math Computer Games on Learners' Math Achievement and Math Course Motivation in a Public High School Setting.

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the game are particularly significant because there is a high correlation between the district maths benchmark tests and the state-wide maths tests (as reported by the district).

Teachers and students report improved maths
Teacher and student interviews support the quantitative findings. The majority of the interviewed teachers (4 of 5) and all of the students (15 of 15) reported that the participants' mathematics understandings and skills improved as a result of playing the mathematics games.

Positive teacher feedback
According to the teachers, the games were effective teaching and learning tools because they (a) were experiential in nature, (b) offered an alternative way of teaching and learning, (c) gave the students reasons to learn mathematics to solve the game problems and progress in the games, (d) addressed students' mathematics phobias and (e) increased time on task. As one of the teachers stated; "It [the games] makes them want to learn [maths]."

Positive student feedback
According to the students, the games were effective because they (a) combined learning and fun, (b) offered mathematics in adventurous and exploratory context and (c) challenged students to learn mathematics.

Consistent with previous studies.
The positive results are consistent with prior empirical research on the effects of math games, including those reported by Ke and Grabowski (2007)[45], Klawe (1998)[46], Moreno (2002)[47], Rosas et al. (2003)[48] and Sedighian and

[45] Kebritchi, M. (2007). The effects of modern math video games on student math achievement and math course motivation. Unpublished dissertation. College of Education, Department of Educational Technology, Research and Leadership. University of Central Florida.
[46] Klawe, M. M. (1998). When Does The Use Of Computer Games And Other Interactive Mult-imedia
Software Help Students Learn Mathematics? Unpublished manuscript. Retrieved July 17, 2007 from http://www.cs.ubc.ca/nest/egems/reports/NCTM.doc
[47] Moreno, R. (2002). Who learns best with multiple representations? Cognitive theory implications for individual differences in multimedia learning. Paper presented atWorld Conference on
Educational Multimedia, Hypermedia, & Telecommunications. Denver, CO.
[48] Rosas, R., Nussbaum, M., Cumsille, P., Marianov, V., Correa, M., Flores, P., et al. (2003). Beyond
nintendo: design and assessment of educational video games for first and second grade students. Computers & Education, 40(1), 71-24.

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Sedighian (1996)[49], suggesting that computer maths video games may improve mathematics achievement.

Consistent with meta-analysis

The results also support findings from two meta-analysis, including: (a) Vogel et al. (2006)[50] who concluded that interactive simulations and games were more effective than traditional classroom instruction on learners' cognitive gains based on a review of 32 empirical studies, and (b) Dempsey et al. (1994)[51] who concluded that students who played math video games and attended the traditional classroom instruction achieved higher mathematics score than students who only attended traditional classrooms based on 94 empirical studies.

8.4. Video games and business management study

A study by Blunt (2006)[52] provides evidence that the use of a management video game can significantly improve the test scores of students in a business management course compared to students using only classroom methods.

In the University of Arlington, Virginia, approximately half of the classes studying the Principles of Management course utilised a video game as part of the classroom experience. The study semester lasted for 15 weeks, during which students received classroom based learning and were provided with an associated textbook to examine management theories and the changing requirements of management in a dynamic, global marketplace. As part of the course, students learn business problem solving skills that are assessed by a formal test at the end of the course.

For the students in the 'video game' condition, half of their lessons utilised a management video game called Virtual U as a study aid. The students used the video game during the lessons. The course instructor presented themes from the course and then utilised the video game to explore these themes with the students. The students played the game and discussed their progress

[49] Sedighian, K. & Sedighian, A. S. (1996). Can Educational Computer Games Help Educators Learn About the Psychology of Learning Mathematics in Children? 18th Annual Meeting of the International
Group for the Psychology of Mathematics Education, Florida, USA
[50] Vogel, J. J., Vogel, D. S., Cannon-Bowers, J., Bowers, C.A., Muse, K., & Wright, M. (2006). Computer gaming and interactive simulations for learning: A meta-analysis. Journal of Educational
Computing Research, 34(3), 229-243.
[51] Dempsey, J.V., Rasmussen, K., Lucassen, B. (1994). Instructional gaming: implications for instructional technology. Paper presented at the Annual Meeting of the AECT, 16–20 February, Nashville, TN.
[52] Richard D. Blunt doctoral work Walden University (2006)

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and findings with the class based upon the study themes. In total this comprised between 4 and 8 hours of gameplay during the semester.

Virtual U engages the player in the tactical and strategic issues of running a college campus. The player must address major areas such as operating budgets, hiring faculty, and endowment management as well as lesser areas such as campus parking and availability of athletic scholarships. The game is an example of an Episodic Sim (see section 9) where the player makes changes to the gameplay that are then submitted and the consequences are computed by the game.

Image 3: A screenshot from Virtual U.

Students in classes using the game scored significantly higher mean test scores than classes that did not.

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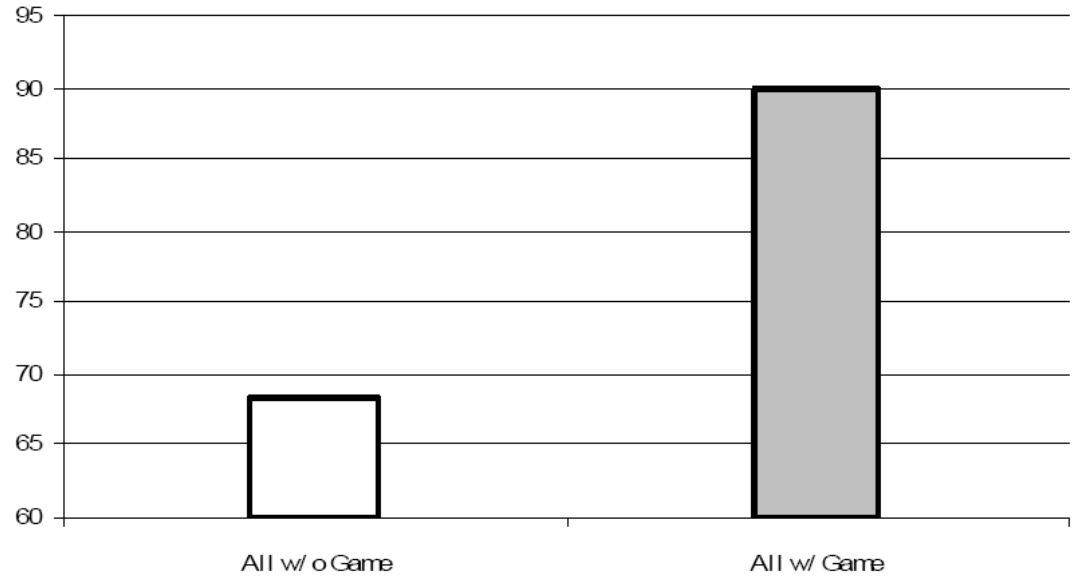

Figure 3: Chart shows average test scores for student groups in conditions: studied using ILS; studied without ILS. Taken from Blunt (2006). The difference was statistically significant.

8.5. Montreal Public Transit System

The e-Learning Guild survey references a valuable case study undertaken by the Public Transit System in Montreal (STM) Canada. Typically, STM job positions require months, and even years, of intensive, critical training to ensure the protection of passengers, employees, and property. In the last few years, the STM has switched its traditional instructor-led training process to a simulation-based training platform powered by uMind's Intelligent Tutoring System.

Using this system STM have developed an ILS to train workers on their Safety and Security programme. The training adopts a blended approach: theory and core knowledge is acquired via traditional eLearning and tutor guidance; the students must then apply this knowledge in the context of real world safety and security challenges. One of scenarios will place the learner within a 3D subway tunnel where they can control many aspects of the avatars interactions. In this environment they will experience and practice fire, accident and electrocution scenarios.

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Image 4: A screenshot from STM's Safety and Security training programme developed by Umind.

STM wanted to embed best practice into scenarios that could be adapted and changed as new corporate learning was generated. They also wanted to ensure that each trainee was exposed to consistent and up to date best practice challenges. Usually, this training involves classroom and then actual training within a real tunnel. However, access to subway tunnels is costly, very slow as only two trainees can attend simultaneously and difficult to arrange as the tunnels are in use. Clearly, it is also very difficult to simulate fires and accidents in subway tunnels regularly. The ILS provided immediate benefits in: cost, speed of roll out, scalability, access to best practice, and the ability to embed new learning goals in a realistic scenario.

An Artificial Intelligence (AI)-enhanced virtual tutor consistently analyzes the user's performance, assists and guides him throughout his learning path, identifies his skill-gaps, and provides remediation by generating case after case to help him build his knowledge until he reaches a high level of performance.

Evaluation

- ROI studies concluded that training costs dropped from $763 per employee to $300
- Simulation-Based Training reduced onsite training time by 50%

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- Test results were compared to previous group's non-ILS training performance. Average test results increased from 62% to 92%
- The number of instructors required to run this training programme was reduced from 3 to 1.

8.6. Officer Training - Battlefield II

The Air Force Training Centre at Kjevik in Norway used the published Electronic Arts game 'Battlefield' in a trial with trainee officers aged between 18-45, with various backgrounds, competences and game playing experience (from serious gamer to novice). They used a server and VOIP for voice communications with real news footage from Afghanistan. The set scenarios and role plays are paper-based and are supplemented by instructor-led reflections and discussion. The game was played several times, raising levels; empty, sniper, IEDs, seeing friendly forces executing prisoners and playing without engagement.

Skills
A range of skills was either explicitly taught or emerged in discussions with instructors and students:

Basic skills Planning and orders Leadership Decision making Information processing	Communications Movements Using terrain Taking cover	Rules of engagement Ethical dilemma

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Image 5: Screenshot of Battlefield2

Conclusion

Motivation was regarded as the main advantage of this approach. Learners' heart rates were monitored and found to double up to 130 bpm. Interestingly, despite some limitations, experienced instructors found that some scenarios were possible to play out in the game that would be impossible in real life.

One great advantage is the ability to freeze the game, reflect and continue, which is impossible in real life, for example, team leaders can become paralysed and freeze. There is always a conflict between those who want to 'play the game' and 'learning'. This is why instructor input is important. On the basis of this evidence the project was deemed a success and training continues on the system[53].

