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Using Frugal Education Principles and the RPG Maker MV Game Engine to Aid the Co-creation of Digital Game-based Learning Resources

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Abstract: The exploration of digital game-based learning (DGBL) as an educational practice has been received relatively well amongst learning practitioners, particularly from a theoretical standpoint. However, when it comes to original content creation, there are multiple barriers to entry from a digital games design and development perspective. Digital games are typically resource heavy for new adopters who face issues such as: a lack of specialist skill; financial backing; personnel; time allocation; and access to essential technologies and infrastructure. At the same time, the pressure on Higher Education authorities to 'do more with less' without providing the tools and opportunities to do so, leaves little room for experimentation with new pedagogies, such as DGBL. In response to these pressures the paper introduces Frugal Education as a concept for fostering sustainable innovation in education and applies the emerging principles to a design case study. The authors present the design methodology of 'Book Runner: A Library Induction' game created in RPG Maker MV alongside evaluation results from developer/ facilitator-based interviews conducted to assess the tool, development process, and validity of the game. The authors conclude with a discussion on how these results align to our mission of lowering the barriers to creating DGBL experiences and furthers our understanding of Frugal Education within the field of Game Science.

Keywords: RPG Maker MV, Game based Learning Design, Frugal Education, Co-creation, Higher Education

1. Background

Numerous studies have shown the successful implementation of games for non-entertainment purposes, particularly in the field of education (Qian & Clark, 2016; All et al., 2016; Subhash & Cudney, 2018). In fact, the popularity of game-based learning (GBL) has led to much discussion within the discipline around the need for developing systematic processes for the design and assessment of GBL (Arnab & Clarke, 2017; Mestadi et al., 2018). Fewer studies, however, are focused on understanding and dispelling the barriers to entry to the field for non-native game designers. Whilst the understanding of design and assessment practices are indeed necessary components to increasing confidence and aptitude of the field in general, these guides are primarily aimed at practitioners who have already vested their interest in applying GBL as a practice, rather than addressing the barriers of entry for non-adopters who may be positioned at the crossroads of curiosity vs. complexity. Of those studies that have been conducted on identifying possible barriers, (Azadegan, Riedel & Hauge, 2012; Tsekleves, Cosmas & Aggoun, 2014; Justice & Ritzhaupt, 2015), several principle areas have been identified as reoccurring concerns amongst practitioners considering GBL-led education. Justice & Ritzhaupt (2015) carried out an internet survey amongst 255 educators to determine what barriers existed and to rate to what degree did these impede adoption of GBL as a practice. The study identified seven main factors: Issues with Negative Potential Student Outcomes, Technology Issues, Issues Specific to Serious Games and Simulations, Teacher Issues, Issues with Games and Simulations in Education, Student Ability and Incorporation Issues. Within each of these main factors, sub-categories were uncovered which included primary concerns around costing, scalability, capabilities and skills of using technology (educators) and how to track progress/ assessment of learning. The authors proposed to address these primary barriers of cost, scalability, educator confidence and assessment by applying Frugal Education (cite) and Transdisciplinary game design (cite) principles to the development of a game aimed at developing Information Literacy skills in first year University Undergraduate students.

2. Frugal Education

The concept of Frugal Education was born out of lessons learned in the development of teaching and learning innovation projects at Coventry University, inspired by methods found in Frugal Innovation practice. The term 'Frugal Innovation' has been utilised in many different cultures, albeit under varying nomenclature, such as

Jugaard in India (Ahuja, 2012) or Bricolage in France (Soni and Krishnan, 2014). Frugal Innovation is described as:

> *"the art of reducing the complexity and cost of products and services, and their production, to meet the needs of developing countries, conscious consumerism, and sustainability"* (Masters, 2019).

