

<b>Institution:</b> Coventry University		
<b>Unit of Assessment:</b> 32		
<b>Title of case study:</b> Transdisciplinary game design and practices		
<b>Period when the underpinning research was undertaken:</b> 2010 to 2020		
<b>Details of staff conducting the underpinning research from the submitting unit:</b>		
<b>Name(s):</b>	<b>Role(s) (e.g. job title):</b>	<b>Period(s) employed by submitting HEI:</b>
Prof. Sylvester Arnab	Professor in Games Science (Applied Games)	2009 to present
Dr. Samantha Clarke	Assistant Professor of Design Futures	2011 to present
Dr. Petros Lameris	Assistant Professor	2012 to present
<b>Period when the claimed impact occurred:</b> 2014 to 2020		
<b>Is this case study continued from a case study submitted in 2014? Y/N</b> No		

### 1. Summary of the impact (indicative maximum 100 words)

The game-based learning market is expected to reach \$17 billion by 2023. Arnab developed a transdisciplinary game design model to enhance the ability of serious games to be replicated for educational purposes with international impact. The impact of the novel game design model on the practices of beneficiaries such as educational game designers, digital technology industry, and non-expert audiences, respectively, are: 1) impact on game production with an increased rigour in the design and development approach, 2) economic impact in the improved capacity and turnover of start-up, small, and medium businesses in Europe, and 3) impact on practitioners through the upskilling of educators in international, marginalised communities to co-design and co-create game-based learning resources.

### 2. Underpinning research (indicative maximum 500 words)

Replicating a serious game can be difficult because many games do not follow a standard or specific set of guidelines based upon scientific and pedagogic rigour. Professor Sylvester Arnab from Coventry University investigated how to develop a novel, transdisciplinary (research that infuses knowledge and practice from various fields) and holistic model for serious game design that could be adapted to a range of educational settings.

From 2010 to 2014, Arnab (G1) investigated how to develop a robust methodology for correlating pedagogical constructs with game mechanics through a control trial of 31 participants. Partnering with Herriot-Watt University, Arnab developed a model for *Learning Mechanics-Game Mechanics* (LM-GM) that was tested with the 31 participants and demonstrated that the LM-GM model was a more rigorous approach compared to other models (R1). In 2014, Arnab partnered with Technology University of Tampere to examine how flow theory (the concept of total absorption in an activity) could be used to analyse educational games quality (R3). An empirical study of 98 students playing 'RealGame' (a business simulation game) indicated that the proposed *Flow Framework* was a useful tool to evaluate the quality of educational games (R3). From 2011 to 2013, Arnab and Clarke used the research findings of G1, R1, R3, and R4 to design and evaluate a game-based intervention about sexual coercion in relationships called *PR:EPARe* (R2). A randomised control trial of 505 participants suggested that blending interactive game-based approaches in a traditional classroom setting was an effective way of encouraging students to engage with sensitive topics (R2).

## Impact case study (REF3)

From 2014 to 2016, informed by R1-4, Arnab and Clarke developed a transdisciplinary methodology for designing game-based intervention that merged the LM-GM Model with other frameworks used to design and develop *PR:EPARe* (R2). In 2015, in partnership with Prof. Margarida Romero (University Cote d'Azur and Laval University), Arnab examined how to incorporate self-determination theory (motivational theory) into LM-GM, producing an adaptable model for mapping motivational constructs to LM-GM that could be used to inform game design (R5). From 2015 to the present, Arnab and Clarke used the research of R1 to R5 and G1, to investigate how to simplify the transdisciplinary model for non-game designers through the *GameChangers Initiative* (G3). Arnab and Clarke tested the simplified model with 122 Coventry University students. The students fed back that the game design approach enabled them to discover the importance of empathy and creativity through the process (G3).

In 2017, Arnab, Lamas and Clarke investigated how teachers could empathically and inclusively design, game-based learning resources for students in rural Malaysia (G4, R6). Arnab and partners from Universiti Malaysia Sarawak (UNIMAS) in Malaysia engaged with 600 teachers, educators and students to support the co-creation of over 20 game-based learning resources. This aligns with UNESCO's emphasis upon teacher upskilling as a key instrument for addressing Sustainable Development Goal for equitable and inclusive quality education.