Pros	Cons
Students find it motivating Repeatable training Low entry threshold for students Network-centric Flexible for multiple scenarios Good overview for instructors Freeze function	Instructor demanding Communications over VOIP (overload) Only 3 actions (move, observe, use weapons) Time consuming Squad limitation (too small at 6, 7-9 in Norway) Only two forces (friend and foe)

8.7. America's Army

America's Army with over 9 million registered accounts, this is the largest example of the use of games in the military. Released on July 4, 2002, its cost is estimated to be between $6 million and $8 million. Drawing its inspiration from a commercial game, Counter Strike - and developed on the Unreal games engine, this online game has been a huge success as a political, PR and recruitment tool for the US Army (N.B. This is not explicitly a training tool).

America's Army incorporates high levels of realism, including an accurate depiction of the US Army's training regime, complete with classrooms, the use of real firearms and depictions of real combat scenarios. Regular soldiers carry an assault rifle (M16A2, M4, or M4A1), specialist automatic rifleman (M249 SAW), grenadier (M16A2 with M203), sniper (M-24 or M82, plus a Beretta M9 pistol as a sidearm), or team leader (assault rifle and binoculars). Enemies carry weapons such as the AK-47. It has had further developments for use by the intelligence agencies and a test centre for new weapons.

[53] Thanks to Captain Morten Hougen mhougen@mil.no for providing the information for this case study.

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Image 6: A screenshot of "America's Army: Special Forces"

The game has 4 training maps and another 13 training levels, the game attempts to build in realistic training. The levels allow players to become one of several types of player such as, special forces operator, SDM (squad-designated marksman), HMMWV driver, CROWS gunner, and Javelin missile operator.

Research

Evidence for the effectiveness of the game as a recruitment tool is sparse, as the US Army completed its quotas in the two years before and after the game's release. However, statements have emerged claiming that the game has been a successful recruitment tool, with large numbers of click throughs to the recruitment website (28%).

There has also been speculation about why the game tracks so much user data. It has been suggested that this data has been used to test the competences of potential recruits.

Apart from the predictable debate around the militarisation of society through entertainment, there has been criticism of the game's lack of combat realism. There is an obvious tension between a game that tries to recruit and the realism of battle.

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The game received considerable publicity through the reported case of In Paxton Galvanek in November 2007, who claimed that the game's medical training tutorials helped him give first aid to two passengers in a car accident.

Academic studies include:

- "Video Games, Manipulation and the U.S. Military: A Comparative Analysis of America's Army and SOCOM II: US Navy SEALs" academic analysis of America's Army and SOCOM II: U.S. Navy SEALs in terms of "Visual Discourse" by Caroline S. Brooks, a PhD candidate at East Carolina University.
- "Social Realism in Gaming" academic analysis of America's Army in terms of "Social realism" by Alexander R. Galloway, a book author and Assistant Professor at New York University.
- "The Potential of America's Army as Civilian-Military Public Sphere" – an extensive February 2004 thesis (149 pages) by graduate student Zhan Li for the Massachusetts Institute of Technology - includes ethnographic analysis of soldiers who play the game during the invasion of Iraq, and interviews with West Point directors of the America's Army project (PDF).

8.8. Military Police - Stop and Search

This games-based performance simulator was commissioned by the UK's Royal Military Police in 2003, to provide knowledge and skills in a range of policing tasks, including drug search, domestic violence and so on. It is still in use today, saving time and money.

Point-of-view Learning

Stop and Search learners are presented with a typical brief and background report, then have to get to the scene and do a proper 'stop and search'. For example, a drug deal is reported, you drive to the scene, question a youth, who denies he's a serviceman, you have to make choices about how to proceed and identify the proper procedures, as well as handling the human situation. The video scenes are all shot point-of-view, so that you the learner are the military police officer. Suspects look you right in the eye and respond, through branching video scenes, to your questions or decisions.

Games techniques

The main games technique is the use of 'catastrophic failure' as a pedagogic technique. If users fail they are sent back to the start of the scenario ('level' in games terms). This encourages repeated practice and reinforcement and motivates the learner to learn best practice quickly, to avoid failure and progress. It is not in learners' interest to work through a complex scenario

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and fail repeatedly, so they stay focused and on task, repeating practice until they get it completely right.

Feedback is clear, with full audio explanations as to why one has failed, and eventually succeeded. Assessment is through completion of the tasks, as full performance is proof of competence.

Learner demand

This performance simulator, although expensive to produce, is cheap to distribute and replicate. After its initial use, and failure on implementation due to other duties, it was brought back through learner demand. This is an interesting example of cultural change being forced through learner demand, in conjunction with an enlightened champion within the organisation. It used game techniques and realistic scenarios to teach practice and procedure in a realistic, human context, through experience, failure and practice.

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9. Taxonomy of Immersive Learning Simulations (ILS)

As noted in the previous section the term "Immersive Learning Simulation" is gathering weight and seems to be less contentious in the majority of settings. This does still cover what are classed as "serious games" but has a slightly wider span and a more concrete description (see section 6).

What follows is a taxonomy of the different types of ILS. The purpose is to:

- Clarify the range, types and utility of different ILS variations
- Focus decision making criteria for the Defence Academy.

Our classification is motivated by differences in what users will be able to see and do and how they may interact with the learning methods. These will include: method of presentation, player controls, user interface and gameplay mechanics (turn based, real time, etc).

Variations in these characteristics produce ILS that look, feel and perform very differently. Each type of ILS may also lend itself to different application to different learning challenges, content areas, user profiles and training conditions. In developing this taxonomy we have only considered the use of ILS for learning and training.

Other taxonomies of Serious Games have considered industry segments as the key classification dimension[54] and have considered using games for entertainment as well as learning and training.

This taxonomy also focuses on the use of virtual worlds and 3D or pseudo 3D serious games. We have not considered 2D games such as Brain Training[55], which are very useful for rapid acquisition of basic subject knowledge. These are valid learning tools but are tangential to this taxonomy.

We have also centered on the PC as a delivery platform – excluding mobile phones, games consoles or personal digital devices. This is a realistic taxonomy based upon the capabilities of the DCMT and Defence Academy to leverage the benefits of available and emerging techniques in the next two years. However, it is practical and useful to note that some of the applications developed using some of the following ILS approaches could be ported to either console or portable hardware.

[54] Ben Sawyer and Peter Smith. Taxonomy of serious Games. http://www.dmill.com/presentations/serious-games-taxonomy-2008.pdf Accessed June 16th 2008.
[55] http://www.nintendo.co.uk/NOE/en_GB/games/nds/dr_kawashimas_brain_training_how_old_is_your_brain_3234.html Accessed July 1st 2008.

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Taxonomy of ILS

The taxonomy describes eight different types of ILS:

- Egocentric Performance Simulations (Sims)
- Branching Story Sims
- Real Time Strategy Sims
- Exocentric Sims
- Episodic Sims
- Construction-based Sims
- Virtual Worlds
- Device-based Sims

Each of these types offer training and learning benefits to the MOD learning enterprise. Each will be more or less appropriate according to the context of use and each has strengths and restrictions to be considered.

9.1. Egocentric Performance Sims

As intimated by the name, in an Egocentric Performance Sim a player plays an individual character in the game space. The player will view the action as through the eyes of an individual character. This may be in a first person viewpoint where literally the player will view the world as through the characters eyes, or it could be a third person viewpoint where the player would control an avatar.

The player controls the avatar and 'performs' actions within the 3D world to influence events and to achieve learning goals. The high level of user control over movement, navigation and interaction, coupled with the personal perspective engenders high levels of 'presence' – a feeling of 'being there' in the situation depicted in the world.

This genre is very popular among developers, as a great deal of training involves human to human scenarios. It is used for a wide variety of learning areas from scenario driven learning such as sales training through to interpersonal skills, health and safety and compliance.

It is less likely to be used for strategy level training that involves the learner in managing multiple resources simultaneously and reacting to consequences.

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Development Tools

Many developers have licensed game engines to build Egocentric Performance Sims:

- Orge3D[56] and Delta3D[57] are both Open Source games engines. They require a strong knowledge of programming and 3D development in order to create a training simulation but have a community of developers
- For high-end fidelity authoring, VBS2[58] offers realistic battlefield simulations. The development tools require programming expertise; however instructors may create new scenarios and then engage the simulation from multiple viewpoints.
- Thinking Worlds[59] is a new type of authoring tool for 'RapidSims' – rapid authoring, editing and publishing of ILS without the requirement for programming with embedded instructional design.

Strengths

- Excellent for real time scenario driven application of knowledge and skills
- High levels of presence for context relevant training
- Controls are simple to master and intuitive
- 'Life-like' therefore easy to design scenarios based on real world needs
- Real time interactivity and user control provides data rich environment for measurement and feedback

Restrictions

- Real time interactivity can make it difficult to engage planning and deliberation skills into the users performance
- Non player characters must be scripted or have AI

Example Military Use Cases

[56] http://www.ogre3d.org/ Accessed 1st July 2008
[57] http://www.delta3d.org/ Accessed 1st July 2008
[58] http://virtualbattlespace.vbs2.com/ Accessed 1st July 2008
[59] http://www.caspianlearning.co.uk/corporate/menu.php?id=2 Accessed 1st July 2008

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- Officer decision making
- Interviewing and persuasion
- Health and safety scenarios
- Interpersonal Skills Training

First Person View Third Person View

Image 7: Examples of Egocentric Performance Sims: screenshots are taken from two applications developed by Caspian Learning for Ufi learndirect[60,61].

9.2. Branching Story Sims

This genre of sims engages the user in an unfolding sequence of animated scenes within a story or event. The user is able to influence and even determine the flow of the story by making choices and decisions at different points. At these points the flow of the story will follow different branches.