Building upon a foundation of Frugal Innovation and design thinking practices, the researchers sought to apply similar methods within an educational context towards a set of guiding principles for Frugal Education. The concept of Frugal Education concerns itself wholly with the improvisation of solutions through a creative problem-solving approach; achieved through repurposing readily available resources in innovative ways to deliver high-quality, scalable, and sustainable pedagogic practice (Masters, 2019). Positive results were observed when applying frugal approaches to innovation projects within Coventry University's Disruptive Media Learning Lab (DMLL); enabling teams to develop high-quality learning materials at pace, at scale, and at a lower cost than previous methods had afforded. Example initiatives that utilised frugal approaches include:

- CreativeCulture – Delivering game-based learning training and facilitation in rural schools in Borneo, Malaysia; requiring the team to rethink the classroom space, technology usage, and communication methods due to the environmental constraints of working in a remote Borneo rainforest community.
- MyCapsule Lab – Designing an innovation lab in the heart of Universiti Malaysia Sarawak (UNIMAS). Modelled on Coventry University's Disruptive Media Learning Lab but realised for a fraction of the budget. The lab was co-created with UNIMAS students in collaboration with the CreativeCulture team and built using existing equipment and repurposed or locally sourced materials.

Methods that were employed during project development became a blueprint for creative problem solving in an educational context. As a result, a set of emerging principles were developed to act as a guide for applying frugal education considerations to future learning design. The principles were subsequently applied in the design of Book Runner to inform the design and to develop an immersive library orientation programme using the limited resources available, while still delivering a high-quality, scalable, and sustainable learning resource.

2.1 Frugal Education Principles

The Frugal Education emerging principles, as they stood at the time of the Book Runner project development, are as follows:

Figure 1*:* Frugal Education Principles

Adopting Frugal Education as a paradigm, the research sought to repurpose RPG Maker MV; a low-cost game engine, as an authoring environment for creating DGBL.

2.2 Design with Empathy

Building a virtual equivalent of the library gave the team a new lens through which to view a student's experience of the space. The virtual space helped the team to place themselves in the student's shoes - virtually in this instance – and afforded them a new perspective on the processes and procedures required to understand, navigate, and interact within the library environment. This empathic approach was vital in ensuring that aspects of the library that might be missed as an oversight were included in the design process. However, thanks to the rapid prototyping methods used in constructing the game environment; testing the game in collaboration with staff and students; and refining the experience through an iterative design process, many of these oversights could be addressed and any future changes could be added by revisiting the game and updating the virtual environment and game narrative as required.

2.3 Build for Everyone

Selected for its functionality and ease of use, combined with affordability and the accessibility of the final game, RPG Maker MV provided the best all-round game engine solution to meet the team's needs. Accessible to all students, regardless of geographic location, and capable of running within a web-browser on almost any computing device thanks to its reliance on trailing-edge technologies over demanding modern game engines.

This approach provided a truly platform agnostic experience, capable of supporting the needs of a majority of CU students in terms of library orientation and introduction to available services and resources. The designers avoided inaccessible academic language due to the audience being largely new students with little to no exposure to academic vocabulary, as well as international students for whom English was there second language.

2.4 Leverage the Trailing Edge

Despite Unity's original goal of democratising "game development by making it accessible to more developers" (cite), the process of game development is still prohibitively complex for small-scale education use cases such as Book Runner. Rather than investing in the costly, time consuming process of developing a game in a heavyweight game engine such as Unity, or building a bespoke engine to cater for the specific requirements of the project, RPG Maker MV provided the ideal balance of simplicity, scalability, and functionality to deliver the project both effectively and efficiently.

RPG Maker MV reduced the barrier of entry to a level of technical ability that was achievable by academic staff, given the time available. Through the software's ease of use, its flexibility, and its reliability – due to the proven track record of the engine through years of iterative development – RPG Maker MV provided the best platform off of which to develop the game, and one that would be easy to adapt in response to changes within the library environment and structure.

2.5 Teach Sustainably

With limited time and budget available to the team, RPG Maker's one-stop-shop approach to RPG development proved ideal for the project. The engine allowed for non-developers to quickly build virtual environments, mirroring those of the library, and incorporate complex game mechanics into an immersive gaming experience without the need of a specialist game programming experience. Capable of running on available laptop hardware and pre-loaded with a dynamic library of game assets, the team were able to build the game environments fast, iterating on their designs quickly through near-real-time feedback provided by staff and students within the DMLL and library space.