Arnab's preceding research (R1-5) also led to the Beaconing project (2016-2019 G2, R6) that investigated 'anytime anywhere' learning with over 6,000 teachers and students in 10 European countries (including Poland and Romania). The project empowered teachers to co-produce their own gamified lesson plans using the resulting authoring tool. 87% of students (1,787 learners) that participated in the research, reported high engagement in the resources; and 84% affirmed that their learning performance had improved.

## 3. References to the research (indicative maximum of six references)

### References

R1. Arnab, S., Lim, T., Carvalho, M. B., Bellotti, F., de Freitas, S., Louchart, S., Suttie, N., Berta, R. and De Gloria, A. (2015) 'Mapping learning and game mechanics for serious games analysis'. *British Journal of Educational Technology* 46 (2), 391–411. DOI: <https://doi.org/10.1111/bjet.12113>

R2. Arnab, S. and Clarke, S. (2017) 'Towards a trans-disciplinary methodology for a game-based intervention development process'. *British Journal of Educational Technology* 48 (2) 279-312. DOI: <https://doi.org/10.1111/bjet.12377>

R3: Kiili, K., Lainema, T., de Freitas, S. and Arnab, S. (2014) 'Flow framework for analyzing the quality of educational games'. *Entertainment Computing* 5 (4), 367-377. DOI: <https://doi.org/10.1016/j.entcom.2014.08.002>

R4. Baalsrud Hauge, J. M., Stanescu, I. A., Arnab, S., Ger, P. M., Lim, T., Serrano-Laguna, A., Lamas, P., Hendrix, M., Kiili, K., Ninaus, M., de Freitas, S., Mazzetti, A., Dahlbom, A. and Degano, C. (2015) 'Learning Analytics Architecture to Scaffold Learning Experience through Technology-based Method'. *International Journal of Serious Games* 2 (1), 29-44. DOI: <https://doi.org/10.17083/ijsg.v2i1.38>

R5. Proulx, J-N., Romero, M. and Arnab, S. (2017) 'Learning Mechanics and Game Mechanics Under the Perspective of Self-Determination Theory to Foster Motivation in Digital Game Based Learning'. *Simulation and Gaming* 48 (1), 81-97. DOI: <https://doi.org/10.1177/1046878116674399>

R6. Arnab, S. 2020, *Game Science in Hybrid Learning Spaces*. *Digital Games, Simulation and Learning*, no. 6. 1st edn. UK: Routledge Taylor & Francis Group. ISBN 9781138239753

### Grants

G1. Arnab S. (Principal Researcher (2010 to 2012), Scientific Coordinator (2012 to 2014)) (2010 to 2014) *GALA - Games and Learning Alliance*. European Commission: FP7-ICT - Specific Programme: Cooperation - Information and communication technologies, grant number: 258169.

## Impact case study (REF3)

Total grant amount: €7,592,571.00 (£6,309,806.13), funding to Coventry University: €255,900.00 (£212,665.70). Available from <<https://cordis.europa.eu/project/id/258169>> [18 December 2020]

G2: Arnab, S. (PI) and Lamas, P. (Col) (2016 to 2019) *BEACONING - Breaking Educational Barriers with Contextualised, Pervasive and Gameful Learning*. European Commission: Horizon 2020 Innovation Action, grant number: 687676. Total grant amount: €7,047,298.75 (£5,201,611.21), funding to Coventry University: €784,987.50 (£579,399.27). Available from <<https://cordis.europa.eu/project/id/687676>> and <<https://www.coventry.ac.uk/research/research-directories/current-projects/2018/beaconing/>> [18 December 2020]

G3: Arnab, S. (PI) and Clarke, S. (Researcher) (2014 to present) *GameChangers*. HEFCE (now Research England): Catalyst Fund Call A: Small-scale, 'experimental' innovation in learning and teaching and match funding from Coventry University, grant number: PK44. Total grant amount: £66,588.10, funding from HEFCE: £33,294.00, match funding from Coventry University: £33,294.10. Available from <<https://gamify.org.uk/>> [18 December 2020].