These simulations are very easy to use and to deploy. There is a very low learning curve for users of all ages and ability. However, branching story sims are often criticised for the simple decision making interface and relatively high levels of linearity. Developing more complex branching stories requires a relatively high degree of effort as more and more 'nodes' are added to the

[60] First person view screenshot. Adult Skills training – scenarios on debt management, parenting skills and health awareness (http://www.caspianlearning.co.uk/corporate/menu.php?id=4)
[61] Third person view screenshot. Business skills training scenarios. (http://www.caspianlearning.co.uk/corporate/menu.php?id=4)

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story tree and must then be scripted and developed. For these reasons, it is often asserted that branching story sims are likely to be most suitable for new entrants or low level learners, rather than for more advanced or creative users within a domain.

Development Tools

All of the engines outlined in the Egocentric Performance Simulations section can be used to develop branching story sims.

- Reality Based Interactive Training System (RBITS)[62] - is a simulation engine that uses a learner's decision to send the learner down any one of hundreds of possible story paths.

Strengths
♦ Simplicity – no control so easy to understand and navigate
♦ Easy to deploy and debug
♦ Often recommended for entry level and inductees
♦ Works well blended with classroom for tutor driven reflection and feedback
Restrictions
♦ Highly scripted with relatively simple choices
♦ Low control
♦ Low presence
♦ Hard to edit content
Example Military Use Cases
♦ Induction training and familiarity
♦ New Role Readiness
♦ Role Playing

[62] http://www.visualpurple.com/rbits.htm Accessed 1st July 2008

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Examples of Branching Story Sims:

Image 8: Screenshot from 'ICS: Foundations' developed by Visual Purple[63]

Image 9: Digital Switchover customer scenarios developed by Caspian Learning[64]

[63] An example of a branching story serious game. See trailer at http://www.visualpurple.com/trailers.htm Accessed 17th June 2008.
[64] www.caspianlearning.co.uk/downloads/videos/branchingStory.wmv Accessed July 1st 2008

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9.3. Real-Time Strategy (RTS Sim)

In this type of sim a player is given control over a range of resources and units to manipulate and deploy within an evolving scenario. The player is typically given a top-down view of the world which could, for example, be a map that has units of resources displayed upon it. The action occurs in real-time, which distinguishes it from its popular cousin – turn based strategy – in which a player assesses a situation, submits the actions and then observes the consequences.

Bruce Geryk[65] describes this difference:

"*Real-time strategy changed all of that so that games would begin to more closely resemble reality: Time was limited, and if you wasted yours, your opponents would probably be taking advantage of theirs*"

In contrast to Egocentric Performance Sims, users do not normally assume the role of a character in an RTS sim – they are usually the overseer or 'god'.

Development Tools

Many RTS games come with an inbuilt scenario editor to modify and customize scenarios. To create whole new RTS games developers require a 3D games engine.

Strengths
♦ Excellent for real time resource allocation decision making ♦ Strategic level skill application – 'Big picture' training ♦ Time based can add realism and pressure for critical training applications
Restrictions
♦ Low levels of Presence ♦ Complex gameplay ♦ Can be difficult to design and develop ♦ Usually restricted to 'Commander' or 'God' roles in the Sim
Example Military Use Cases

[65] http://www.gamespot.com/gamespot/features/all/real_time/ Accessed June 25 2008.

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- Command role training
- Logistics
- Emergency planning and response

Example of Real Time Strategy Sims:

Image 10: Screenshot of "Ground Truth"; a real time strategy Sim developed by Sandia National Laboratories and The Gamepipe Laboratory (University of Southern California)[66].

9.4. Exocentric Sims

Using an Exocentric Sim, the player views an angled overhead view of the 3D world in which the learning takes place. Typically, this type of sim will involve human situations and events where the player controls characters and objects in the scenario. The player control will most often be 'point and click' using the computer mouse. For example, the player clicks on a character in the world and points to another location, to which the character will move.

The action unfolds in real time – characters and events will be ongoing, the player can intervene and make decisions. Often, time is a key variable in these scenarios, meaning that the gameplay can be moved on to different

[66] http://www.youtube.com/watch?v=l-R2MYi9_go accessed June 2008

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times of the day etc. This gives great scope for scenario generation and testing strategic skills.

There is less 'presence' than in an Egocentric Sim – the view is not so personal, there is less feeling of control and the scenario does not move as rapidly in visual terms.

Development Tools

- 3Dwave[67] is an authoring tool for developing Exocentric Sim scenarios, enabling the creation and simulation of 3D objects, environments, and scenarios.

Strengths
♦ User movement controls are intuitive
♦ The variety of situations which can be created is large
♦ Action is real time for time based strategy level skills
♦ Time jumps are possible
Restrictions
♦ Immersion and presence is less high
♦ Tactical interactions have limited realism
♦ Variety of interface control options can be complex for users
Example Military Use Cases
♦ Emergency response
♦ Disaster management

[67] http://www.3dsolve.com/3dwave.html Accessed 1st July 2008

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Examples of Exocentric Sims:

Image 11: Screenshot from Sims2.

Image 12: Screenshot from SOBT – an application developed for the US Navy by 3D Solve. The topic of the training is the Force Protection Anti-Terrorism

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safety and security procedures at ports involving docked nuclear submarines[68].

9.5. Construction and Management Simulation Games

Construction and Management Simulations (CMS) are games about processes. A player must build, expand or manage an entity or project with limited resources. The interface and controls associated with CMS are often similar to Turn Based or Real Time Strategy genres, but their focus is different. The tools within a CMS are focused upon two activities:

- Building – an interface that enables the player to allocate resources onto a surface such as a geographical map or grid. The resource will interact with other items present - for instance, it could be a building entity as the player grows a city or a factory or a road in an economy simulation.
- Managing – an interface that enables the player to manipulate and change values and properties within the simulation - for example, to change the level of funding for a public department within an economy simulation.

As with all types of sim focused upon strategic resource allocation skills, the player can make choices only within the overall rules programmed into the sim by the designer.

Strengths
♦ Highly versatile in creating options for strategy level simulations
♦ Can be used for skills such as negotiation
Restrictions
♦ Low feeling of presence
♦ Limited control over the 'game shape'
♦ Development time and complexity can be high
Example Military Use Cases
♦ Resource deployment
♦ Project management

Example of Construction and Management Simulations:

[68] http://www.3dsolve.com/video.html for video demo of SOBT. Accessed 1st July 2008.

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Image 13: Sim City 4 screenshot.

9.6. Episodic Sims

Another, but distinct type of resource management and decision making genre, Episodic Sims differ from Real Time Strategy Sims in that they are 'turn based'. An episode of action and events will occur and then the player is given their 'turn' to make a response. Typically, the player will have unlimited time in which to consider and formulate a response. Events in the 3D Simulation will not progress while the player deliberates. The player can then deploy resources, specify actions etc before 'pulling the lever' to submit the chosen actions. The simulation assimilates these actions, calculates the consequences and modifies the scenario in response.

This is a popular format when the scenarios under observation are long-term or where a task involves interpreting data over time. An example is for business simulations where players are given resources, asked to make decisions, submit their answer to run the simulation and see the consequences of their decisions. There is usually a system engine or model running in the background.

Development Tools

Tools available in this genre are typically 'scenario editors'. They are used to create variations of scenarios that are based upon content in existing simulations. They are not used to create entirely new Episodic Sims.

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- Making History[69] - "The Calm & the Storm" is a turn-based strategy game where players lead real nations through the World War II years. The game comes with a scenario editor which can be used to modify or "mod" games. Users can create new versions of World War II scenarios.

Strengths
♦ Integrate periods of reflection and deliberation directly into the learning application ♦ Target strategy level skills
Restrictions
♦ Controls and interface can be complex to master ♦ Time consuming – can take many hours to progress through, which translates into months of training time
Example Military Use Cases
♦ Business planning simulations ♦ Project management

[69] http://www.making-history.com/content_packs/calm/features.php Accessed July 1st 2008

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Examples of Episodic Sims:

Image 14: Screen shot from "Making History", a turn based strategy game about World War II. Developed by Muzzy Lane.

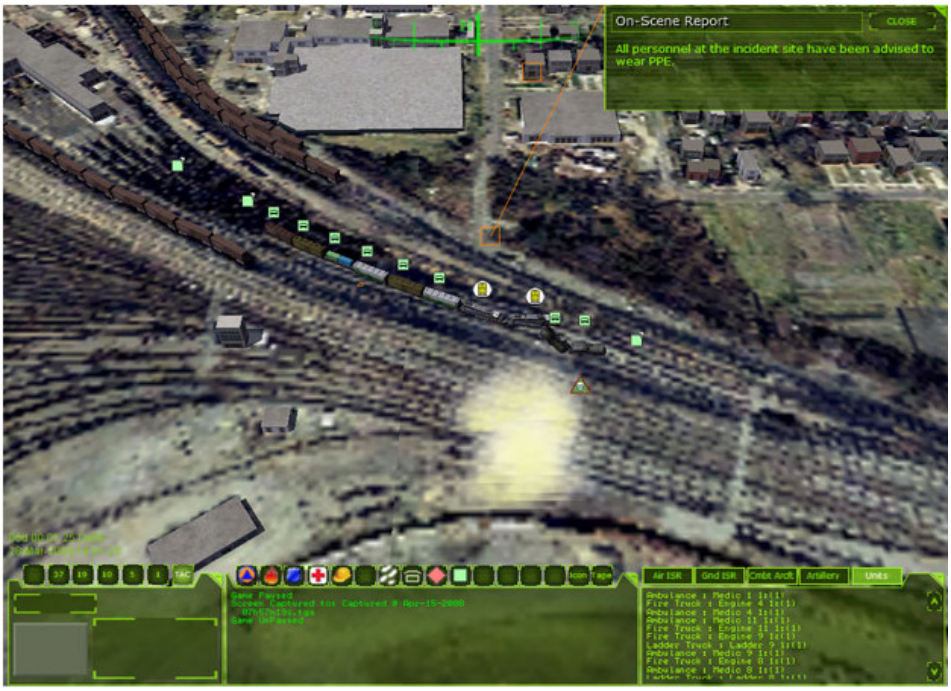

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Image 15: Screenshot of Incident Commander™ NIMS-compliant training tool for Homeland Security[70].