What's more, the game engine, game mechanics, and available assets were largely pre-defined; freeing up the author to focus on narrative and user interactions to support the learning outcomes. In this case the outcomes were physical orientation and visibility of systems and services available to CU students.

The successful development of the Book Runner game opens up opportunities to reuse aspects of the library environment, and narratives therein, as a foundation for expanding the virtual campus experience to include other university locations. Through this modular design approach, each new location and its respective unique characteristics, could be woven into a larger overarching narrative; connect each location together into a single adventure, delivered through multiple episodes.

With near-zero cost of delivery, and the ability to scale the 'CU universe' over time with relative ease compared to that of a more complex game development environment, the Book Runner game provides a sustainable solution to student orientation through a high-quality, low resource approach to learning design.

2.6 Make it Open

For this particular project, the target audience for the game is specific to Coventry University's library resources and physical space, therefor providing this resource as an open educational resource is not applicable. It is however important that the project be discoverable and shareable at an institutional level. This RPG maker MV engine proved advantageous in this regard as it allowed for the creation of a platform-agnostic library induction game; one that could be accessed by CU students regardless of the computing devices used to access the game.

One factor that was of paramount importance was the ability for international students to have access to the game as a means to explore the library and its services before arriving in Coventry to begin their academic

studies. This has only grown in importance as we navigate the complexities of student induction and orientation in the grips of a global coronavirus pandemic. The Book Runner project now provides all students with the ability to orientate themselves with library spaces and resources at a time where no student is able to visit the physical space; regardless of geographical location.

3. Needs Assessing the Problem

All undergraduates in Coventry University's School of Strategy and Leadership take a Continuing Professional Development (CPD) module in all three years of their course. The module is designed to enhance their employability and allows students to choose which workshops and activities they wish to take part in, earning a required number of 'CPD points' for each. 'Library Basics' and 'Searching Business Databases' are two of six sessions delivered by the Library on the CPD module. Historically, they had been taught as two separate, optional, one-hour sessions. In September 2018, the CPD course team determined that these workshops were essential for all students and asked for them to be merged into a two-hour mandatory session. This change prompted the Business subject librarians to review the content and structure of the sessions, to ensure that they were engaging and cohesive in the new combined format.

During the review and the needs analysis stage (cite) of the design process, scalability, accessibility, resource management (including educator proficiency) and engagement factors were listed as high-priority considerations due to the number of students both on-campus and off-campus that were required to complete the module. It was noted here by the librarians themselves that the content could be 'a little dry' due to the introductory nature of the material which was designed to introduce basic information. The librarians had also noted that they had seen some previous successes with GBL-led initiatives for engaging students, but these initiatives were time-consuming for staff to run and weren't always suitable for supporting large numbers of students or students who couldn't physically attend the class. It was proposed that a hybrid approach to the redesign of the CPD module was adopted which would include a GBL-led approach for the first hour of the session followed by a traditional lecture-led taught hour.

To address the primary considerations of scalability, accessibility, resource management and educator proficiency, each of these elements were considered against the Frugal Education principles when looking at whether to take an analogue or digital approach to the development of the game. Having had some experience with delivering analogue educational games, the librarians were keen to stress that these approaches were often time and staff resource heavy, so much so that they felt an approach that could be accessed online at any point by the students, may be easier to manage as a whole, and would provide opportunities for students to revisit the materials. On further reflection of these concerns, the design team agreed a digital approach would be developed to support scalability and staff resource issues in line with the librarian's concerns.

The next stage of the process for the design team was to consider what game engines/ digital applications could be utilised to develop an educational digital game. With the Frugal Education principles in mind, several engines were ruled out due to project time and resource constraints. This included the Unity and Unreal engines (although these engines are free to use, these engines require a level of expertise in programming that wasn't accessible for the project).