G4: Arnab, S. (PI), Lamas, P. (Col) and Clarke S. (Col) (2017 to 2019) *CreativeCulture - Creative and Participatory Transcultural Practices and Problem Solving Through Game Design and Computational Thinking*. Arts and Humanities Research Council (AHRC): (UKRI-ODA) Newton Fund UK-SEA and Ministry of Higher Education, Malaysia (MoHE), grant number: AH/P013937/1. Total grant amount: £172,000.00, funding from AHRC: £80,640.00, funding from MoHE: £91,360.00. Available from <<https://gtr.ukri.org/projects?ref=AH%2FP013937%2F1>> and <<http://creativeculture.my>> [18 December 2020]

G5: Arnab, S. (PI) and Clarke, S. (Researcher) (2020 to 2021) *CreativeCulture 4.0 - Transforming 21st century teaching and learning of STEM in Malaysia through creative play and gamification towards Education 4.0*. Arts and Humanities Research Council (AHRC): Newton Fund Impact Scheme and MIGHT, Malaysia, grant number: AH/V004077/1. Total grant amount: £167,000.00, funding from AHRC: £74,809.00, funding from MIGHT: £92,191.00. Available from <<https://gtr.ukri.org/projects?ref=AH%2FV004077%2F1>> and <<http://creativeculture.my>> [18 December 2020]

G6: Arnab, S. (PI), (2020 -2023) *ACES - A Community-Centred Educational Model for developing Social Resilience: Playfulness towards an inclusive, safe and resilient society*. Economic and Social Research Council (ESRC): (UKRI-ODA) Global Challenges Research Fund, grant number: ES/T004789/1. Total grant amount: £1,371,786.00, funding to Coventry University: £845,000.00. Available from <<https://gtr.ukri.org/projects?ref=ES%2FT004789%2F1>> and <<https://aces.gchangers.org/>> [18 December 2020]

## Awards and accolades

A1. Gamification Awards (2020) *Gamification Award for Education and Learning 2019*. Awarded to the GameChangers Project (G3). Available from <<https://gamificationawards.org/blog/gamification-in-education-learning-award-winner/>> [18 December 2020]

A2. Gamification Awards (2020) *Gamification Award for Software 2019*. Awarded to the Beaconing Project (G2). Available from <<https://gamificationawards.org/blog/gamification-software-award-winner/>>

**The research references listed in this case study are from academic peer-reviewed articles, books, reports, and digital monographs. The grants listed in this case study were awarded through a competitive, peer-reviewed process.**

## 4. Details of the impact (indicative maximum 750 words)

The international impact on the practices of beneficiaries such as educational game designers, digital technology industry, and non-expert audiences are: 1) **impact on game production** with an increased rigour in the design and development approach, 2) **economic impact** from the improved capacity and turnover of start-up, small, and medium businesses, and 3) **impact on practitioners**

through the upskilling of teachers in international, marginalised communities to co-design and co-create game-based learning resources.

### 1. Impact on game production through increased scientific and pedagogical rigour of game design methodology

The LM-GM model (R1) was used by researchers internationally, to enhance the rigour of educational game design. In 2015 researchers from Ulster University and Worcester University (S1) adopted the LM-GM model (R1) to inform the design of 'Circuit Warz', a game for teaching electrical engineering principles to A-level and first-year undergraduate students. The use of the LM-GM model (R1) enabled the researchers to map the pedagogical elements of Circuit Warz with the game elements of the model, leading to the global release of Circuit Warz. Circuit Warz is now published for PC/VR platforms on gaming websites (including STEAM and Itch) with over 6,000 downloads worldwide to date. Circuit Warz won best overall game at the prestigious 4<sup>th</sup> *International Game Competition* at the *European Conference of Game-Based Learning* in Glasgow, Oct 2016 (S1), with the game being praised for good aesthetics and challenging learning puzzles. Circuit Warz has also been translated into Portuguese as a teaching aid for students at the Universidade Federal de Santa Catarina (UFSC), Brazil (S1, S2). Researchers at UFSC used the LM-GM model to develop a new photovoltaic systems game that was tested with 18 students through 30 game sessions (S2). 94% of the students agreed or strongly agreed that the game had been useful for establishing their knowledge of photovoltaic systems.