9.7. Virtual worlds

The online virtual world is a new entrant into the sim developer's toolset. Virtual worlds come in many shapes and forms but share some recognisable properties:

- Multiplayer – virtual worlds can be populated by tens or many thousands of other human representations, simultaneously, in a shared 3D environment
- Synchronous communication - if one player changes something then other players will recognise this
- Egocentric perspective – most virtual worlds will offer the player a third person perspective with a personal avatar
- High degree of player control – players can navigate their avatar with relative freedom around a virtual world and are able to interact with objects and characters (chat, manipulate objects, etc)

For training and educational purposes, virtual worlds differ in the degree to which rules and/or structure are embedded into the world:

- Open ended – these worlds have relatively few embedded rules and structures. Players have the ability to communicate and interact with other users of the world. There are no, or very few, preordained objectives nor purpose. Behaviour is free form and any patterns emerge from social interaction. Second Life is the stand out example of this type
- Structured – contain rules and or structures that can provide focus, objectives and direction to user's behaviour. Examples of this genre would be World of Warcraft as a fantasy game and the Olive virtual world platform that is used for sophisticated first responder and military multiplayer training scenarios

Development Tools

- OLIVE™ - On-Line Interactive Virtual Environment[71] - an open, distributed client-server platform for building private, realistic virtual

[70] http://www.incidentcommander.net/

[71] http://www.forterrainc.com/index.php?option=com_content&task=view&id=8&Itemid=7 Accessed July 1st 2008

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worlds. The architecture scales from single user applications up to thousands of concurrent users.

- Blink 3D[72], a platform for creating multi-user Web based virtual worlds and 3D environments. It uses the Induality plugin for web browsers.
- Second Life[73] - A number of companies are developing virtual world applications using development tools within Second Life. There is a 3D modeling tool to create buildings, landscape, vehicles, furniture, and machines. Second Life also includes a scripting language called Linden Scripting Language, or LSL. LSL is used to add autonomous behavior to many of the objects in Second Life, such as doors that open when approached.

Strengths
♦ Excellent for collaborative and human team building exercises
♦ Highly suited to informal learning experiences and virtual meetings
♦ High degree of presence
Restrictions,[74],[75]
♦ Synchronous – training can only take place at a given time and date
♦ Replication – it is difficult to set up and re-run simulation scenarios
♦ Structure – virtual worlds often lack embedded learning methods and activities for learners
♦ Automated measurement mechanisms are difficult to implement
Example Military Use Cases
♦ Emergency responder scenarios
♦ Crowd control

[72] http://www.pelicancrossing.com/index.htm Accessed 1st July 2008
[73] http://secondlife.com/ Accessed 1st July 2008
[74] See Clark Aldrich criticisms of Second Life as a learning tool http://clarkaldrich.blogspot.com/2007/05/top-ten-missing-features-of-second-life.html Accessed June 25th 2008.
[75] A similar debate on the strengths and weaknesses of Second Life for learning can be viewed on Stephen Downes blog http://www.downes.ca/cgi-bin/page.cgi?post=45158 Accessed July 5th 2008

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- Team building / teamwork
- Conferencing

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Examples of Virtual Worlds:

Image 16: Screenshot from a multi player first responder Simulation developed by Forterra using their Olive platform[76].

Image 17: Screenshot of a virtual classroom in Second Life

[76] http://www.forterrainc.com/index.php?option=com_content&task=category&sectionid=7&id=13&Itemid=53 Accessed July 1st 2008

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9.8. Device Based Sims

As the name implies, Device Based Sims provide the player with realistic operating control over various kinds of vehicles. Well known examples of this type include flight simulators and driver simulators. From the review of learning in the Defence Academy, it is apparent that Device Based Sims are the least appropriate form of sim. However, they are included within the taxonomy for completeness and for the recent availability of development tools from Microsoft Enterprise Simulation Platform (ESP), which may reduce the complexity of developing these types of sim and bring them more into the mainstream.

A goal of most Device Based Sims is to approximate closely the operational reality of vehicles. Typically, they provide extremely high levels of fidelity in 3D graphics, sound, and movement.

The sim can provide instant feedback to the user, for example through terrain physics impacting on the vehicle and also through inbuilt AI that examines performance levels. PC-based simulators of this fidelity show excellent levels of training effectiveness and are used to train people to high levels of proficiency within their particular field.

User controls and navigation approximate the real world equivalent, such as the gears and steering of a car or the complex cockpit dashboard of an airplane.

Development Tools

- Microsoft ESP - The initial version of the platform focuses on Microsoft's expertise gained through its Flight Simulator franchise in aviation capabilities and is targeted to military and commercial aviation audiences. Future versions will be extended to ground and maritime operations, indoor and avatar-centric simulations for commercial, government and academic learning.

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Strengths
♦ High end psychological and physical fidelity
♦ High degree of presence
♦ Detailed performance diagnostics
Restrictions[77]
♦ Cost and development time can be prohibitive
Example Military Use Cases
♦ Technical skills training
♦ Vehicle deployment training

Example of Device Based Sims:

Image 18: Screenshot of Microsoft Flight Simulator[78].

[77] See Clark Aldrich criticisms of Second Life as a learning tool http://clarkaldrich.blogspot.com/2007/05/top-ten-missing-features-of-second-life.html Accessed June 25th 2008.
[78] http://www.microsoft.com/esp/

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10. ILS and the DCMT landscape

In assessing the DCMT landscape via both teacher and trainer interviews as well as learner surveys, a number of consistent themes emerged that demonstrate a powerful fit with the use of ILS. These were also tied to a handful of consistent cultural considerations that are likely to restrict the speed of adoption. The following section pulls out some of these powerful themes and provides further evidence to either support or challenge the use of ILS solutions within military systems and culture. However, the synergy between the pedagogical benefits of using ILS and the system and culture in place within the MOD and the DCMT as a subset of this is extremely evident.

The key themes emerging from interviews and surveys are:

- Safe Failure
- Rich skills Practice
- Competitive behaviour
- Sport
- Learner Motivation
- Learner Demographic

10.1. Safe failure

The practice of training is dominated by methods of error avoidance (Ivancic & Hesketh, 1995)[79]. Culturally, learners are often shamed by errors during training performance; they are seen as the opposite of good performance and evidence of poor judgment or bias. Indeed, many learners see training and testing as the same thing and frequently this is true - cognitive experiments often use number of errors as a measure of bad performance. This fear of failure and the perceived effects on a student's career came across in almost all interviews at the DCMT.

Comments included:

"failure is not an option"

"career progression is so important that learners will avoid anything that can be seen as failure"

"in the context of most courses here they are expected to pass, so any hint of failure does not go down well"

[79] Ivancic, K., & Hesketh, B. (1995). Making the best of errors during training. Training Research Journal: The science and practice of training. 1, 103-126.

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Why is this, when errors themselves are highly likely in the performance of any work task[80]? In reviewing the findings of error management studies, Michael Frese of the University of Giessen and London Business School has defined a 'Law of Error Frequency';

"You make approximately 3 to 4 errors per hour every task that you are working on"

Errors as tools for learning improvement

"The only real mistake is the one from which we learn nothing"

Organisational Psychology researchers have responded to this by incorporating error management methodologies into training interventions. The basic principle of error management training is that participants are given opportunities to make errors during training. Participants are provided with only minimal information and are then given the opportunity to explore the system individually. Error management training studies have shown that across a range of training domains, including pharmaceutical management training, software simulation, cockpit resource management, computer programming, business skills and firefighters[81], error management training leads to better performance by participants than error avoidant training (Keith 2005)[82].

A positive approach to errors in training design is supported not only by the requirement of management and preparation of trainees to errors, but also because errors can be used to enhance learning performance.

A number of studies have demonstrated the important role that errors can play in learner reflection. When learning materials present error making as a positive learning tool to learners and embed methods to encourage a rate of error making, they can become a significant cue for learner reflection and a device for metacognitive thinking on the materials (Keith et al.2005)[83].

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[80] Lab studies of error rates have covered many familiar tasks: Number of errors in driving a new car: 10 per hour (Heinbokel & Frese, 1992); Errors in using a new washing machine – 60 per hour
(Prümper, Heinbokel, Rohs, 1990); Average of 50 faults per 1000 lines of code of software (estimate by Jones, 1987).

[81] See references: (Joung, W., Hesketh, B., & Neal, A. (2006). Using "war stories" to train for adaptive performance: It is better to learn from error or success? Applied Psychology: An International
Review, 55, 282-302.)

[82] Keith N, Frese M. Self-regulation in error management training: emotion control and metacognition as mediators of performance effects. J Appl Psychol. 2005 Jul;90(4):677-91

[83] Keith N, Frese M. Self-regulation in error management training: emotion control and metacognition as mediators of performance effects. J Appl Psychol. 2005 Jul;90(4):677-91

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This is an area in which we feel the DCMT and the MOD at large can make significant progress. By showing that ultimate performance can be improved by small and safe failures, the fear associated with making mistakes can be eased. Learners will be accepting of the idea of "safe failure" in their education and training and are likely to self-reflect more.

This point is noted by many other researchers. Schaller & Allison-Bunnell (2003)[84] link the provision of a safe failure environment to the increase in user exploration of learning stimuli and reflection upon it. They note that adult learners develop complex mental organisation and can typically experience real, significant learning and growth if given safe opportunities to explore the extremes of their reality and their place within it. This fact is particularly relevant when so much of the learning at the DCMT and in the wider MOD landscape demands highly contextual learning experiences. Much of the knowledge learnt and skills trained will be put into practice in environments yet to be explored. For this reason a system that exposes learners to contextual experiences where failure is both allowed and encouraged to improve real operational capability would be a powerful step forward and ILS can help deliver this.

Somewhat unexpectedly, it seems that errors can also have a positive impact on learner motivation. Where learners are encouraged to identify and constructively manage errors, then those errors can be highly motivational within training (Wood, Kakebeeke, Debowski & Frese, 2000). This phenomenon is widely seen in game design, where players actively make errors as part of the gameplay linked to progression and reward.

An open culture in which errors are viewed as learning opportunities and actively managed is characteristic of many creative and productive companies. Work by Michael Frese and his colleagues on small business performance in Europe and China has shown that 20 percent of variability in corporate profitability is determined by error management culture[85]. If a company focuses on managing errors rather than simply avoiding them, it is significantly more likely to be profitable.