Although the Twine engine was also a strong contender, the design team chose to develop the game using the RPG Maker MV platform due to its visual story-led features. Since there was no previous evidence (that could be found) of RPG Maker MV being used to create a serious game, the authors believed it would be a good opportunity to test the engines suitability in terms of ease of development, deployment and suitability for use in an educational context.

4. RPG Maker MV

RPG Maker MV is a game engine platform that forms part of the larger RPG Maker series created originally by Japanese company Enterbrain in 1992. RPG's MV version was later released by Degica in 2015. As the name suggests, the software is used to design and develop digital 2D Role-Playing games, and several entertainment games have been developed and released on STEAM. One of the key selling points that the RPG Maker series boasts over other game engine platforms, is that no prior knowledge of programming or artistic skills are needed in order to create your own games. Instead, RPG Maker MV offers a simple tile-based map editor that is

accompanied by pre-made art tiles (both environment and characters), scripted events and audio, which are simply assigned to tiles on the editing map (See Figure 3).

RPG MV utilises the programming language JavaScript, however, as most in-game events are already pre-scripted in the editor, there is little need for previous knowledge of JavaScript in order to develop a perfectly functional game. RPG Maker MV however, does allow for the creation of bespoke script to be developed into projects for those who are more confident in their abilities. This supports a range of user competencies, which makes the software an excellent gateway game-development engine. It's ability to hand-hold complete beginners to quickly develop a game, alongside access of advanced programming functionality, gives the tool a flexibility that could be adapted successfully as a resource for teaching games design and development at all levels. It also makes it a viable tool for creating digital serious games in an environment where budget, time and resources are often limited. RPG Maker MV was therefore chosen as the engine in which to develop a serious game to assist the delivery of library basics and Mathematics & Statistics support on behalf of Coventry University's library and sigma teams.

5. Book Runner: The Library Induction Game

One of the key selling points in the design process of utilising the RPG Maker MV game engine was having access to a series of high-fidelity, pre-generated art assets and pre-scripted programming commands. These functions were an essential component for saving time and being able to quickly construct a game environment as seen in Figure 2, that visually represented the Coventry University Library space. On reflection of how these functions aligned with the Frugal Education principles, cutting out the need for additional team members to contribute artwork and specialised programming ensured that the project was financially manageable with less need for staff resources to be assigned to the project. It also ensured that from a design and development standpoint, it was easier to involve the librarian members of staff in all areas of the development process, as the engine interface and functionality felt more user-friendly than that of some of the more well-known game engines (Figure 3).

Figure 2*:* Screenshot of Book Runner Game Interface.

