**Institution: Coventry University**

**Unit of Assessment: 11**

**Title of case study: Serious Games Innovation and Business Engagement**

## 1. Summary of the impact

The key impacts of the research into the non-entertainment use of computer games technology and virtual worlds at the Serious Games Institute (SGI) have been:

- **Economic and commercial impacts on various stakeholders**
- **Impacts on practitioners, professional services, public understanding and public debate**

The reach of these impacts extends to partners both within the UK and overseas.
**Beneficiaries** include companies, health professionals, educators, young people and their parents.

## 2. Underpinning research

Professor **de Freitas** co-founded the Serious Games Institute (SGI), and was responsible for building up a group of computer scientists and other researchers to develop and evaluate serious games as a new cross-disciplinary area in the intersection between technology-enhanced learning and human-computer interaction. **de Freitas** joined Coventry University in 2007. While the use of games in teaching and learning dates back to the early 1980s there was very little in the way of rigorous research to prove and validate the efficacy of game-based learning approaches for training and education applications. Much of what was published was inconclusive or lacked an understanding of educational research methods.

Between **2007** and **2009 de Freitas** developed her research on the basis of funding from the Joint Information Systems Committee (JISC) e-Learning Programme and a large Technology Strategy Board (TSB) part-funded project led by Blitz Games Studios, a medium-sized games company based in the West Midlands. This early research aimed to prove and validate the efficacy of game-based learning approaches for training and education applications by undertaking the first pragmatic controlled trials in serious games research [1]. The study involved Knight (Birmingham University), **de Freitas** and **Dunwell** (SGI). The trials involved 91 NHS Doctors, Nurses and Paramedics who attended Advanced Life Support Group (ALSG) Major Incident Medical Management and Support (MIMMs) training courses. The controlled trial compared a table top exercise with serious game-based training and showed that serious games were more effective than traditional training methods in the area of Medical Triage Training [1,2]. This research significantly catalysed the debate around serious games, helping to move it from the margins to a mainstream topic for organisational training and development. The research group at the SGI increased in number and the research focused upon evaluation methodologies and validation metrics, building upon **de Freitas'** four-dimensional framework for designing and evaluating immersive learning experience in virtual worlds [3] and the exploratory learning model [4]. This early research led to what is now termed the 'first generation' of serious games, and the main focus was on validation and evaluation, rather than innovation.

Between **2009** and **2013**, research had proved the efficacy of game-based approaches had been proven [5], and there was a shift in focus to more advanced problems in the field, such as improving visualization and modelling, as well as innovative brain-computer interaction issues. **de Freitas** and her research group focused upon the usability of Brain-Computer Interface (BCI) [6,7]. This research led to an exploration of other brain scanning approaches including early work focusing upon Near-Infrared Spectroscopy (NIRS) with Yang at Imperial College, which tested traditional compared to game-based learning with novice and experts in the Triage Trainer. This preliminary work helped solve experimental design problems by using eye tracking and led directly to the current research studies with Neuper's group at Graz University under the European Union funded Network of Excellence in Serious Games (GALA). GALA focuses upon studying the role of dynamic brain input signals during game play as an adaptive feedback mechanism, using Near-Infrared Spectroscopy (NIRS), electroencephalography (EEGs) and eye tracking.

Between **2012** and **2013**, **de Freitas** and her group consolidated the wide range of studies completed since 2007. As well as holding Scientific Coordination of GALA during this period, the team had 24 projects, including 12 European Union funded projects, such as Inspiring Science,

ALICE, MEducator and MASELTOV. This later work aimed to produce and consolidate validation and evaluation methodologies, perfecting new experimental designs and pioneering new forms of human-computer interaction. The new wave of research has focused on understanding feedback in game play, and on methods for replicating effective educational game design techniques. This includes ALICE where the game is implemented within a Learning Management System (LMS) as a learning object [8], and the Jaguar Land Rover funded project which is developing a mobile avatar interface for vehicle drivers. In collaboration with health researchers submitted to UoA3, **de Freitas** and her research group used a cluster randomized control trial to evaluate a serious game called PR:EPARe for Relationships and Sex Education [9].