However, it appears that many students, when faced with traditional error avoidant training practices, are uncomfortable making errors. Culturally, we know that only a small number of students are comfortable making errors in training and learning. These individuals usually have higher cognitive ability and on personality tests show high openness to new experience (Gully et al.,

[84] Schaller, D. T., & Allison-Bunnell, S. (2003). Practicing what we teach: how learning theory can guide development of online educational activities. *Museums and the Web 2003.*
[85] C Van Dyck, M Frese, M Baer, S Sonnentag - Journal of Applied Psychology, 2005 Organisational error management culture and its impact on performance: A two-study replication

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2002). In sharp contrast to this finding, studies of test anxiety have shown that fear of failure among low ability students predicted low performance on reading and mathematics tests (Bryan et al 1983)[86].

Safe failure in ILS

Whilst games enable the learner to experience successes and gain rewards, at the same time they also provide opportunities for failure. Catastrophic failure such as dying or being thrown back to the start is a common feature of game design. The user learns from the failure and is motivated to try again in order to overcome the challenge next time.

In games, player errors / failure are closely related to feedback. This is analogous to the learner reflection and feedback element described above. Games provide feedback in real time. The consequences of the user's actions and choices are immediately apparent. Feedback motivates and stimulates action, even when it is negative. The balance between risk and reward (feedback) is important to the success of a game.

Many ILS developments have utilised the safe-failure / feedback / reflection loop in their design to improve learning outcomes. A recent report by the eLearning Guild of over 1,100 corporations identified safe failure as a key benefit of ILS[87].

"The great promise of immersive learning simulations (ILS) is that best practice modeling is now possible in a computer generated, 3-D, real-time, safe environment. People can test scenarios, get real-time feedback, and review and evaluate both good performance and potentially catastrophic mistakes"

In one example, 'Serious Gordon' places learners within a simulated industrial kitchen environment. Using an egocentric design, learners are able to use a variety of tools and communication methods to accomplish real world tasks in the kitchen. Clearly, hygiene and health and safety play a key role in restaurant work. Learners were able to try out their skills and explore avenues to best practice within the virtual world before moving into the real kitchen[88].

[86] The Relationship between Fear of Failure and Learning Disabilities, by J. H. Bryan, L. J. Sonnefeld and B. Grabowski © 1983 Council for Learning Disabilities.
[87] eLearning Guild (2008) IMMERSIVE LEARNING SIMULATIONS - The demand for, and demands of, simulations, scenarios, and serious games.
[88] http://www.comp.dit.ie/bmacnamee/papers/SeriousGordon.pdf Accessed July 5th 2008

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Image 19: A screenshot from Serious Gordon - an interactive digital game developed to teach the basics of kitchen food safety to workers in industries dealing with food.

Richard Blunt (2006)[89] employed causal comparative study methodology to examine the effect of ILS on management student education in Walden University. Over a 15 week semester, classes of students used a Turn Based Strategy Sim called Virtual U as a basis for learning in half of their formal lessons. Virtual U is designed as a simulation of running a university. Instructors used this as a basis for assigning progressively harder scenarios that supported the subject lectures in the curriculum. Students in classes using the game scored significantly higher mean scores than classes that did not. In describing these results and making observations on the overall study, Blunt makes clear the role of safe failure:

"The decisions were sometimes made slowly, sometimes quickly, sometimes very quickly. The advantage to games and simulations is the player gets to view and analyze the consequences of decisions without actual risk to people, resources, capital, or reputation. Practiced routinely, game-based learning can, as this study is used to show, increase learning which leads to increased competitive advantage"

This has been further demonstrated in a study by Ufi learndirect. This study focused upon adult learners with learning difficulties that had been unemployed for a minimum of two years. The ILS utilised in this study significantly improved learning outcomes compared to groups using traditional

[89] http://www.rickblunt.com/phd/blunt_richard_dissertation_final.pdf Accessed July 5th 2008

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eLearning. Learner self reports and observed error / replay behaviour indicated a key role for 'safe failure' in motivation and performance.

Do you mean it's a game where you can try being at work? What a great idea, you can make mistakes and won't be made to feel silly – or get the sack!'

'It's great being able to talk to all the different people to find out what they do without feeling that you're being a nuisance and asking stupid questions.'

The researchers describe this element as:

"Authentic fail safe environment - learners felt very confident in these virtual worlds. They were able to make mistakes in realistic scenarios without the high consequences of the real world."

Image 20: Screenshot of 'Ready to Work!' an ILS developed by Ufi learndirect

10.2. Rich Skills Practice

In the last 30 years, research into expert performance has described the application of 'deliberate practice' methods as fundamental to the acquisition of expert skills (Ericsson 2006)[90]. Within the research literature, deliberate practice has been strongly linked to improved performance across many professional domains, including[91,92,93]: medicine, interviewing, music, athletics,

[90] Ericsson, 2006, chapter 38. In 'Cambridge handbook of expertise and expert performance' Cambridge University Press.
[91] Ericsson, K. A. (1998). The scientific study of expert levels of performance: General implications for optimal learning and creativity. High Ability Studies, 9, 75-100.

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reading, coaching, learning, and weather prediction. This covers a range of skills and competences from spatio-motor and kinetic to cognitive and emotional - from a golfer putting under pressure to doctors interviewing and lawyers negotiating.

The importance of practice and experiential learning came through as the second key theme from both the learner survey and interviews at DCMT. 90% of the interviews identified "practice", "role play" or "experimentation" as key elements of the learning format. All learners identified the "ability to practice" as the most powerful enhancement to the current learning mix at DCMT. With so much background theory being conveyed at the Defence Academy, it was evident that learning interventions that can enable "knowledge application" or "skills practice" would be powerful additions.

Using deliberate practice, individuals develop exceptional skills by the structured application of key processes under the supervision and direction of the best coaches and teachers. The conditions and processes within deliberate practice are described by Farmer and Williams (2005)[94] as: 1) a highly motivated student (2) with good concentration (3) performs a well-defined task, (4) at an appropriate level of difficultly, (5) receives informative feedback and (6) is given opportunities for repetition to correct errors and polish the skill before moving to the next task.

Without the application of technology, the use of deliberate practice methods requires, typically, one-to-one expert mentoring and a high performance environment of measurement, feedback and practice – requirements that are costly and difficult to meet consistently and coherently in the real world. The use of ILS affords great potential through the provision of a virtual environment in which the trainee can be motivated, can practice skills repeatedly in a realistic environment, can be optimally challenged and receive immediate feedback and can be mentored via best practice.

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[92] Patel, V., & Groen, G. (1991). The general and specific nature of medical expertise: A critical look. In K. Ericsson & J. Smith (Eds.), Toward a general theory of expertise (pp. 93-125). Cambridge, MA: Cambridge.
[93] Ericsson, K. A. (1996). The acquisition of expert performance: An introduction to some of the issues. In K. A. Ericsson (Ed.), The road to excellence: The acquisition of expert performance in the arts and sciences, sports, and games (pp. 1-50). Mahwah, NJ: Erlbaum.
[94] 'The Rigorous Application of Deliberate Practice Methods in Skills Courses'. Research paper by Larry C. Farmer & Gerald R. Williams 2005. http://www.law.ucla.edu/docs/farmer_williams-_deliberate_practice_methods.pdf Accessed 7th July 2008

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ILS and Rich Skills Practice

The most up to date survey of ILS deployments has been undertaken by the eLearning Guild in 2008[95]. The Guild surveyed over 1,100 organisations globally to understand how they were using / intended to use ILS today. Over 320 different organisations provided feedback on their direct experience of developing and using ILS in their organisations. Their experiences were overwhelmingly positive; key reasons for deploying and using ILS related directly to their ability to provide an environment for rich skills practice and decision making. The findings state:

"Over 93% of Guild members who have created an ILS report that their efforts produce results that are either somewhat or much better than other forms of rich-skill practice. They provide challenging contexts in which to practice the critical decisions that you need your learners to be able to make"

Example – Tactical Iraqi

The Tactical Language and Culture Training System (TLCTS)[96] is an interactive learning platform that helps learners quickly acquire communication skills in foreign languages and cultures. This is an excellent example of the effective and appropriate use of an ILS to improve student skills within a military context. The Tactical Iraqi package teaches soldiers how to communicate in tactical situations safely and effectively. Trainees are immersed within realistic 3D worlds and cultural scenarios in which they must acquire and practice a rich set of communication skills. Language training covers mission-related spoken vocabularies and pronunciation. Cultural instruction teaches the non-verbal and etiquette norms. Over 20,000 U.S. servicemen and members of the Australian Defence Force have successfully completed this ILS driven skills programme.

The ILS simulates real life cultural situations in which the trainee must communicate with intelligent computer-generated characters. The scenarios are state based and non-linear. The trainee can practice many methods of approach. However, the computer-generated characters will respond badly if the trainee shows inappropriate cultural behaviours and the trainee will not be able to progress.

[95] eLearning Guild (2008) IMMERSIVE LEARNING SIMULATIONS - The demand for, and demands of, simulations, scenarios, and serious games.
[96] http://www.tacticallanguage.com/

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Image 21: Screenshot from the Tactical Iraqi ILS.

Beal et al (2005)[97] assessed the effectiveness of Tactical Iraqi and described the opportunities for practice afforded by the ILS in the realistic missions:

"Providing trainees with a progression of practice opportunities, both exercises and games, helps promote transfer, since learners are continually transferring their skills from one practice opportunity to the next. Finally, the Mission Game provides learners with a practice experience that bears strong similarities to real-life conversation; this increases the likelihood that trainees will actually be able to apply their skills in real life."

[97] Beal, C., Johnson, W.L., Dabrowski, R., & Wu, S. (2005). Iterative feedback and simulation-based
practice in the Tactical Language Training System: An experimental evaluation. Proceedings of the
International Conference on Artificial Intelligence in Education. IOS Press, Amsterdam.