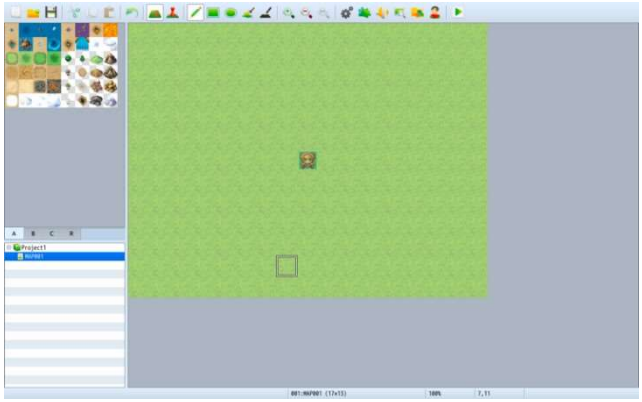

Figure 3: Interface of RPG MV Game Engine

To address the area of student engagement, a strong narrative in which to deliver the learning objectives was proposed. Based around the narrative-led game elements traditionally found in RPG games, it was important for the developers to bring this to life in the Library game. It was proposed early on in the pre-production phase, that the game shouldn't come across too seriously and instead, should deliver a humorous experience in an effort to make it as accessible as possible, especially to those students who may not be gamers. Based on a familiar storyline of 'rogue technology' (Portal, Space Odyssey 2001), the developers sought to use this narrative structure to familiarise students with Coventry Universities Online Database service; Locate. Structuring Locate as the game 'enemy', has allowed the developers to develop learning objective tasks that send the player out into services such as Locate, outside of the game. This allows for a multi-media style approach in which, players can explore many different aspects of the library (online services, real-world locations). One of the areas that the design team felt worked quite well whilst developing the story, was having a shared document in which all members could contribute sections or add suggestions to the narrative's development. This allowed the process to feel like everyone had a say in the direction of the design and familiarise themselves with the content that was being written into the game.

6. Evaluation

After seeking ethical approval through the Universities internal procedures, an online questionnaire was sent to the participants via email. The questionnaire was designed to assess the librarian's perceptions of the design and delivery of an educational game made with RPG Maker MV, in particular focusing on staff members confidence, skill, accessibility, ease, student engagement and resource management perceptions of the game. As the questionnaire was given to the members of staff who were involved in the project, the sample size of 3 is very low. However, it is a useful first step to see honest interpretations of how the game was received and whether it had any impact on their perceptions of using Digital Game-Based Learning as teaching resources. Thematic Analysis was used to identify key themes to come out from the responses of the participants.

6.1 Confidence & Skills of Creating Digital Game-Based Learning Resources

When asked about their confidence and skills of creating DGBL resources, it was found that all participants reported feeling like their confidence had improved, with some indicating a significant improvement to confidence with the process of game design itself. Whilst each participant had indicated that they had, had some dealings with game-based learning previously, it was the first project that they had experienced in designing and delivering a digital game.

The questionnaire highlighted that the participants had less direct use of the RPG Maker engine itself, as they relied on one person from the team to create the game within the engine. However, although the participants did not use it directly to create the game, they found that having trialled the program it was:

> *"fairly easy to use though, so given enough time I am confident that I would be able to design a new game-based learning resource using the program."* Participant A.

Whilst there was less direct contact with the engine in terms of creation and programming, the participants responded that their skills had grown from a design and delivery perspective.

> *"The practical experience of developing content gave me insight onto the different design considerations implicit in digital game design and how these might impact on the final product."* Participant B.

Going through a game design and development process was also found to be in of itself a valuable process. Participants reported feeling more confident with both design and delivery, having understood the complexity of the process and the time commitments required.

> *"As this was my first opportunity to be involved in designing and delivering game-based learning, I was able to gain a huge amount of experience."* Participant A.

> *"Once I was more familiar with the game and how the students progressed through it, I felt I could better relate it to the library and encourage the students to do the same. I also had a better sense of timing once I had delivered it a few times."* Participant C.

> *"I did gain insight and experience around the pedagogy of digital games-based learning and the wider design considerations. I had a better sense of how to use a digital game to deliver on learning outcomes."* Participant B.

On reflection of this project, and a suggestion brought up by one of the participants, was that it would have been nice to have, had worked on the development in the engine as a group. Of course, this raises a few questions around management and ensuring effective work flows, however, it was interesting to hear that the participants wanted to experience more of the technical development of the game.

The participants did however highlight that the RPG Maker MV engine allowed the:

> *"design of a much more advanced game than we would have been able to otherwise." Participant A.*

And that in terms of accessibility, the engine was perceived to be accessible for both students and facilitators.

> *"For learners it is very accessible given it doesn't require additional software installation and is multi-platform. For teachers it is fairly accessible; it has a low bar-of-entry to develop content but higher-quality products require significantly more input and experience"* Participant B.

> *"As long as users have a reasonable general level of digital literacy, I think it is very accessible as a development tool."* Participant A.

One of the key findings that has come from the work carried out in the Book Runner project in terms of building confidence in teaching staff unfamiliar with DGBL design, is ensuring their involvement with all aspects of the design and development process. Participants reported feeling more confident from the overall process of design, rather than interaction with the RPG Maker MV tool itself. This of course needs further validation with participants using the RPG Maker MV platform as part of the development cycle in more depth. However, we have certainly found a case that providing more opportunities for making quick digital games to teach the design and development process may be key to building confidence rapidly in educational facilitators.

