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**To cite this Article:** Santonen, Teemu & Faber, Edward (2015). Towards a comprehensive framework to analyse edutainment applications. In Shaping the Frontiers of Innovation Management. Proceedings of the XXVI ISPIM Conference: Budapest, Hungary. ISBN 978-952-265-779-4.

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This paper was presented at The XXVI ISPIM Conference – Shaping the Frontiers of Innovation Management, Budapest, Hungary on 14-17 June 2015. The publication is available to ISPIM members at www.ispim.org.

# Towards a comprehensive framework to analyse edutainment applications

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**Abstract:** By following action research principles this study develops a comprehensive framework that enables more systematical data collection on the design and impact of edutainment applications, in particular serious games and gamification, from learning and learner's points of view. Schell's original game design framework including aesthetics, story, mechanics and technology dimensions was enhanced with pedagogy and player dimensions. Moreover, these abstract dimensions were decomposed into individual functional elements on the basis of prior findings in literature. The enhanced framework was tested with four serious games. The framework helped to gain deeper insight in design choices being made and reveals subtle differences between game designs. There is, however, room for improvement. Some elements seem to be partly overlapping; others do not seem to differentiate much across different games. More research is needed to fine-tune and operationalize the framework elements.

**Keywords:** edutainment; serious game; gamification, framework development, action research

## 1 Introduction

Edutainment is a diffusion of education and entertainment, which often emphasises the possibilities of interactive technology (Addis, 2005). Game-like learning systems, such as simulation games and digital toys, have increasingly being applied to foster higher-level abilities in educational contexts (Kim et al. 2009; Tan and Biswas, 2007) for different target groups ranging from small children to senior citizens (Alessi and Trollip, 2001; Gredler, 2003). Edutainment is not a novel idea and we have witnessed edutainment like games (Hannafin et al. 1996) already in mid in the eighties (Meskill, 1990) and futurologists have forecasted the business benefits of edutainment for the past two decades (Olsen, 1995).

Significantly, the poor execution of edutainment applications have resulted in critics towards learning games especially in the digital domain (Van Eck, 2006). Edutainment has not yet been able to live up to its promises. At the best edutainment applications can provide variety of benefits such as better motivation, retention and higher order thinking, yet factors such as instructions, assessment tools, learner's personality and cognitive style influence

the outcomes (Hogle, 1996). As a result, there is a need to develop better edutainment applications, which are derived from strong theoretical background while providing genuine educational and entertainment value to the learner. However, currently there are no comprehensive frameworks available which enables systematical analysis of various types of edutainment applications and comparison of their assumed benefits and weaknesses from learner's point of view. This argument is in-line with Gredler (1996) and Van Staalduinen and de Freitas (2011) observations that game design and theories of learning are disconnected.

### *Research design*

The goal of this study is to develop a comprehensive framework that enables more systematical data collection on the design and impact of edutainment applications, in particular serious games from learning and learner's points of view. By combining various theoretical frameworks from the emerging edutainment literature and action research observations from multiple innovation management related serious games, we will construct and test out the proposed framework will trying to close the gap between game design and theories of learning. As a result this multiple case study (Yin, 1994) can be considered as a constructive action research. Constructive research aims to develop a solution to a practically relevant problem by applying theoretical knowledge and demonstrating the functioning and innovativeness of the suggested solution (Jaatinen and Lavikka, 2008). In this study we follow a specific constructive action research framework originally proposed by Kasanen et al. (1993) and recently subtly refined by Oyegoke (2011) although a significant amount of different approaches have been presented (Cassel and Johnson, 2006).

We first justify the practical relevance of our proposed problem by describing the existing body of knowledge relating edutainment, serious games and gamification. Second, based on prior knowledge, we design a comprehensive construct, which will provide a framework for analysing and classifying the various types of edutainment and serious games applications especially from learner's point of view. Third, we demonstrate that the suggested framework is working by analysing different edutainment applications in the context of innovation management. In action research besides data collection for scientific purposes, researchers typically play an active role in development and implementation efforts. Therefore, during the past 6 years the second author of this study has co-developed and co-implemented the selected games, which enables data collection and practical level framework validation also from game developer point of view. Therefore this study can be characterized as a theoretical concept development, which usefulness will be empirically tested with the help of multiple case studies (Yin, 1994).