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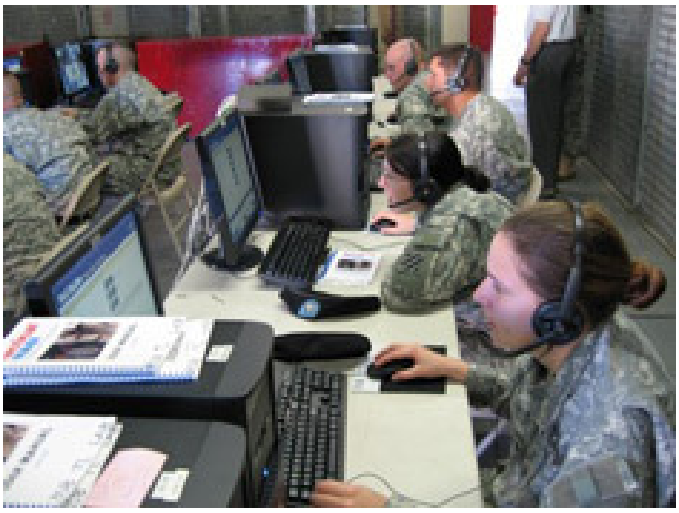

Image 22: Screenshot of Warfighters of the U.S. Army's Third Infantry Division learning Iraqi Arabic language and culture with the Tactical Iraqi course at Ft. Stewart, Georgia[98].

10.3. Competitive behaviour

Humans are competitive animals; this is not controversial. Laboratory studies have consistently found that competition induces performance goals and affects learning motivation (Lam et al 2004)[99]. Games have utilised this element to entertain and educate us for generations. More recently, insights from psychology and neuroscience have begun to identify how fundamental this mechanism is to human behaviour and how it motivates and rewards us.

In the majority of interviews at Shrivenham, the view was expressed by both teachers and trainers that the military culture was inherently competitive. Ultimately this was competition against an enemy; however 80% of interviewees suggested military students were likely to be more competitive than their civilian counterparts. The learner survey, whilst demonstrating less extreme opinions, has all respondents rating themselves as either moderately or extremely competitive. It is a natural and obvious conclusion that, on this basis, systems such as the various ILS described in this report (section 9) that can encourage either self or peer competition might be useful additions to the learning tools that are utilised currently.

Modern brain imaging techniques have begun to uncover the key role that competition plays in performance. Neuroscientists have been able to identify 'reward centres' in the brain that are activated when humans achieve or receive rewards. The activation of these areas is context dependent – they

[98] http://www.tacticallanguage.com/approach.html accessed July 7th 2008
[99] The Effects of Competition on Achievement Motivation Lam, S-f.; Yim, P-s.; Law, J. S. F.; Cheung, R. W. Y. British Journal of Educational Psychology, v74 n2 p281-296 Jun 2004

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vary according to size of reward and even the perception of the reward that could be received (Nieuwenhuis et al 2004)[100].

Recent experiments provide further insight into human reward and motivation. The level of activation in the brain reward centre is moderated by our competitive instincts. We are highly competitive beings. It seems as though our ability to 'beat' or 'outscore' others is more important to us than the actual score or size of reward we receive.

Economists and brain scientists at the University of Bonn (Fliessbach et al 2007)[101] tested male subjects in pairs, asking them to perform a simple task and promising payment for success. Each participant also learnt how his partner in the game had performed and how much he would pocket in return. Participants who got more money than their co-players showed much stronger activation in the brain's reward centre than occurred when both players received the same amount. For the subjects who earned less, blood flow to the brains 'reward centre' actually decreased, even though they had performed the task successfully and had been rewarded. Being rewarded and the absolute size of the reward were not so important - the subjects were motivated primarily by gaining a bigger reward that their counterpart.

Games and competition

'Conventional' games have challenge and competition hard-wired into their design, from chess, checkers, bridge, noughts and crosses, monopoly or scrabble. Video games are no different; indeed they magnify and extend this element. Whether slaying dragons, escaping pyramids, building communities or solving puzzles the player will be competing: individual against self, against the clock, against artificially intelligent actors, against friends and peers in high scores, against tens or hundreds of other players in a massive multiplayer world. This is part of the success and power of video games. Some researchers argue that competition is the key mechanic behind the success of a video game design (Vorderer et al 2003) [102].

[100] Sander Nieuwenhuisa, Dirk J. Heslenfelda, Niels J. Alting von Geusaua, Rogier B. Marsb, c, Clay B. Holroydd and Nick Yeunge (2004). Activity in human reward-sensitive brain areas is strongly context dependent. NeuroImage Volume 25, Issue 4, 1 May 2005, Pages 1302-1309
[101] Social Comparison Affects Reward-Related Brain Activity in the Human Ventral Striatum. K. Fliessbach, B. Weber, P. Trautner, T. Dohmen, U. Sunde, C. E. Elger, A. Falk. Science, 23.11.2007
[102] P Vorderer, T Hartmann, C Klimmt (2003) Explaining the enjoyment of playing video games: the role of competition. ACM International Conference Proceeding Series; Vol. 38

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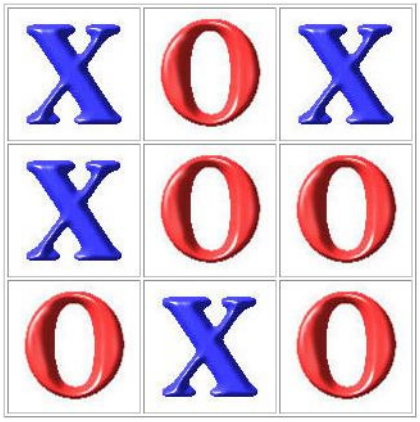

Image 23: Screen shot of simple computer noughts and crosses game.

"Games have conflict/competition/challenge/opposition. That gives us adrenaline" - Marc Prensky 2004

Evidence from neuro-imaging supports this claim. Many studies have shown activation of the brain reward centres in response to achievement or economic compensation for gambling or competitive decision making games.

A recent study has given us the first look at brain reward behaviour while playing video games. Allan Reiss[103] and his colleagues at Stanford University took brain activation readings from subjects while playing a video game. The game required the subjects to acquire territory by clicking on balls that were closer to a wall. The design was very simple in terms of graphical fidelity and level of interactivity; however the subjects had to work out the rules of the game while playing and it proved highly motivating. Male subjects acquired significantly more territory than females but both groups reported significant levels of motivation. After analyzing the imaging data for the entire group, the researchers found that the participants showed activation in the brain's mesocorticolimbic centre, the region typically associated with reward and addiction. Male brains, however, showed much greater activation, and the amount of activation was correlated with how much territory they gained – motivation and competition in action.

[103] http://med.stanford.edu/profiles/frdActionServlet?choiceId=facProfile&fid=4418

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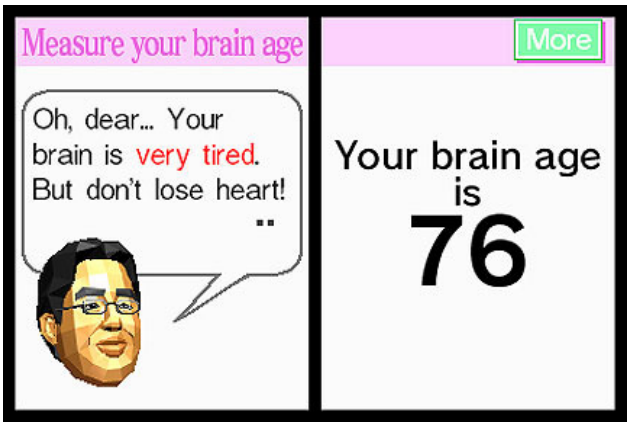

Image 24: Screenshot of the highly successful Nintendo Brain Training game. 20 million units sold across all age ranges. Competing against yourself can be highly motivating.

One interesting cultural phenomenon observed during interviews and learner discussions was a fear of "game stigma". Many learners felt they could only admit to playing games in private. When 30 students were asked openly in a classroom environment, none admitted to playing computer games. However, when then given the chance to play with a "serious game" used on one of the courses at Shrivenham, the peer to peer conversations told a very different story with many joking with each other that they "*were not going to admit to playing "Gears of War" or Frontliners*" . This was then followed with a highly competitive multi player serious game experience based on the VBS platform.

The hypothesis put forward by one of the interviewees who has seen this phenomenon many times was what he called the "Walter Mitty syndrome". In explanation he pointed out that

"Some will feel that admitting to playing computer games, and particularly first person shooters, will leave them open to criticism. Because war is serious and their ultimate job, anything that is seen as trivialising or fantasising it will create barriers."

This is an important barrier that must be overcome by focusing on the performance benefits of ILS as opposed to the entertainment benefits of mainstream computer games. The tools fit so strongly with the subject matter, the learners and learning needs, therefore overcoming this cultural hurdle is a must. Using examples of ILS that can improve performance is one step in achieving this.

The ILS *'Airport Emergency Response'*, illustrated below, uses an egocentric design to give the player a high degree of control over the learning interactions. Challenge is provided by explicit timing and ongoing scoring. This is supplemented by real time feedback to key actions during the scenario.

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These competitive elements will appeal to and engage learners, particularly those who, like many in the military, enjoy competition in other areas of life.

Image 25: ILS example – Screenshot from 'Airport Emergency Response' developed by IncredibleBox[104].

10.4. Sport and competition

As discussed, the Military ethos is highly competitive, with sports and competitions at the heart of military culture. One extension of this element of competition worth exploring is that of the role of 'sport'. No other private or public sector organisation puts so much emphasis on sport and competition as does the military.

Internationally there is a Military International Sports Council, with 131 participating nations in hundreds of events in 25 sports. Nationally, competition between the Services and other entities, such as regiments, is seen as fundamental[105]. In other words, the ethos of sports and competition is supported institutionally.

The learner surveys from the DCMT showed all respondents to be involved in sport at least once a week. Furthermore, the majority are involved more than twice a week in a sporting activity. This helps demonstrate how central to the

[104] http://incrediblebox.com/clients/simclient Accessed 7th July 2008.
[105] The annual Army Navy rugby match is a good example: in May 2008, the match was attended by 50,500 people, many of them serving or retired members of the Armed Services and their extended families.

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student's life sport is. This is seen in even greater detail elsewhere in the UK MOD.