6.2 Resource Management

When asked about their perceptions of the resource management aspects of developing a game in RPG Maker MV, there were mixed responses to areas of scalability and sustainability amongst the participants.

One of the most interesting areas of discussion was that of 'investment of time'. All participants reported that the games development required a 'significant investment of time', although one participant commented that the time commitment was not that different to other learning intervention development.

> *"There were a substantial number of working hours at the beginning of the process to help with project aims, writing learning outcomes, project spec' etc. The delivery of the game did not involve much more time than alternative interventions except for staff training to prepare them to deliver the game. Student and staff feedback would suggest that it was a worthwhile investment of time." Participant B.*

On reflection of the time the game took to develop, which was around 6 months in total from conception to final implementation after the testing period, this time scale is regarded as quite long and time resource heavy for many educators. Perhaps one of the areas for continuing development is investigation into games that are shorter in length. Inspiration can perhaps be drawn from the mini-game genre often found in larger AAA entertainment games. This suggestion was highlighted by one of the participants.

> *"I would definitely like to use the program again. Next time, I would develop a range of shorter games, each focusing on a different topic. This would allow them to be used more flexibly in different classes, and would make updating the games easier."* Participant C.

However, we also have to acknowledge here that digital games do take a significant investment of time, and this must be considered in the planning phase as to whether this time commitment is feasible. Although the amount of time was acknowledged as a factor, the participants also noted that they believed the investment of time was worthwhile.

On reflection of the game's sustainability and scalability, the participants each pointed out that the online nature of the game meant that they could easily direct students to a resource where they could take a more self-directed learning approach where they can access learning materials at their own time.

> *"It allowed for a much more self-directed learning experience than most other learning materials I use."* Participant A.

> *"It allowed me to direct students to an interactive and engaging platform for library inductions as a scale that wasn't possible for other interventions."* Participant B.

> *"As they accessed in online, they could do this in their own time, so could reach a wider audience. It didn't need to be in a classroom setting, although I feel to appeal to all students, some aspects would need more explanation or a get out to move beyond hurdles."* Participant C.

The ability to have a wider reach than non-digital game-based learning formats was also highlighted by one of the participants as a benefit to the scalability and reach of the digital game. Whilst the scalability of the digital game was highlighted as a positive outcome, each participant observed that sustainability could be an issue when needing to update the learning materials or if something had changed in the layout of the library building.

> *"It reduced the sustainability compared to more traditional learning materials. Because developing the game took so much time, when things changed about the Library (e.g. enquiry desk being removed, layout of ground floor changing) it was not possible to quickly amend the game accordingly. Consequently, the content is now out of date."* Participant A.

> *"It increased the sustainability of learning materials by allowing me to direct students to a single learning resource. But the process of editing content to reflect changes will likely be time-consuming, resource-intensive and require expert input (especially compared to less interactive learning materials)."* Participant B.

Even with a stripped back development program such as RPG Maker MV, as highlighted by the participants, DGBL can still be a heavy investment in terms of resources for educators. Being able to make quick changes to update materials seems to be one of the key issues that educators face when using DGBL teaching resources. However, this is also the area that has caused much of the debate surrounding sustainability of DGBL as a general teaching practice, particularly when changes to the materials or updates regarding system requirements are needed and the developers are no longer available to work on the game.

7. Conclusions

Although the RPG Maker MV game engine was initially proposed to develop a DGBL resource due to its perceived simplicity, it was found that there are still hurdles that face DGBL development particularly around sustainability and the time that educators need to invest. Whilst the game created with RPG Maker MV was less resource heavy in terms of staff/ specialist involvement and development/ testing time was still relatively low, this was still viewed as a significant investment of time for the participants. However, perhaps this is a realisation that needs to be made in that DGBL will always require a larger investment of time than more traditional resources. The question needs to be asked in the beginning, will that development and upkeep time be worth that investment, or could a less costly alternative be developed in its place.

