A Model for the Development of Stealth Serious Games

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Abstract. In this paper, a model for serious game (SG) development is presented and explained along with a definition of stealth serious games (SSG). A systemic review on existing models is performed; based on the existing model's deficiencies and the researchers' previous experience in the development of SG the SSG model is created and explained. To observe how a SSG developed with the SSG Model would behave, "Chain of Command: A Sustainable Supply Chain Management Stealth Serious Game" is developed and tested. The developed SG is tested on 4 metrics: replay value, education, fun and simple vs realistic. The SSG model is successful in helping to develop a SSG that performs acceptably. Further validation of the SSG model is still required.

Keywords: Serious game model · Sustainable supply chain management
Stealth serious games · Replay value · Stealth learning

1 Introduction

Any serious game (SG) starts with an idea, how the idea of the specific serious game is further developed is the responsibility of the SG designer. Serious game designers have several tools at their disposal, such as models, to help them along the creative process. In this paper, a model is a simplified version of a system to facilitate understanding by eliminating unnecessary components and presenting only the most important features that should be considered when developing SG. The use of models help ensure quality work.

Mechanics Dynamics Aesthetics (MDA) [1] is a model whose limitation is primarily that is was not conceived as a model to help in the design of SG, MDA's primary concern is the design of entertainment games. This issue was partially solved by Design Play Experience (DPE) [2] which is an extension of MDA. The player is presented with what he/she must learn from the SG. The Educational Games (EG) Design Framework [3], provides a model that focuses on Game Design, Pedagogy and Learning Content Modelling. This model/framework leans towards the design of highly educational SG that clearly show the user what he or she should be learning. The EG Design Framework generates SG that remove from the player the opportunity to experiment and build his/her own knowledge without him/her being aware of it. This paper presents an alternative model for SG development and a definition for stealth serious games (SSG).

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A novel model for SG design is presented in this paper, the SSG model (SSG). The purpose of the SSG model is to bridge the gap between game design and serious game design, to create experiences that are educational, nevertheless, the player is not fully aware the he or she is learning, known as "stealth learning" [4] and that possess a high replay value. Replay value is the property of the SG to be played repeatedly, providing new experiences, and learning to the player every time the SG is played. Additional to presenting a model to develop SG, a definition of what SSG should be is presented. SSG have a high replay value coupled with an equal ratio of fun to educational content, the player is not aware that he or she is learning when playing and can be played for amusement or education. SSG are primarily designed with education as a goal, thus, SSG differ from conventional games acquired at toy shops. Games acquired at toy shops have not been designed with any educational purpose into consideration.

2 Background Research

A systemic review of models available for SG development is performed to identify what current models may lack. Systematic review has its origins in the medical field [5] but has also been adopted to education [6]. This study's approach entailed extensive searches using a meta search engine (Google scholar). Words used for performing the search were: Serious, Game, Model, Framework, Education. The previous keywords are later combined into several strings. The strings used in the search are:

(1) Serious Game Model
(2) Serious Game Framework
(3) Serious Game Model Education
(4) Serious Game Framework Education

The intention is to create a search that will yield the most relevant examples. A 12-year limitation is set as to encompass all possible modern SG models. The results of the search are categorized as follows:

Models taking into consideration Fun: Educational Games Design Framework [3], MDA [1], Design Play Experience (DPE) [2], P-III Framework [7], SGSID [8], Theoretical Framework for Serious Game Design [9], Robert L. Appelman Model [10], Six Facets of Serious Game Design [11] Serious Game Constructivist Framework for Children [12], SGameFlow Framework [13].

Models taking into consideration replay value: Key Criteria for Game Design [14].

Models taking into consideration stealth learning: Design Play Experience (DPE) [2], Theoretical Framework for Serious Game Design [9], Serious Game Constructivist Framework for Children [12].

Models not including fun, replay value or stealth learning: Simport [15], HABS +ISIS [16], Model Driven Framework to Support Development of SG [17], DODDEL [18], 4 Dimensional Framework [19], CMX Design Framework [20], Digital Game Based Training Systems [21], ARCS [22].