## 2 Theoretical foundations of edutainment, serious games and gamification

### *2.1. What is edutainment?*

Edutainment can be defined as a diffusion of education and entertainment, which often emphasises the possibilities of interactive technology (Addis, 2005). The idea behind edutainment is to attract and hold the attention of the learners by engaging their emotions by providing a joy while merging educational contents and entertainment activities. Games

can be engaging if they are intrinsically motivating, appropriately challenging, as well as offering elements of curiosity, fantasy and control (Malone, 1981). In practice edutainment, is a hybrid genre that relies heavily on visual material, on narrative or game-like formats, and on more informal, less didactic characteristics than traditional learning approaches (Buckingham and Scanlon, 2005).

As typically in academic literature, multiple terms having similar meaning as edutainment have been suggested including infotainment, educational electronic games, digital game-based learning and technotainment (Rapeepisarn et. al., 2006; Veltman, 2003; Prensky, 2005). Moreover alongside edutainment, serious games (Charsky, 2010) and gamification (Deterding at al. 2011) appear to be the dominant terms. Authors of this study consider edutainment as a higher abstraction and serious games and gamification as practical applications of edutainment.

### *2.2. Serious games*

Serious games can be defined as "*games that do not have entertainment, enjoyment or fun as their primary purpose"* (Michael & Chen, 2005). The core idea of serious gaming is to leverage the power of engagement and learning of (computer) games for real world issues. Well-designed serious games reduces the complexity of wicked problems to such a level of abstraction that players can easily interact with it and discuss it with each other, without losing the link or transfer to reality. By trying out different strategies and providing feedback of the effects, learners can get a better understanding of complex systems work and how it is affected by their actions and those of others (Hugos, 2010). Games are claimed to be most effective when they facilitate a flow experience (Salen & Zimmerman, 2004). Flow is a state of complete absorption or engagement in an activity such as game play (Csikszentmihalyi, 1990). However, little is known about what elements of games influence learning outcomes (Wilson et al., 2009). Research that critically and empirically examines game-based learning in general (Wouters et. al., 2009) and to support innovation management (Faber et al., 2012; Faber et al., 2013; Faber and Mettau, 2014, Faber et al., 2015) is scarce. Consequently, the design of serious games is still in its infancy and is more a craft or art than a scientific founded approach. As Van Eck (2006) argues "*continuing to preach the effectiveness of games may create the impression that all games are good for all learning outcomes, which is categorically not the case*" (p.18).

### *2.3. Gamification*

Gamification can be defined as the use of game design elements in non-game contexts (Deterding et al., 2011). The term was first coined in 2002 by Nick Pelling and became popular as result of TEDx presentations by Jesse Schell (2010) and Jane McGonical (2010). The core idea is to leverage the power of motivation and engagement of games to encourage certain behaviour from users (e.g. completing a survey in marketing research) and solve problems (e.g. using the wisdom of the crowds to solve innovation challenges). This definition of gamification can be broken down in the following elements. First, game design elements emphasizes that it is not a complete game such as a serious game but parts of it. Second, non-game contexts emphasizes that it is about taking things that aren't games (unlike serious games) and try to make them feel more like games (Schell, 2010). Criticasters of gamification often point out that organizations that apply gamification often narrowly apply game elements. The term pointsification has been used for gamification

systems that add nothing more than a scoring system to a non-game activity (Robertson, 2010).

To sum it up, edutainment, serious gaming and gamification strongly emphasise reinforcing learning via entertainment or game design elements without fully knowing which elements genuinely benefit the learning process.