One such way of helping make these decisions earlier on and was found to be a useful exercise in the Needs Assessment stage of the development was the consideration of the Frugal Education principles. The approach encourages educators to consider a set of guiding principles to help address some of these common barriers,

but to also highlight key questions surrounding what can be achieved with the available resources they have at their disposal.

From a development perspective, the use of the RPG Maker MV engine, dramatically reduced development time of a DGBL resource, particularly in that it was a very self-contained process as art, sound and programming could all be done by one developer quickly by access to pre-made assets and logic programming. Further studies are proposed in which educators are given greater access to the development process in the RPG Maker MV engine. Smaller, less involved games, are also suggested as a consideration to ensure time investment is further reduced.

8. Limitations

The authors wish to acknowledge the small sample of participants used in the feedback of the development of the game. Future studies will look to increase participant numbers with participants being asked to develop their own short games on RPG Maker MV.

References

Ahuja, N.R.J.P.S. (2012) Jugaad Innovation: Think Frugal, Be Flexible, Generate Breakthrough Growth. Jossey-Bass

All, A., Castellar, E. P. N., & Van Looy, J. (2016). Assessing the effectiveness of digital game-based learning: Best practices. Computers & Education, 92, 90-103.

Arnab, S., & Clarke, S. (2017) Towards a trans-disciplinary methodology for a game-based intervention development process. British journal of educational technology, 48 (2), 279-312

Azadegan A., Riedel J.C.K.H., Baalsrud Hauge J. (2012) Serious Games Adoption in Corporate Training. In: Ma M., Oliveira M.F., Hauge J.B., Duin H., Thoben KD. (eds) Serious Games Development and Applications. SGDA 2012. Lecture Notes in Computer Science, vol 7528. Springer, Berlin, Heidelberg

Masters, A. (2019) Frugal Education [online] Available from https://frugal.education/

Mestadi, W., Nafil, K., Touahni, R., & Messoussi, R. (2018). An assessment of serious games technology: toward an architecture for serious games design. International Journal of Computer Games Technology, 2018.

Groom, J. (2013) Ds106: It's All About the Trailing Edge [online] available from <https://bavatuesdays.com/ds106-its-all-about-the-trailing-edge/>

Jean Justice, L., & Ritzhaupt, A. D. (2015). Identifying the Barriers to Games and Simulations in Education: Creating a Valid and Reliable Survey. Journal of Educational Technology Systems, 44(1), 86–125.

Qian, M., & Clark, K. R. (2016). Game-based Learning and 21st century skills: A review of recent research. Computers in Human Behavior, 63, 50-58.

Runciman, J. (2019, March). Using Diffusion of Innovations Theory to Optimally Plan Professional Development on Game-Based Learning. In Society for Information Technology & Teacher Education International Conference (pp. 855-861). Association for the Advancement of Computing in Education (AACE).

Soni, P. and Krishnan, R.T. (2014) 'Frugal Innovation: Aligning Theory, Practice, and Public Policy'. Journal of Indian Business Research 6 (1), 29–47

Subhash, S., & Cudney, E. A. (2018). Gamified learning in higher education: A systematic review of the literature. Computers in Human Behavior, 87, 192-206.

Taylor, A. S. A. (2015, September). The active instructor: Benefits and barriers to instructor-led serious gaming. In 2015 7th International Conference on Games and Virtual Worlds for Serious Applications (VS-Games) (pp. 1-8). IEEE.

Tsekleves, E., Cosmas, J., & Aggoun, A. (2016). Benefits, barriers and guideline recommendations for the implementation of serious games in education for stakeholders and policymakers. British Journal of Educational Technology, 47(1), 164-183.

Udell, J. (2013) MOOCs Need to Be User Innovation Toolkits [online] available from <https://blog.jonudell.net/2013/10/11/moocs-need-to-be-user-innovation-toolkits/>