19 models were analyzed and categorized; based on the limitations that these models possessed the SSG model was developed. Stealth learning and replay value were 2 important concepts that the previous models do not address in conjunction.

3 Stealth Serious Games Model

3.1 Replay Value

Replay value is the property of the SG to be played repeatedly, providing a new experience, and learning to the player every time the SG is played. Replay value has a direct interaction with the Gaming aspect of the model and is profoundly dependent on mechanics and dynamics. SG often make the mistake of not emphasizing replay value. After playing the SG once, there is no need to replay the SG again, as all learning has already been achieved.

Replay value has three main aspects:

No game is the same: The SG should have several mechanics and dynamics that can generate multiple scenarios and situations.

Allow for different approaches: The SG should permit the player the freedom to approach any situation the game simulates in any way he/she wants.

New learning happens every time the game is played: Not all learning should be achieved if the game is played once.

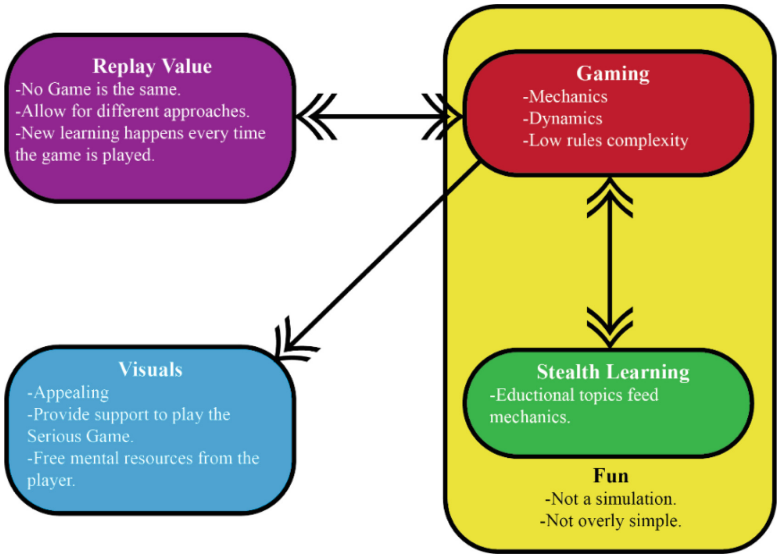

Fig. 1. SSG model components.

3.2 Gaming

Low Rule Complexity: This aspect is extremely important, if the rules are too complex the barrier to play the game becomes too high and some players might lose motivation to learn how to play. Rules directly affect mechanics and dynamics; simple rules that allow for deep mechanics and dynamics are necessary.

Mechanics: Describe the components of the SG, at the level of data representation and algorithms [1].

Dynamics: Describes the run-time behavior of the mechanics acting on player inputs and each other's outputs over time [1].

3.3 Stealth Learning

Stealth learning: Eventuates when "players are focused not on learning but on playing" [23]

Educational topics feed mechanics: The mechanics in the SG must be generated using the topics the designer wants the player to learn. It is important to state that the topics must be presented in such a way that the player does not fully realize he/she is learning.

3.4 Fun

Fun is a combination of simulation, simplicity, and the gaming and stealth facet.

Not a simulation: If the game is a simulation the SG becomes too complex for non-professionals and can potentially lead to boredom for those who are not professionals. Complexity in this case is defined as giving the player several variables and interdependencies to control when playing the SG, the ability to control every aspect of the game is not always met with joy by players.

Not overly simple: If the game is too simple, professionals will not take the game seriously.

3.5 Visuals

Visuals encompass how the SG looks and must emerge from the Gaming aspect of the SSG model.

Appealing: SG usually lack enthralling visuals; good visual representations allow for more player immersion and make the player feel excited about playing the SG.

Provide support to play the SG: The player does not need to remember everything in the game. It is the game's responsibility to remind players about important rules, mechanics, and dynamics.

Free Mental resources from the player: Well implemented visuals free mental resources in the player allowing him/her to focus on the strategic layer of playing the SG.