## 3 Towards a comprehensive framework to analyse edutainment applications

### *3.1 Prior game design frameworks*

While developing their own game-based framework, Van Staalduinen and de Freitas (2011) also summarized the prior attempts to develop educational theories related game design frameworks. According to them (Ibid.) many current models are derived from the Quinn's early work (1994) and grounded on constructivism. By referring Resnick (1989) definition Richardson (2003, p. 1623) argued that in constructivist theory and pedagogy learners "create their new understanding on the basis of an interaction between what they already know and believe and ideas and knowledge with which they come into contact". Therefore constructivism has been considered as a student-centred learning approach (also known as learner-centred, flexible learning, experiential learning and self-directed learning), which highlights high level of student choice, activity and power (O'Neill and McMahon, 2005). For more in-depth discussion on the technology-enhanced student-centred learning environments see Hannafin and Land (1997).

The existing frameworks to analyse edutainment and serious game applications includes Game Object Model I and II (GOM) (Amory and Seagram, 2003; Amory, 2007), Kiili's (2005, 2007) experiential and problem-based gaming models, the four-dimensional framework by de Freitas and Oliver (2006), input-process-outcome game model by (Garris et al. 2002) and Van Staalduinen and de Freitas (2011) the game-based learning framework. Also frameworks with more limited focus have been proposed such game achievements by Hamari and Eranti (2011) and flow framework by Kiili et al. (2012, 2014). In our opinion, the above framework development efforts have resulted relatively complex constructs, which in practice are hard to apply for systematic game analysis. A significantly more simplified framework proposed by Schell (2008) has gain a lot of attention although his model is not including as clearly attempts to align game design to educational theories. According Schell's model, the key elements of the game are: 1) *Aesthetics* -- the graphic design of game, 2) *Story* – the information that needs to be made accessible to players to be able to play the game, 3) *Mechanics* – procedures and rules of a game and 4) *Technology* – the medium in which the aesthetics take place, the mechanics will occur and through which the story will be told. Schell's model has previously been successfully applied in context of several serious games (Faber et al., 2012, Faber et al., 2013, Faber and Mettau, 2014, Faber et al., 2015) and justified its usefulness for evaluating serious games. As a result, we take Schell's model (2008) as a starting point.

### *3.2 From game-centred playing framework to player-centred learning framework*

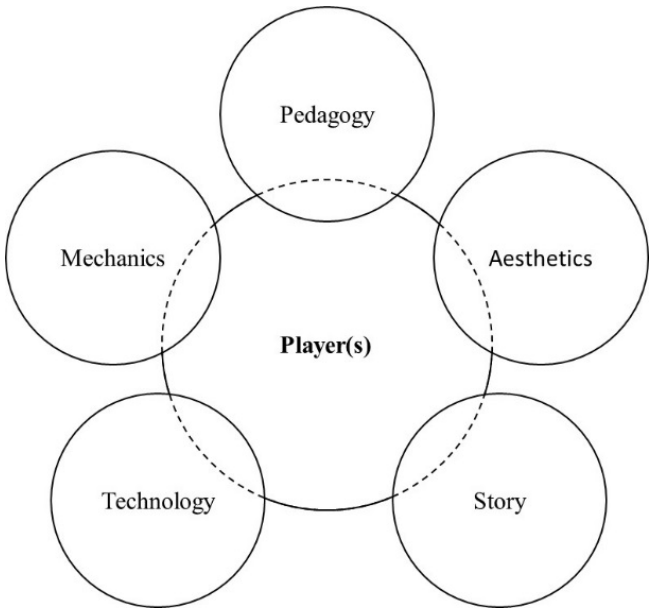
Schell's model is a simple construct and therefore it is actually missing the two most obvious elements of learning: 1) pedagogy and 2) player-learner. We define player-learner in the context of edutainment and serious gaming as *a person(s) who is taking a part to*

*game activities in order to learn a specific and predefined learning goals according to selected pedagogical approach, while enjoying him/herself during this process*. In the case of pedagogy we define pedagogy in game context as *interactions between player-learner, game environment and learning tasks* (Murphy, 1996, P.35).