**3. References to the research**


1) Knight, J.F., Carley, S., Tregunna, B., Jarvis, S., Smithies, R., **de Freitas, S., Dunwell, I**., & Mackway-Jones, K. (2010). Serious gaming technology in major incident triage training: A pragmatic controlled trial. Resuscitation 81(9), 1175-1179. (Citations: 15; Impact Factor: 4.104)
2) Jarvis, S. & **de Freitas, S**. (2009). Evaluation of an immersive learning programme to support triage training. *IEEE Virtual Worlds for Serious Applications First International Conference, VS-GAMES 2009* Los Alamitos, CA: IEEE Computer Society. (Citations: 6)
3) **de Freitas, S.** & Oliver, M. (2006). How can exploratory learning with games and simulations within the curriculum be most effectively evaluated? Computers and Education, 46 (3): 249-264. (Citations: 127; Impact Factor: 2.775)
4) **de Freitas, S.** & Neumann, T. (2009). The use of 'exploratory learning' for supporting immersive learning in virtual environments. Computers and Education, 52(2): 343-352. (Citations: 51; Impact Factor: 2.775)
5) **de Freitas, S**., Rebolledo-Mendez, G., Liarokapis, F. Magoulas, G. & Poulovassilis A. (2010). Learning as immersive experiences: using the four dimensional framework for designing and evaluating immersive learning experiences in a virtual world. British Journal of Educational Technology, 41(1): 69-85. (Citations: 24; Impact Factor: 1.313)
6) Rebolledo-Mendez, G. & **de Freitas, S.** (2008) Attention modeling using inputs from a Brain Computer Interface and user-generated data in Second Life. In Proc. of the Workshop of Affective Interaction in Natural Environments (AFFINE) 2008. In association with ACM Tenth International Conference on Multimodal Interfaces (ICMI), Crete, Greece. (Citations: 9)
7) Rebolledo-Mendez, G., **Dunwell, I.,** Martínez-Mirón, E.A., Vargas-Cerdán, M.D., **de Freitas**, **S**., Liarokapis, F. & García-Gaona, A.R. (2009). Assessing NeuroSky's usability to detect attention levels in an assessment exercise. *Human-computer interaction. New Trends. 13th International Conference, HCI International 2009, San Diego, CA, USA, July 19-24, 2009, Proceedings, Part I.* Berlin: Springer. (Citations: 8)
8) **Dunwell, I., Petridis, P.**, Arnab, S., Protopsaltis, A., **Hendrix, M., & de Freitas, S**. (2011). Blended game-based learning environments: extending a serious game into a learning content management system. *Third IEEE International Conference on Intelligent Networking and Collaborative Systems: IEEE INCoS 2011.* IEEE Computer Society. (Citations: 2)
9) Arnab, S., Brown, K., Clarke, S., **Dunwell, I**., Lim, T., Suttie, N., Louchart, S., **Hendrix, M**., & **de Freitas, S**. (2013). The Development Approach of a Pedagogically-Driven Serious Game to support Relationship and Sex Education (RSE) within a classroom setting. Computers and Education, 69: *15-30.* (Impact Factor: 2.775)


**Key Funding**


- Serious Games – Engaging Training Solutions Grant held by Blitz Games. Co-funded by Technology Strategy Board. Duration: Three years: 2006-2009 Amount: £1,000,000, project total of £2,000,000. **de Freitas'** share of the funding £70,000.
- JISC Funding **de Freitas'** share of the funding £412,000.
- The GALA network of excellence, grant held by Genoa University, funded by the European Union FP7 (NoE). Duration: 4 years: September 2010-August 2014. Amount: €5,600,000. **de Freitas** is Scientific Coordinator of the Network. **de Freitas'** share of the funding €255,000.
- ALICE, funded under the FP7 STREP by the European Union. Duration: 2 years: September 2010-October 2012. Amount: € 2,244,720. **de Freitas'** share of the funding £247,000. The

project was rated 'Excellent' in the final review.

- Engineering and Physical Sciences Research Council (EPSRC): Future ICT-enabled Manufacturing. January 2013-December 2018, total budget: £2,000,000. **de Freitas'** share of the funding £467,079.
- European Commission Framework 7 Programme. Integrated Project. FP7-ICT-2013-10: MAGELLAN October 2013-September 2017, total budget €6,750,000, **de Freitas'** share of the funding €366,320.

**4. Details of the impact**

In 2007, the Serious Games Institute (SGI) was set up as a hub of excellence in serious games and virtual world research, providing business development support and flexible rental accommodation for new and emerging SME companies in the UK and worldwide. The aim was to bring business development capabilities and networks of supported companies together with high quality research in a unique physical and virtual network environment. The SGI was funded by a £7 million recoverable grant from the West Midlands Regional Development Agency and others. The various funders required the SGI to deliver quantifiable annual measures of impact including: spin outs, product development, technology transfer, knowledge transfer, jobs created and protected, IP generated, overseas partnerships and direct industrial funding. This research group is therefore focused on ensuring these measures are delivered over the 15 year life-time of the recoverable grant. To achieve this the SGI works with a network of over 30 companies including: US-based Area/Code (now Zynga) and NeuroSky and, within Europe: Blitz Games Studios (founders now working in new company, Radiant Worlds), I-Maginary, PlayGen, Roll7, Succubus Interactive, Serious Games Interactive, V-Step etc.

**Economic and commercial impacts on various stakeholders**

**Business Engagement:** The research on the efficacy of serious games, and work around game design, validation and evaluation metrics, has had a quantifiable impact upon a network of over 30 companies. **de Freitas** and her group's research has had a direct impact upon educational game design and improved usability of products that in turn have improved the reputation of the companies and their products. For example, Mr Richard Smithies, previously Chief Executive Officer, Blitz Games Studios (now co-founder of Radiant Worlds), stated that "the use of the four-dimensional framework for learning through games was often quoted in company presentations as well as used for design ...the research published about Triage Trainer did increase profile" [d]. Triage Trainer validated TruSim's (a division of Blitz Games Studios) approach to serious games and enhanced its reputation as a leader in the field. This resulted in a major contract from the US Department of Defence to create a 3D motion controlled game for combatant rehabilitation.