4 Method

The SSG model and the five dimensions it encompasses are developed based on the gap current models exhibit and from the lessons learned from previous SG development and testing [24].

Chain of Command: A Sustainable Supply Chain Management Stealth Serious Game (CoC) Fig. 1 is the SSG developed to test the SSG model. CoC is a board game

(2 to 4 players) where players need to optimize their supply chain to meet environmental needs, achieve economic success, uphold ethical behavior in dealings with other players and manage risk as they try to outperform rival supply chains to be the only player left in the game. Players must make decisions to go green, invest in technology, establish partnerships with other players, build close loop supply chains, optimize their supply chain to meet their needs and choose which products to manufacture to have an edge over the competition. The game uses event cards to introduce penalties and bonuses as well as a dice mechanic for the strategic combat mechanic in the SG.

CoC manages each of the SSG model dimensions in the following way:

Replay Value: Adversarial multiplayer SSG with a strategic layer giving players control over where they produce, deploy units, and how to invest his/her cash. Depending on how the players chooses to invest cash and interact with other players he/she will learn different aspects of sustainability in supply chains.

Gaming: In CoC the game manual is designed to have many visuals and as few text as possible. Rules are simple to understand yet the mechanics and dynamics allow for multiple scenarios to develop.

Stealth Learning: Focus is not placed on definitions of supply chains or sustainability. It is not desired to portray CoC as a SG in the mind of the player. The player acquires knowledge by exercising the mechanics and dynamics of CoC.

Fun: The player is given just enough controllable parameters to not overburden his/her decision process. Relevant parameters for sustainability and supply chains are chosen, such parameters include lead time, investment in newer technologies, human relationships etc.

Visuals: CoC is made to be visually appealing and present the player with relevant information that helps the player focus on controlling the parameters that are important for sustainability and supply chain management (Fig. 2).

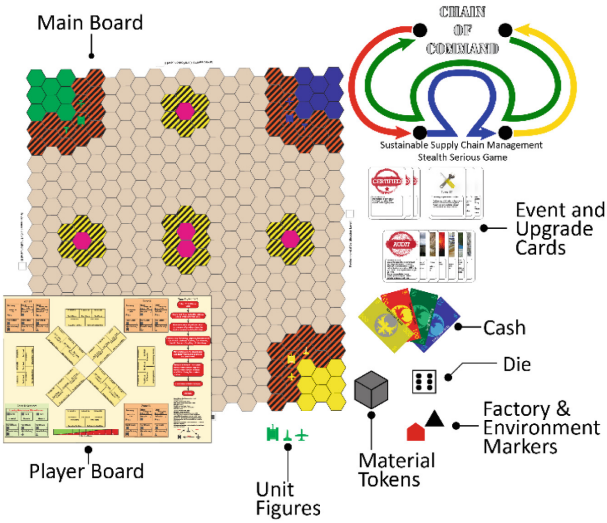

Fig. 2. Chain of command a sustainable supply chain stealth serious game

To observe how SSG developed with the SSG model perform, CoC is tested with a sample of 30 people. A total of 8 tests are performed, each testing session lasting an average of 3.5 h and having 4 to 2 players per test. Test participants are graduate students with no background knowledge on sustainable supply chain management, 50% engineers and 50% other disciplines. The participants were given the game manual to read, the facilitator was present during the time the participants were reading the manual to answer any questions regarding the rules. There was no further interaction with the facilitator after the game rules were read by the participants. The game facilitator was present during the whole game session. At the end of each test, players are required to evaluate the SSG CoC on the following four important metrics: Fun, Simple vs Realistic, Replay Value and Educational. Prior to each session players were briefed on how to play the SG CoC. Sessions were photographed. No explanation regarding sustainable supply chain management was given to the players before or after the game session. Users rated the game on a 0 to 100 scale on the following metrics: simple vs realistic (closer to 0 means the SG is simple closer to 100 means the SG is realistic), fun (closer to 0 means not fun and closer to 100 means significantly fun), replay value (closer to 0 means low replay value and closer to 100 means high replay value) and educational (closer to 0 means less educational and closer to 100 means highly educational). The average rating for each metric is then calculated and reported in Fig. 3.