Highlighting the player is especially important since according extensive pedagogical literature, learner's personality, cognitive style and academic abilities are influencing on learning results and learning process (Hogle, 1996; Bredemeier & Greenblat 1981; Dempsey et al., 1993; Gardner, 1983; Jacobs & Dempsey, 1993; Seginer, 1980). Therefore in all learning approaches, including edutainment and serious games, opportunities for multiple learning styles and different kind of learners should be provided by default (Fontana et al., 1993; Smith, 1992; Turner and Dipinto, 1992). This proposal is also in-line with the principles of the student-centred learning approach (O'Neill and McMahon, 2005).

As a result we enhance Schell's (2008) original framework by adding player and pedagogy dimensions. In Figure 1 we have illustrated our enhanced Schell (2008) framework in which the overlapping circles are representing player experience on the game pedagogy, aesthetics, story, technology and mechanics dimensions.

**Figure 1:** Player-centred learning framework




These additions are also justified on the basis of the four-dimensional framework for evaluating games- and simulation-based education (de Freitas and Oliver, 2006), which includes *learner specific*, *pedagogy*, *representation* and *context* dimensions. While *learner specific* and *pedagogy* are very similar to our newly added *pedagogy* and *player* dimensions, *representation* and *context* can basically be fitted either to Schell's (2008) *aesthetics*, *story*, *mechanics* or *technology* dimensions.

Alexander (1964) proposed that good architectural designs are made of subsystems that can be adjusted independently to changes in the environment. Furthermore, according to system design approach, the general properties and overall functionalities of the product or process such as serious game can be decomposed into 1) individual functional elements

and 2) interactions how the individual elements interact and provide the overall functionalities of the system (Simon, 1962; Sanchez, 1999; Baldwin and Clark, 1997; Clark, 1985). Grounded on the Van Staalduinen (2010) overview of the game elements identified from the prior game development literature, Van Staalduinen and de Freitas (2011) abstracted 25 game elements and argued that these elements can be aligned to the four-dimensional framework proposed by de Freitas and Oliver (2006). Therefore, also we aligned the proposed 25 game elements to our Player-centered learning framework (see Appendix A: Table 1) and made some additions relating player and pedagogy dimension from various pedagogical theories (in-depth reasoning omitted due space limitation).

## 4 A first test of the framework – Comparison of the four serious games

In table 1 (see Appendix A) we have compared BEST game (Faber et al., 2012), ISS game (Faber et al., 2013), e-Gov. game (Faber and Mettau, 2014) and Aerogame (Faber et al., 2015) according to our framework.

From the case examples it can be observed that games are very similar in some aspects (e.g. sensory stimuli and problem-learner link) while being fundamentally different in others (e.g. interaction and player composition). Hence, the framework provides a deeper insight in the design choices being made and reveals subtle differences between game designs. Another general observation is that the design choices in the different elements seem to be interrelated. For obvious reasons design decisions in *who*, *what* and *how* are interdependent. For instance, the Target group and Learning objective influence the Theme element. The cases also show that design decisions in Pedagogy and the four 'Schell' dimensions are interrelated as well. For instance, Problem-learner link, Sensory stimuli, Representation, and Interaction need to be aligned to provide players with a relevant and challenging learning experience.

Filling the framework was not so straightforward as we hoped for. Some of the concepts seem to partially overlap. For instance, the element 'Problem-learner link' and 'Sensory stimuli' seem to be related and partly overlapping. Sensory stimuli can be regarded as way to make the game relevant for a player (problem-learner link). The element 'Safety' does not seem to differentiate between the games considered. Risk-free experimentation is in the heart of many games. Another observation that can be made is that some game elements can be placed under more than one game dimension. For instance, the 'Fantasy' element can be elaborated using graphical representations (Aesthetics) and narratives (Story).

## 5 Conclusions

The main aim of this study was to develop a comprehensive framework that enables more systematical data collection on the design and impact of edutainment driven serious games from learning and learner's points of view. On the basis of prior literature we identified various frameworks, which however typically were "game-centred playing frameworks" instead of focusing on the "a player-centred learning framework". Our novel framework was grounded on Schell's (2008) framework which original dimensions were enhanced with pedagogy and player dimensions. Next these abstract dimensions were decomposed into individual functional elements on the basis of Van Staalduinen and de Freitas (2011) game elements list and additions relating player and pedagogy dimension from various

pedagogical theories. By following action research principles, the enhanced framework was tested by comparing four different serious games. Following observations were made. The framework helped to gain deeper insight in design choices being made and reveals subtle differences between game designs. Practitioners can use the framework as a checklist for the design of edutainment driven serious games. For scholars the framework is relevant for collecting empirical data on game designs and studying the effectiveness of these designs. There is, however, room for improvement. Some elements seem to be partly overlapping; others do not seem to differentiate much across different games. More research is needed to fine-tune and operationalize the framework elements.