The RAF Sports Board is responsible for policy, providing guidance to volunteer sporting committees throughout the RAF and also administers funding for sport. Sport in the RAF provides an inducement to physical fitness, and contributes to military effectiveness by encouraging personal qualities such as courage, resilience and esprit de corps and has a significant effect on morale. Sport is an integral part of the RAF ethos, and the fulfillment of the sporting expectations and activities of RAF personnel remains a significant retention and recruitment factor.

The Army Sport Control Board has 42 Sport Unions and Associations and organises competitions at all levels in 53 different sports, with over 100 international sportsmen and women currently serving in the British Army. Adventurous Training is an adjunct to formal military training; it has been recognized as giving support to the values and standards of the British Army:

"To develop, through authorised challenging pursuits and within an outdoor environment, leadership and the qualities necessary to enhance the performance of military personnel during peace and war.

"Challenging outdoor training for Service Personnel in specified adventurous activities, involving controlled exposure to risk, to develop leadership, teamwork, physical fitness, moral and physical courage, among other personal attributes and skills vital to operational capability."

Interestingly, these activities are seen as providing both direct and indirect training and preparation for military staff.

Competition and challenge as shown are key ingredients in gaming, and it is therefore highly likely to be well received by the military target audience that embraces so much of this in sport.

10.5. Games and motivation

In terms of retaining students and staff and motivating them to learn, the particular arguments around the use of games seem clear. Games and play are cultural universals (see section 5). Huge numbers[106] of people enjoy, watch, dabble and participate in games and play. The empirical evidence for the motivational power of games and play, from existing use alone, is compelling.

[106] In May 2007, published figures revealed that 8 million people world-wide subscribed to the online fantasy/role-playing game World of Warcraft.

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Whilst some see games as 'frivolous', there is strong evidence that the motivational 'pushes and pulls' that games and play provide solve what is often a problem in learning – lack of motivation. Whilst students were reluctant to self confess to being demotivated or not optimally engaged in lessons, there were plenty of suggestions as to how to make the teaching more engaging. These included practice sessions, use of simulations and competition. In addition it was noted during the interviews that many of the topics taught at the DCMT are "theory heavy" - ensuring optimum engagement would be a valuable goal.

Games are congruous with motivational theory, providing many ingredients, some identical to learning virtues, for motivational success:

1. Intrinsically motivating
2. Autonomy
3. Self-confidence
4. Challenges
5. Feedback
6. Goals
7. Social

Of course, motivation is not the same thing as learning, and learning is not wholly down to motivation; there are many factors that affect both motivation and learning that are beyond the learner's control. However, without motivation, there is no learning; motivation is not the whole solution, but it is a necessary condition for success. Much of what passes for teaching is demotivating. Even advanced learners do not take readily to sitting in a classroom, lecture theatre, conference hall or training room, particularly if they are not stimulated and motivated. In an age where there is fierce competition for the attention of learners, we are duty bound to recognise that motivation matters. This should be noted when 70% of the teaching format at DCMT is classroom or lecture based.

These motivational opportunities go far beyond the well-researched areas of Modeling and Simulations. It is often too easy to centre a view of games technologies on physical equipment simulators, mathematical modeling programmes and real equipment exercises. The fact is that the pedagogical and motivational benefits of games technologies are as applicable to an officer student in the classroom as they are to the provision of, for example, a rifle simulator to hone an infantryman's skills.

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10.6. Learner Demographics

Another clear and consistent fact emerging from the interviews was the age of the current learners and an awareness of their improving digital awareness. At DCMT the average age of the learners was approximately 30 years old. New recruits into the Armed Forces range from late teens to early twenties, placing many well inside a group dubbed "Generation Y".

Generational shifts take place driven by major events such as; wars, cultural changes, or more recently by technological advances.

Size	Age (2007)	Years born
WWII Generation	76+	1932 to earlier
Swing Generation	61- 75	1945 to 1933
Baby Boomers	42-62	1946 to 1964
Generation X	30-43	1965 to 1976
Generation Y	12-31	1977 to 1994
Post Millennial	0-13	1995 to Present

Table 1: A list of popular demographic group descriptions.

Further demographic distinctions have been made around gaming, which would indicate that current learners at DCMT are likely to have had an upbringing where computer games played an increasing role and were becoming more and more 'immersive' (a function of the combined effects of interactivity, realism, cognitive processing and collaboration):

	Gamer 1.0	Gamer 2.0	Gamer 3.0	Gamer 4.0
Born	1960-1970	1971-1980	1981-1990	1991-2010
Gaming period	1970-1980	1981-1990	1991-2000	2001-2010
Games	Pong	Pac-Man Space Invaders Super Mario	Myst Zelda Tomb Raider Diablo EverQuest	Sim City The Sims Halo World of Warcraft America's Army GTA
Interactivity	Extremely low	Low	Moderate	Immersive
Realism	Extremely low	Very low	Low to moderate	High to extremely high
Cognitive	Low	Low	Moderate	High

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processing				
Collaboration	None	Low	Minimal	High

Table 2: Taken from Kapp 'Gamer demographics' (2007)[107]. The table illustrates the changes in game technology and methods over time.

Baby boomers were shaped by the culture of television, gamers by games. One need not have played games to have been influenced by them and their cultural effect. In practice, anyone recruited from 1970 (this will undoubtedly include many of those currently undertaking courses at the Defence Academy) will have been aware of gaming culture and, as the years progress, that culture has become deeper and stronger.

Current recruits are likely to have a view of the military shaped through the lens of military gaming. In many cases this will have been hundreds of hours of military gaming, playing various roles from infantryman to commander, using a huge range of weapons and even flying aircraft using the actual instrumentation. New officers are, for the first time, Generation Y (born after 1977) and therefore likely to be technically proficient in playing games. This significantly male target audience is likely to be familiar, in varying degrees, with games and gaming conventions and culture. All of this points to a world in which gaming is seen as a normal, mainstream form of military training, certainly for Generation Y and beyond.

10.7. Recruitment and retention

Recruitment now targets Generation Y and with the extraordinary success of America's Army (over 9 million registered users) and games on service recruitment sites in the UK, this technology may already have become an expectation.

Recruitment has to use professional marketing to target its audience and make the right people take action. Traditional marketing techniques, such as schools activity and high street recruitment centres, are being supplemented and increasingly replaced by online marketing. RAID and Commando Adventure are games found on the Royal Navy recruitment site and games culture has influenced recent TV recruitment ads. Increasingly, recruitment draws on games culture as potential recruits are likely to be gamers.

Whilst this seemed a small consideration for the learners at the Defence Academy, who were all junior officers and committed to their careers, the issue of soldier retention has been noted in many other areas of the MOD.

[107] Kapp K -Gadgets, Games and Gizmos for Learning: Tools and Techniques for Transferring Know-How from Boomers to Gamers (2007) - Pfiffer.

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11. Barriers to ILS adoption

Learner and trainer interviews also identified a number of barriers to ILS adoption. These potential obstacles were consistently cited. In addition, the researchers have sampled views of learning and training practitioners across all services in the MOD. The same barriers to progress were listed by these parties. While the latter observations are somewhat anecdotal, it is the view of the authors that the list of barriers cited is germane to many military functions and does not only reflect the situation in DCMT.

The barriers to adoption do not only apply to "games-based learning" approaches but were cited also with reference to eLearning and other forms of technology based learning. The barriers identified can be described as either 'cultural' or 'structural' in nature. Those identified are listed below:

Cultural barriers:

- Command and control, hierarchical culture – the use of ILS and in particular Virtual Worlds was perceived as a decentralising format.
- Risk averse culture – many responses mentioned the 'conservative' nature of the culture. This appeared at odds with many of the cutting edge technologies and methods used in operations.
- Fear of failure within hierarchy, and among peers – this applied to training managers around the risk of trying a new learning method to their credibility and also to learners as described within 'Safe failure'.
- Strong cultural of didactic, instructor-led learning – linked to the 'conservative culture' responses, this was seen as a barrier to trying new methods.
- No culture of 'change management' – especially relating to IT deployments; there was a perception that technology use in training was difficult to implement successfully.

Structural barriers:

- Linear training and promotion pipeline with no side-feeds – personnel involved in training and development change role regularly. It was therefore seen as difficult to build expertise in a new learning discipline such as ILS. In addition, 'new blood' did not enter the training and development ranks from industry.
- Generation gap in awareness and skills – high level decision makers were seen to be from a different generation. Convincing them of the utility of ILS would take a lot of evidence.
- Policies that focus on management of teaching, not learners – this can overly focus on a top line of teaching or lecture hours as a measure of learning investment into the organisation. This can then be a barrier to implementing other methods that require greater time investment but which deliver greater learner engagement and performance.

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- SMEs block change as they don't want to lose their power – this is seen in many organisations. The SME holds an esteemed role in learning design. The introduction of new technologies is sometimes perceived as a threat to these roles.

Combined, these result in initiatives that address tasks, not cultural and structural changes, with little sustainability through change management. Champions are scattered, often younger, and not yet in powerful enough positions to form an effective coalition. In addition, knowledge of possibilities and successes is fragmented.

Potential solutions to these barriers do exist and should be considered for individuals wishing to utilise ILS within their learning mix. We describe these in the next section.

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12. Conclusions and Recommendations

This report has started the process of exploring the synergy between the Defence Academy/DCMT, the wider military context and the use of ILS. It has found many compelling reasons, and a growing evidence bank, that justifies the adoption of a "learning through games strategy". These involve researched intuitions and hypotheses about the merits of games that seem to fit with the DCMT and wider military context, including; *learner demographics, need for motivation, competition, dry subject matter, opportunities for safe failure, need for rich practice, and familiarity with simulations*. The evidence bank both within the military and outside is also becoming powerful, with ROI measures in specific ILS case studies showing developments such as: *reduced training costs, reduced training time, increased learner engagement / motivation, improved learning outcomes.*

There is now available an almost overwhelming set of case studies, researched arguments and well thought through intuitions that point towards embracing this approach. It would be hard to argue against the view that the evidence is already as compelling as that behind the use of traditional CBT or e-learning approaches.