5 Results

In Fig. 3 the results of the evaluation of CoC can be observed. In the "Simple vs Realistic" metric, CoC was rated 67.25 points. CoC, as based on the SSG model was designed to not be overly simple or overly realistic. The perfect score for CoC, from the researchers and developer's viewpoint, would have been a 50. It is important to clarify that CoC was rated by non-experts in SSCM. CoC could come across as simple when rated by experts in the field of sustainable supply chain management. The rating of 67.25 as rated by non-expert users is an acceptable rating. "Replay value", the game was given an average score of 64.75. It is important to mention that participants did not play CoC more than once, hence, the rating in this category represents the potential replay value as perceived by the players. The game was rated a 62 in the "Fun" metric. While the game is fun to play, there is still a considerable amount of player downtime which negatively impacts the fun factor of the game. The "Educational" metric had an average rating of 57.5 points. A possible explanation for the low rating in this area can be the way the tests were conducted. Participants were never briefed on SSCM; participants were only instructed to play the game. It is conceivable that a structured SSCM discussion before playing CoC can further enhance the rating given on the "Educational" metric. The fact that CoC manages to have an average rating in education above 50 with no discussion of SSCM indicates that stealth learning is being achieved.

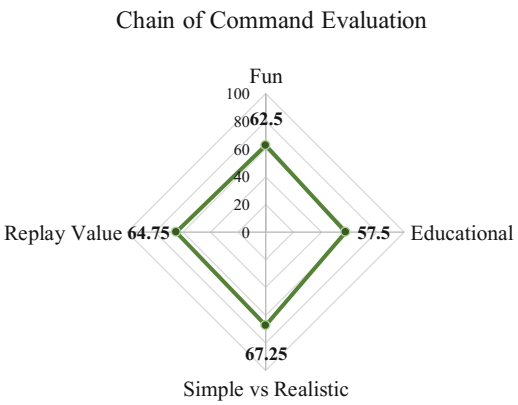

Fig. 3. Results of chain of command evaluation

6 Discussion and Conclusion

Using the SSG model could lead to more compelling SG that can make players learn without them realizing and also provide enjoyment. The next generation of SG should aim to educate and entertain in equal shares. The difficulty lies in balancing the previous two dimensions. Failing to do so, results in games that are too serious or games that are not serious enough, and therefore, not useful for learning. By bringing an emphasis on visuals, the SSG model can help create more compelling experiences that should be able to rival conventional board games or video games. The significance of having a high replay value is that the player must play the SSG several times to potentially experience everything the SSG has to offer. The SSG model aim is to develop SG in which no facilitator is required, at the same time, the SG is able to teach players regarding the topic for which it was designed.

This paper presented a systemic review of current models and tested the SSG model with the development and testing of CoC. Further validation of the SSG model is still required. Additional SSG using the SSG model need to be developed and tested. The concept of SSG requires additional empirical evidence.

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References

1. Hunicke, R., LeBlanc, M., Zubek, R.: MDA: a formal approach to game design and game research. In: Proceedings of the AAAI Workshop on Challenges in Game AI (2004)
2. Winn, B.: The design, play, and experience framework. In: Handbook of Research on Effective Electronic Gaming in Education, vol. 3, pp. 1010–1024 (2008)