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## Appendix A: Table1: Comparison of four games using the Player-centred Learning Framework

| | BEST game (ISPIM 2012) | ISS game (ISPIM 2013) | e-Gov. game (ISPIM 2014) | Aerogame (ISPIM 2015) |
|---|---|---|---|---|
| **Player - a person(s) who is taking a part to game activities in order to learn a specific and predefined learning goals, while enjoying him/herself during this process** | | | | |
| Target group: intended players of the game | Stakeholders involved in Strategic Technology Planning | Maintenance managers | Employees of the Dutch Tax and Customs Authority | Stakeholders in Air Traffic Management |
| Learning goal: what learners need to learn in the game | Insight in the likelihood of viability of business concepts | Become aware of new maintenance concepts | Become aware of future orientation | Become aware of need to change and collaboration, cost and benefits of new innovations |
| Motivation: intrinsic and external motivation to play the game | Curiousity, status<br>Asked by manager to participate | Curiousity | Professional development | Curiousity |
| Prior knowledge and skills: knowledge and skills on the game topic before playing the game | Carefully selected multidisciplinary teams (marketing, sales, R&D, finance) | Novice and experienced maintenance managers | No specific prior expertise needed | Background in Air Traffic Management, not necessarily familiar with the technology concepts |
| Player composition: the organisation of players in a game | Multiple competing teams | One team of multiple stakeholders | Single player | One team of multiple stakeholders |

Table continues in the next page.

| | BEST game (ISPIM 2012) | ISS game (ISPIM 2013) | e-Gov. game (ISPIM 2014) | Aerogame (ISPIM 2015) |
|---|---|---|---|---|
| **Pedagogy - The learning approach used to educate players of the game** | | | | |
| Assessment/Feedback: within game feedback on player actions | Players receive in-game feedback on solutions using human respons cell (expert panel) | Players are provided with feedback on mission availability and use of financial resources | Players receive individual feedback on decision making styles, time spent on dilemma's, consulted advisors, and information marked as important | Players receive in-game feedback on actual vs. target KPI values using a digital effect viewer |
| Debriefing/Evaluation: capturing of the lessons learned after playing the game | Debriefing and evaluation using a semi-structured questionnaire | Debriefing and evaluation using a semi-structured questionnaire | Group de-briefing (social learning) | Debriefing and evaluation using a semi-structured questionnaire |
| Safety: the lack of real world consequences | Risk free experimentation | Risk free experimentation | Risk free experimentation | Risk free experimentation |
| Action-domain link: transferability of actions in the game to the real world | Actions (technology planning) can be linked to actions in real world | Actions (organizing maintenance) can be linked to actions in real world | Actions (judgment and decision making) can be linked to actions in real world | Actions (investing in technology) can be linked to actions in real world |
| **Story -The information that needs to be made accessible to players to be able to play the game** | | | | |
| Problem-learner link: the way by which the game is made relevant to the player | Recognizable problem/ challenge | Recognizable problem/ challenge | Recognizable problem/ challenge | Recognizable problem/ challenge |