**Technology transfer and brokering partnerships:** In 2009, while looking for a low cost brain-computer interface to support a new research area, **de Freitas** and her group found NeuroSky, a Brain-Computer Interface (BCI) headset that uses electroencephalography (EEG) technology. The headset can read a user's level of concentration and relaxation and in turn those signals can be used to control game-play. Following evaluation of the research and commercial potential of the NeuroSky Brain-Computer Interface it was introduced to the network of 30 SGI companies. This technology transfer allowed Roll7 and NeuroSky to forge a commercial deal with backing from the West Midlands Regional Development Agency to create a series of games to be bundled with the headset to show off its capabilities. Current sales figures indicate that Roll7 has gained over £150,000 in sales with three new jobs created. Roll7 is also working with the Singapore SGI (one of the international spin-outs from the SGI) on applications of brain-computer interfacing, co-funded by the Singapore Media Development Authority (MDA). For example, *Focus Pocus* is a serious-game aimed at children with attention deficit hyperactivity disorder (ADHD) and is being rolled out in Singapore. Similarly, Mr Johnny Liu, Manager at NeuroSky, has stated that the association with **de Freitas** and her research group had helped them make continuous improvements in their technology and encouraged them to make both a consumer and a research version of the product which has resulted in a five-fold growth in sales since 2009 [c].

**Commissioning and bidding for funds with partners**: PlayGen attracted a commission from the Primary Care Trust for the sexual health game for parents, benefiting directly from **de Freitas** and her group's research on the efficacy of serious gaming. PlayGen's turnover is approximately £1

million, of which the relationship with **de Freitas** and her group secured some 6% over the period including one staff post being created. Collaborative research has also led to an EPSRC I-Case studentship amounting to £82,000. Mr Kam Star, Managing Director of PlayGen, indicated that 'The company's future direction had fundamentally shifted their fortunes and they were in line to receive hundreds of thousands of Euros working with Universities across Europe as a direct result of involvement in the EU-Funded GALA Network of Excellence' [a].

**International SGI partners:** Serious Games Institutes are being established overseas, with the support of the Unit's researchers. For example, in 2011 **de Freitas** and her team worked with the spin-out company, Singapore SGI, securing £500,000 investment from the Media Development Authority (MDA) to support development of a cluster of companies in Singapore's serious games sector. Similarly, in South Africa, a joint venture between SGI and North Western University was opened in 2012 with initial investment of £50,000 p.a. from Nuffic (Dutch funding agency). A collaborative SGI at George Mason University in Washington has been established with regional funding. To date, jobs have been created in Singapore (5), South Africa (3) and America (1). The close working relationship with industry ensures impact on both sides and has encouraged other partners across four continents to set up branches using the same model. The model replicates the SGI including: business services such as mobile application development, training services, shared IP, a Doctoral school, student and staff exchanges and Masters programmes, as well as collaborative project work and co-development of projects. Technology and knowledge transfer are being supported by this model, which impact on local industries.

**Commercial spin-outs:** The success of the SGI led to the spin-out of UK company Serious Games International Ltd (SGiL) which attracted £2 million in Coventry University investment to exploit the intellectual property using technology and expert knowledge from the research of **de Freitas** and her research group. To date, 27 new jobs have been created and after its first year of trading the turnover is in excess of £2 million. Projects have been secured from Jaguar Land Rover, Nissan, BAE Systems, Vision Express, TXMax, NHS and others [b].

**Impacts on practitioners, professional services, public understanding and public debate**
The PR:EPARe game aims to support the delivery of the Relationship and Sex Education (RSE) programme, promoting shared discourse and debriefing within a formal classroom setting. The project is funded by the Health Innovation and Education Cluster (HIEC) for West Midlands (South), UK and the game was developed as a result of the funded research collaboration between **de Freitas**, her research group and a research team submitted to UoA3 Allied Health. The interactive serious game is called Positive Relationships: Eliminating Coercion and Pressure in Adolescent Relationships (PR:EPARe). The game was designed, developed and evaluated by Coventry University and is currently being rolled out across local schools in Coventry and Warwickshire. The game is designed for teachers, parents, and teenagers themselves, as a resource to aid sex education, tackling pressure and coercion in teenage relationships. There are over 22,000 visits a year to website on which the PR:EPARe is hosted and the PR:EPARe serious game received significant media attention, promoting and stimulating public awareness.

**5. Sources to corroborate the impact**

(a) Testimonial from the Director of PlayGen UK Ltd
(b) Testimonial from the Managing Director of Serious Games International Ltd
(c) Testimonial from the Manager at NeuroSky, USA
(d) Testimonial from the previous Chief Executive Officer, Blitz Games Studios UK