3. Ibrahim, R., Jaafar, A.: Educational games (EG) design framework: combination of game design, pedagogy and content modeling. In: International Conference on Electrical Engineering and Informatics 2009. ICEEI 2009, pp. 293–298 (2009)
4. Sharp, L.: Stealth learning: unexpected learning opportunities through games. J. Instr. Res. **1**, 42–48 (2012)
5. Sheldon, T., Chalmers, I.: The UK cochrane centre and the NHS Centre for reviews and dissemination: respective roles within the information systems strategy of the NHS R&D programme, coordination and principles underlying collaboration. Health Econ. **3**(3), 201–203 (1994)
6. Hemsley-Brown, J., Sharp, C.: The use of research to improve professional practice: a systematic review of the literature. Oxford Rev. Educ. **29**(4), 449–471 (2003)
7. Vanden Abeele, V., et al.: P-III: a player-centered, iterative, interdisciplinary and integrated framework for serious game design and development. In: De Wannemacker, S., Vandercruysse, S., Clarebout, G. (eds.) ITEC/CIP/T 2011. CCIS, vol. 280, pp. 82–86. Springer, Heidelberg (2012). https://doi.org/10.1007/978-3-642-33814-4_14
8. Kirkley, S.E., Tomblin, S., Kirkley, J.: Instructional design authoring support for the development of serious games and mixed reality training. In: Interservice/Industry Training, Simulation and Education Conference (I/ITSEC) (2005)
9. Rooney, P.: A theoretical framework for serious game design: exploring pedagogy, play and fidelity and their implications for the design process. Int. J. Game Lear. **2**, 41–60 (2012)
10. Appelman, R.L.: Serious game design: balancing cognitive and affective engagement. In: Proceedings of ISAGA, Nijmegen, The Netherlands, pp. 1–10 (2007)
11. Marne, B., Wisdom, J., Huynh-Kim-Bang, B., Labat, J.-M.: The six facets of serious game design: a methodology enhanced by our design pattern library. In: Ravenscroft, A., Lindstaedt, S., Kloos, C.D., Hernández-Leo, D. (eds.) EC-TEL 2012. LNCS, vol. 7563, pp. 208–221. Springer, Heidelberg (2012). https://doi.org/10.1007/978-3-642-33263-0_17
12. Obikwelu, C., Read, J.C.: The serious game constructivist framework for children's learning. Procedia Comput. Sci. **15**, 32–37 (2012)
13. Zain, N.H.M., Jaafar, A., Razak, F.H.A.: SGameFlow framework: how to experience enjoyment in serious game (SG) for motor impaired users (MIU). In: 2012 International Conference on Computer & Information Science (ICCIS), pp. 1020–1024 (2012)
14. Sanchez, E.: Key Criteria for Game Design. A Framework (2011)
15. Warmerdam, J., et al.: SimPort: a multiplayer management game framework. In: 9th International Conference on Computer Games (CGAMES06), Dublin, Ireland (2006)
16. Marsh, T., Yang, K., Shahabi, C.: Game development for experience through staying there. In: Proceedings of the 2006 ACM SIGGRAPH Symposium on Videogames, pp. 83–89 (2006)
17. Tang, S., Hanneghan, M.: A model-driven framework to support development of serious games for game-based learning. In: Developments in E-Systems Engineering (DESE), pp. 95–100 (2010)
18. McMahon, M.: Using the DODDEL model to teach serious game design to novice designers. In: Ascilite 2009, pp. 646–653 (2009)
19. De Freitas, S., Oliver, M.: How can exploratory learning with games and simulations within the curriculum be most effectively evaluated? Comput. Educ. **46**(3), 249–264 (2006)
20. Malliarakis, C., Satratzemi, M., Xinogalos, S.: A holistic framework for the development of an educational game aiming to teach computer programming. In: European Conference on Games Based Learning, p. 359 (2013)
21. Brennecke, A., Schumann, H.: A general framework for digital game-based training systems. University of Rostock (2009)

22. Bulander, R.: A conceptual framework of serious games for higher education: conceptual framework of the game INNOV8 to train students in business process modelling. In: Proceedings of the 2010 International Conference on E-Business (ICE-B), pp. 1–6 (2010)
23. Shreve, J.: Let the Games Begin. Video Games, Once Confiscated in Class, Are Now a Key Teaching Tool. If They're Done Right." George Lucas Educational Foundation (2005)
24. Cuesta, V., Nakano, M.: Appendix A: ISAGA-JASAG 2015 program "the use of origami in serious games". Simul. Gaming Netw. Soc. **9**, 463 (2016)