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| | BEST game (ISPIM 2012) | ISS game (ISPIM 2013) | e-Gov. game (ISPIM 2014) | Aerogame (ISPIM 2015) |
|---|---|---|---|---|
| Instruction, Help and Hints: the support that is provided to get the player started quickly | Instruction on game rules before playing game | Instruction on game rules before playing game | Instruction on game rules before playing game | Instruction on game rules before playing game, exercise round |
| | Game master helps players with game rules | Game master helps players with game rules | No game master | Game master helps players with game rules |
| Fantasy: the make belief aspect of the game | Plausible future scenario: public safety in a specific region | Fictive missions | Fictive government rule that needs to be implemented | Plausible future scenario: increasing air traffic |
| Mystery: the gap between available and unknown information | Disturbing events are not known beforehand | Disturbing events and mission extensions are not known beforehand | Advisors reason consistently from one future scenario | Disturbing events are not known beforehand |
| **Mechanics - Procedures and rules of a game** | | | | |
| Goals/ Objectives: win conditions of the game | Players define the goals themselves. At the end of the game it is checked to what extent they succeeded | Mission cards are used to provide players with game objectives | The goal is to solve complex challenge as outlined in context scenario | Individual goals can be selected from predefined goal cards |
| | | | | Collective goals are given (KPI levels) |

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| | **BEST game (ISPIM 2012)** | **ISS game (ISPIM 2013)** | **e-Gov. game (ISPIM 2014)** | **Aerogame (ISPIM 2015)** |
|---|---|---|---|---|
| Rules: structure, limitations and affordances which guide players' actions in the game | The game is structured in time boxed game phases and steps | The game is structured in rounds and steps. Players have to do all steps themselves | The game is structured in decision-making dilemmas.<br>Game play is time boxed | The game is structured in rounds.<br>Game play can be time boxed<br>Effects on KPIs are calculated by effect viewer |
| Adaptation: adjustment of the difficulty of the game to the skill level of the player | Game facilitator can provide examples, increase complexity by introducing events | Game facilitator can provide examples, increase complexity by introducing events | Not adaptable during game play | Game facilitator can provide examples, increase complexity by introducing events |
| Sensory Stimuli: the incentives build in to allow players' (temporary) acceptanceof the game reality | Relevant and realistic (enough) model of reality | Relevant and realistic (enough) model of reality | Relevant and realistic (enough) model of reality | Relevant and realistic (enough) model of reality |
| Progress: the measure of how the player progresses in achieving goals | Remaining time, score | Rounds left, score | Dilemmas resolved and time left | Actual vs. target KPI values |
| Challenge: difficulty of realising goals within a game | How to deal with future safety situation | Realise system availability during mission for the lowest possible costs | Take responsible decisions within the time given | Jointly realise target KPI’s |
| Conflict: solvable problems a players is confronted within the game | Event cards provide players with additional challenges | Event cards provide players with additional challenges | Unclear and contradictory information | Event cards provide players with additional challenges |
| Control: player's possibilities for active and direct manipulation of the game state | Player can bring in ideas (open content) | Player can exert control over predefined resources | Players need to take complex decisions and are confronted with the consequences | Player can exert control over predefined resources |

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| | BEST game (ISPIM 2012) | ISS game (ISPIM 2013) | e-Gov. game (ISPIM 2014) | Aerogame (ISPIM 2015) |
|---|---|---|---|---|
| **Aesthetics - The graphic design of game** | | | | |
| Representation: player's perception of the game's reality | Jigsaw puzzle, depicting technology planning process | Simplified and playful value chain visualisation | Playful visualisation of meeting room | Playful airport visualisation |
| Theme: the setting or context of the game | Playful jigsaw business theme | Maritime theme | Decision making theme | Airport theme |
| **Technology -The medium in which the aesthetics take place, the mechanics will occur and through which the story will be told** | | | | |
| Interaction: how a player interacts with the game and with other players (combination of equipment, inter-personal and social interaction) | Analogue board game | Analogue board game | Digital video game | Hybrid game: combination of analogue board game |
| | Social interaction | Social interaction | Computer mediated interaction with digital avatars | Social interaction |
| Pieces or players: the game objects and people that are included in the game scenario | Game pieces: cards | Game pieces: personnel, ships, spare parts, cards | No game pieces | Game pieces: resources, event cards |
| | Players are put in own role, human feedback (expert panel) | Players play a role (financial, supply chain, and maintenance manager) | Player are put in top-level decision making role. Other characters are modelled (avatars) | Players play a role (airline, airport, ANSP or Government) |