However, this report also points to a number of barriers that may exist in the military context, which will have to be considered when looking at many forms of online learning, but are further emphasised in the case of ILS. Some of these issues are specific to the military, and often work against the acceptance of new technology solutions:

Potential solutions to these barriers do exist and should be considered for individuals wishing to utilise ILS within their learning mix. These include:

- Utilising the evidence base already in existence, some of which has been captured in this report, to help demystify the approach.
- Development of clarity in business case generation about what type of ILS is needed to achieve identified learning objectives.
- Development of a critical mass of success stories, especially trigger point successes, whether they be overall transformations within a training establishment, individual projects in a specific subject area or successful applications of a new approach or technology.
- Planned development of the 'intelligent trainer' and adoption of new knowledge and skills.
- Professional change management so that successes can be sustained and structural and cultural issues addressed 'head on'

This report has been developed on just one area of the MOD and on one site only within the Defence Academy. Therefore, whilst the arguments and evidence base are far broader, the ease of extrapolation to other sites with

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different learning environments and learner demographics would have to be examined. In some instances the cases might be even more compelling, whilst the use cases might make less sense in others. Furthermore, this demonstrates the need for further analysis and research into a number of areas, and for decision makers or business case creators to use the tools provided within this report to help them make a broad, evidence-based representation, focused on their own needs and objectives. The definitions provided, along with the ILS taxonomy, should be used in presenting any arguments for the use of ILS within a military landscape. In addition, the case studies and weight of literature should be used to show that we have passed the "untried and untested" phase. Whilst further research must be generated and further pilots commissioned, presenting this data can help remove some of the ingrained cultural resistance that exists.

Suggestions for Use Cases

In carrying out the interviews with a range of trainers and teachers at DCMT, a handful of potential developments were flagged as excellent examples of "needs for an ILS approach". These suggestions are headlined below for further consideration.

- Scenario planning and project management decision making - organise resources, construct plans and test scenarios within military context. Recommend Real Time Strategy or Construction Based Sim design.
- Advanced Decision Making techniques – applying appropriate decision making techniques in scenarios that are high pressure and information rich. Recommend Egocentric Performance Sim design.
- Interpersonal skills development – a range of human to human scenarios examining the learners ability to deal with [resistant / irate / demanding / frustrated / distraught / hostile / confused / angry] individuals or groups at various levels within and outside the organisation effectively. Recommend Egocentric Performance Sim or Branching Story Sim designs.
- Officers Command Training – command, leadership and management skills. Recommend Scenarios that require learners to manage complex resources in a Real Time Strategy or Episodic Sim.
- Crowd control, patrol and cultural awareness on operations – team based, multiplayer ILS. Recommend structured Virtual World.
- Teambuilding and teamwork to solve operational issues – team based, multiplayer ILS. Recommend structured Virtual World.

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- Induction training and familiarity – interactive problem solving scenarios that enable new inductees to rapidly understand new roles, health and safety and locations. Recommend Branching Story Sim or Exocentric Sim design.

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13. Appendices:

13.1. Structured Interview Flow

Defence Academy Serious Games and Virtual Worlds Study

Structured Interview Questionnaire

Name of Interviewee:

Appointment/Post:

Foreword

A recent report by the e-Learning Guild[108] has helped to define what is meant by and the usefulness of Immersive Learning Simulations, Serious Games and Virtual Worlds.

An **Immersive Learning Simulation (ILS)**, also known as a **Serious Game**, is an optimized blend of simulation, game element and pedagogy that leads to the student being motivated by, and immersed into, the purpose and goals of a learning interaction. Serious games use meaningful contextualization and optimized experience to integrate the engagement of well-designed games with serious learning goals.

A **Virtual World** is a computer-based simulated environment intended for its users to inhabit and interact via avatars. These avatars are usually two-dimensional or three-dimensional graphical representations. Often many users can interact simultaneously within the worlds across networks.

Permission

I give permission to record my responses. I understand that these recordings will only be used in connection with this study and that the information from this study will be annonomised accordingly.

Signed (Interviewee):

Date:

Signed (Interviewer):

Date:

[108] http://www.elearningguild.com/

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Landscape:

1. Please describe the typical/main courses you teach. Include subject domain, course duration, frequency, mix etc.

2. Please describe how many lessons you would teach in a typical day

3. Please describe the most common lesson structure and duration

Delivery:

1. What content type do you usually deliver lecture style (Knowledge, Case Studies, Practical examples, Skills)?

2. How important is contextualization in your teaching and how do you achieve this?

3. What would you say is the key to gaining student engagement and attention in lessons/courses and how do you achieve this?

Learners:

1. Please describe the range of students you teach. Include gender split, age range

2. Please describe how much time you will spend with these students during a normal working week

3. What would be the average formal qualification levels of the students you teach (military and civilian)

4. Do you feel these learners have changed at all over the past 5-10 years in terms of attitude, ability, demands?

5. How competitive do you feel the typical learners are (more so or less than individuals of similar social-demographic profile that are not in the military) why do you think this is?

6. How "tech savvy" do you feel your learners are? Has this changed over the last 10 years?

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7. How comfortable do you feel your learners are with the concept of failure during learning experiences?

Teachers/Trainers:

1. Please describe the range of teachers used on your courses

2. What would be the formal qualifications these teachers/trainers would have on your courses

3. Do you feel these teachers/trainers have changed at all over the past 5-10 years in terms of attitude, ability, demands? (reference technology use/awareness)

Technology/e-learning:

1. How often do you use technology (in all its forms including laptops, projectors, audio, video, multi media) in your lessons? And why do you use it?

2. How often do you use elements of e-learning in your courses (either self study, group work or pre work)?

3. What benefits do you hope to derive from using such methods?

4. Do you think the students respond well to this type of delivery when compared to other methods?

5. In your view, what are the strengths of e-Learning delivery in the organisation?

6. In your view what barriers exist to e-learning delivery? These maybe systemic, cultural or personal.

7. Where, if anywhere, do you feel you could use more e-learning in your courses? And for what benefit?

Simulations and Games

1. In what areas of your curriculum, if any, are simulations and games (including war games) used in the delivery of learning?

2. What in your view are the strengths of these approaches?

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3. What in your view are the drawbacks or issues associated with these approaches?

4. Where else could you see games and simulations being used in your courses?

Serious Games / Immersive Learning Simulations

1. What do the terms Serious Games or Immersive Learning Simulation mean to you?

2. Where do you think that these approaches could be used in your learning curriculum?

3. Where do you think that Serious Games / Immersive Learning Simulations could **not** be used in your learning curriculum?

4. What do you think the benefits of such and approach are?

5. What do you think the learner reaction would be to the use of them in the courses

Virtual Worlds

1. What does the term 'Virtual Worlds' mean to you?

2. Where do you think Virtual Worlds could be used in your learning curriculum?

3. Where do you think that Virtual Worlds could **not** be used in your learning curriculum?

4. What do you think the benefits of such and approach are?

5. What do you think the learner reaction would be to the use of them in the courses

Close:

Thank the interviewee for their time, explain that these interviews, along with the literature review, the pre-interview questionnaires are going to be the evidence base used to develop the full report and we expect to submit the final draft in June. Ask if there are any other comments, questions that they would like to raise.

Comments:

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13.2. Learner Survey Flow

1. Defence Academy Learner Survey - Technology Section

This is a short "Learner Survey" which aims to collect some raw data from learners currently studying at the Defence Academy. It is part of a wider report on the use of new technologies within education and training. The report has a particular focus on understanding the appropriateness of the use of Games, Simulations and Virtual Worlds within the different courses at the Defence Academy.

The aim of this short survey is to get a top line view of the learners studying at the Defence Academy.

All result are made completely anonymous and only the aggregated data will ever be made public knowledge. The results will only ever be used for the purpose of this survey and will not be shared with any other parties

Thank you in advance for spending the 5 minutes or so it will take to complete it.

*

1. How often do you use the internet?

Every day

2/3 times a week

Once a week

Once a month

Very rarely/never

*

2. For those that use the internet, how many hours do you spend a week for each of the outlined activities? Work (include education, training, research)

0 1-4 5-10 11+

Other (include entertainment, personal comms, interest & hobbies etc)

0 1-4 5-10 11+

*

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3. How often do you use any social networking sites such as Facebook, Myspace, Bebo, Second life, MSN forums?

Very frequently (eg a number of times a day)

Often (eg at least once a day)

Occasionally (eg at least once a week)

Seldom (once a month)

Never

What?

*

4. How often do you play computer/video games? (this includes, PC, console, handheld or arcade games)

Every day

2/3 times a week

Once a week

Once a month

Rarely/Never

*

5. On a scale of 1 - 5 , where 1 is the least and 5 is the greatest, how technology literate would you say you are compared to the general population? (technology includes all aspects of ICT)

1. Completely Illiterate 2. Below Average Literacy 3. Average Literacy

4. Above average literacy 5. Advanced literacy

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2. Defence Academy Learner Survey - learner profile

*

1. How often do you play sport?

Every day

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2/3 times a week

Once a week

Once a month

Rarely/Never

*

2. How competitive would you say you are?

Not at all competitive Mildly Competitive

Competitive Extremely competitive

*

3. Do you feel that you learn more from success or failure?

Success

Failure

Equal

*

4. Are you prepared to be seen to fail in front of your peers/superiors?

Yes

No

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3. Defence Academy Learner Survey - Lessons section

*

1. How would you rate both the availability of and the effectiveness of the use of technology to support learning and teaching on your course(s)?

Ubiquitous Available most of the time for most tasks

Available some of the time Very limited availability

What Technology?

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How would you rate both the availability of and the effectiveness of the use of

*

2. How engaging or motivating are the majority of your lessons at the Defence Academy?

Highly Engaging Mostly Engaging Somewhat Engaging

Not Very Engaging Boring

Percentage of Lessons

How engaging or motivating are the majority of your lessons at the Defence Academy? Percentage of Lessons Highly Engaging

0-25%

26-50%

51-75%

76-100%

76-100%

*

3. Out of the options below click the boxes that you feel would make the lessons even more engaging?

More context and concrete examples

More use of competition in learning

More practice opportunities

More theoretical background

More use of games that aid learning

More use of models and simulated situations