### 2. Impact on economic growth and innovation by stimulating start-ups/SMEs in Europe

Arnab used the research outcomes of R1 to R5 to develop European-wide, industry standards for game applications through the Beacons project (G2). The project led to seven European start-ups/SMEs expanding job creation, turnover, spin-off products, and recognition (S3, S4). Geomotion Games (Spain) was a one-person start-up, who since being involved with the project employed four additional people and significantly increased their turnover (from €7 thousand to €40 thousand in 2019). Informed by the research outcomes in Beacons (R6), Geomotion has also released a spin-off product, *PlayVisit*, a geolocation game authoring tool (Monthly Recurring Revenue of €1,250) (S5). *PlayVisit* has been used by the municipal authority in La Ramblas, Barcelona, to develop a location-based retail experience that attracted 700 participants into the area, and expanded the customer base of participating retailers (S5, R6). In January 2020, the learning approach developed by the Beacons project won the *Gamification Award for Software 2019*, demonstrating the recognition of its influence at an industrial level (A2).

### 3. Impact on practitioners through the upskilling of educators in the co-creation of game-based learning resources that are empathic to the needs of marginalised communities internationally

The game design methodology from R1, R2, R3, R6 and G3, has been adapted in Malaysia through the *CreativeCulture* project (G4, S6). The project provided over 600 teachers and students from rural schools in Borneo with access to game-based learning techniques and practices (R6, S6). Participating teachers developed over 20 game-based learning resources; co-produced practical game templates and guidelines; and created a set of playing cards for teaching game design (S6, S7, R6). The project also enabled educators at UNIMAS to embed Arnab's game design methodology (R1-3, R6, G3) in the Masters Programme in Learning Sciences and establish the first Gamification Centre in Malaysia (S6). The Centre provides teachers with a space to practice game-based learning methods in schools in Borneo, to enable the techniques to be replicated in their own schools (S6). *CreativeCulture* generated press coverage in Malaysia, which in turn led to the Department of Education collaborating with Arnab and UNIMAS upon the *CreativeCulture 4.0* project (G5). The project involves training 400 teachers in game-based learning methods by the end of 2021 (S6). The success of *CreativeCulture* led to the development of the ACES project (G6). The ACES project is rolling-out Arnab's transdisciplinary, game-based learning approach across education settings in Malaysia, Vietnam and Indonesia, and help these countries to achieve Sustainable Development Goal 4: '*Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all*'. In January 2020, the GameChangers initiative (G3) and the adaptation of the project methodology in the *CreativeCulture* project (G6), was recognised for its international impact by winning the *Gamification Award for Education and*

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*Learning 2019* (A1). Arnab's game-based learning methodology (R1-6, G1-6) has also been included as a key resource for game-based learning by the EU School Education Gateway (S8).

**5. Sources to corroborate the impact** (indicative maximum of 10 references)

S1. Reader, Ulster University (2020) *Influence of the Learning Mechanics-Game Mechanics Model (LM-GM Model) on Circuit Warz Testimonial* letter to Coventry University

S2. Coordinator of the Applied Research Laboratory, Universidade Federal de Santa Catarina (UFSC) (2020) *Influence of the Learning Mechanics-Game Mechanics Model (LM-GM Model) upon the development and application of Phototype testimonial* letter to Coventry University

S3: BEACONING Project (2018 to 2019) *Breaking Educational Barriers with Contextualised, Pervasive and Gameful Learning, Periodic Technical Report Part B*. European Commission. SME impact in turnover and employees see p. 44.

S4. BEACONING Project (2019) *Beaconing: Dissemination and exploitation of results (confidential report)*. European Commission. Impact summary see p. 18.

S5. Chief Executive Officer, Geomotion Games (2020) *Influence of the Beaconing project on Geomotion Games testimonial* letter to Coventry University

S6. Senior Lecturer and Associate Professor, Universiti Malaysia Sarawak (2020) *Influence of the CreativeCulture project upon Teaching and Learning practices in rural Malaysian schools testimonial* letter to Coventry University

S7. Evidence of teacher-created resources to showcase empowerment of teachers in innovative educational practices to corroborate S5.

S8: Evidence of how R1-6 and G1-6 have been included as a key resource for game-based learning by the EU School Education Gateway (available from <https://www.schooleducationgateway.eu> [18 December 2020]).