

EXTENDING TAXONOMY OF SERIOUS COMPUTER GAMES WITH EMPHASIS ON LEARNABILITY AND ITS APPLICATION

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Doctoral Dissertation
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RAZŠIRITEV TAKSONOMIJE RESNIH
RAČUNALNIŠKIH IGER S POUDARKOM NA
UČLJIVOSTI IN NJENA UPORABA
Doktorska disertacija

Supervisor: Assist. Prof. Dr. Tanja Arh

Ljubljana, Slovenia, January 2017

Acknowledgments

I want to express my deep thankfulness for the given support and guidance to my supervisor Asst. Prof. Tanja Arh, to my colleagues at the Laboratory of Open Systems and Networks at the Jožef Stefan Institute, especially to Primož Cigoj and to my parents for their continuous support and enthusiasm. Thanks also to the Jožef Stefan Institute for funding my studies through the projects running at the Laboratory for Open Systems and Networks. I am also thankful to my supervisor Dr. Claudia Ribeiro during my stay at the Lisbon University and her guidance in the realm of educational computer games.

Abstract

Serious games are part of the new emerging world of an education environment that is based on sophisticated technology with elements of entertainment. They have been seen as a good opportunity to support learning processes because of their ability to increase visualizations and challenge student creativity. They have the potential to significantly improve training and education activities and initiatives. As a part of serious computer games, business simulation games support training and learning that is focused on management of economic processes. They are to be considered an effective tool for empowering and mediating learning business content. They act as serious games that bring learning outcomes through simulation of real-life situations and business environments. Most of the results presented in the chapters 3,4 and 5 are published in journal papers, conferences and as a chapter in a book addressing e-learning.

This dissertation is divided into three major parts. The first part is focused on exploring the existing business simulation games and the selection and classification of their technical properties. The second part explores the existing attempts to design a comprehensive and complex taxonomy framework for business simulation games designed to categorize and evaluate their properties. The identified missing elements in the current proposed taxonomies were used as a starting point for the design of a new category addressing the games' educational properties. The usability of the new category is illustrated with an assessment of two use cases, i.e. simulation games taken from the area of project management. The results obtained using a survey and a teacher and student evaluation are presented and discussed. In the third and last part, we have applied the learnability parameters that have been developed in the previous part to other serious games in one of the fields of science and education – engineering. The incorporation of these properties in game development and implementation in the thesis was present through the development of the FOREVICA game, which teaches and practices the digital investigation procedure. The observation and the survey for the evaluation of FOREVICA lead to the conclusion that game implementation is effective and ensures that the educational objectives can be achieved through entertainment and learning provided by the implemented game scenario.

Povzetek

Resne igre, ki temeljijo na informacijski in komunikacijski tehnologiji, z vgrajenimi elementi zabave so postale del pedagoškega okolja razvitega sveta. Uporabljajo se kot podpora učnim procesom, ker omogočajo vizualizacijo učne snovi in hkrati podpirajo učenčevo ustvarjalnost. Vsebujejo potencial, ki bistveno izboljša uspešno usposabljanje učencev, poveča učinkovitost izobraževalnih aktivnosti ter spodbuja iniciativnost učencev. Resne poslovne igre so del skupine resnih iger, ki se uporabljajo kot podpora usposabljanju in izobraževanju na področju managementa poslovnih procesov. So učinkovito orodje za krepitev učinkovitosti poslovnih učnih vsebin. K boljšim učnim rezultatom prispevajo s simulacijo različnih primerov iz realnega življenja in poslovnega okolja.

Disertacija je sestavljena iz treh poglavitnih delov. Prvi del se osredotoča na raziskavo in pregled že obstoječih simulacijskih poslovnih iger in podaja izvirno klasifikacijo njihovih tehničnih lastnosti. Drugi del vključuje raziskavo že obstoječih predlogov za oblikovanje obširne in problemsko usmerjene taksonomije simulacijskih poslovnih iger za potrebe izbora in ovrednotenja njihovih lastnosti. Rezultat raziskave je seznam manjkajočih elementov v obstoječih predlaganih taksonomijah resnih iger. Ugotovljeni manjkajoči elementi so bili uporabljeni kot izhodišče za oblikovanje nove kategorije v taksonomiji, ki obravnava učljivost iger. Uporabnost nove kategorije in pripadajočih parametrov je prikazana z dvema primeroma simulacijskih poslovnih iger s področja projektnega menedžmenta. Rezultati ocenjevanja, ki so pokazali uporabnost nove kategorije, so bili pridobljeni z analizo iger in z anketo sodelujočih študentov. V tretjem in zadnjem delu disertacije je predstavljena uporaba parametrov učljivosti pri načrtovanju igre za področje inženirstva. Parametri učljivosti so bili uporabljeni pri načrtovanju in razvoju igre FOREVICA, ki je namenjena učenju in praksi na področju digitalne forenzike. Evalvacija igre in opravljena anketa med študenti sta pokazali, da je implementacija parametrov učljivosti možna in učinkovita ter da zagotavlja realizacijo izobraževalnih ciljev z igro in učenjem konkretnega scenarija pri izvajanju.

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Abbreviations

ARCS	..	Attention, Relevance, Confidence and Satisfaction
ICT	..	Information Communication Technology
BSG	.	Business Simulation Games
GBL	..	Game-Based Learning
GUI	..	Graphical User Interface
DVD	..	Digital Versatile Disk

Glossary

Simulation - imitation or enactment, as of something anticipated or in testing, the representation of the behavior or characteristics of one system through the use of another system, especially a computer program designed for the purpose.

Business Simulation - is simulation used for business training, education or analysis.

Business Simulation Games - games that focus on the management of economic processes, usually in the form of a business.

Virtual environment - a computer-generated, three-dimensional representation of a setting in which the user of the technology perceives themselves to be and within which interaction takes place; also called virtual landscape, virtual space, virtual world

eLearning - is learning utilizing electronic technologies to access educational curriculum outside of a traditional classroom. In most cases, it refers to a course, program or degree delivered completely online.

Gaming - the playing of games developed to teach something or to help solve a problem, as in a military or business situation or any other industry sectors.

Gamification - is the concept of applying game mechanics and game design techniques to engage and motivate people to achieve their goals. Gamification taps into the basic desires and needs of the users' impulses which revolve around the idea of Status and Achievement.

Gameflow - it is a process that creates difficult situations for the player that are rewarded when completed. For example, Gameflow gives the player the motive for playing.

Game-based learning - is a type of game play that has defined learning outcomes. Generally, game-based learning is designed to balance subject matter with gameplay and the ability of the player to retain and apply the said subject matter to the real world.

Digital Forensic - (sometimes known as digital forensic science) is a branch of forensic science encompassing the recovery and investigation of the material found in digital devices, often in relation to computer crime.

Chapter 1

Introduction

In the last several decades the world's most developed countries have shifted from an industrial economy to a knowledge economy. The knowledge economy is based on “the production and distribution of knowledge and information, rather than the production and distribution of things”.

Several economists have begun to argue that the knowledge is an intrinsic part of the economic system. This is concerned as a third factor, added to the traditional two of labour and capital (Florida, 2002; Romer, 1990). These analysts point to the importance of creativity, innovation and ingenuity in the knowledge economy. Education systems across the world are nowadays trying to address the fundamental challenges in order to respond to the need of the knowledge economy labour market. The attempts to provide basic education for all continues but the focus (in all parts of the world) is on the value and the impact of the educational experiences on the individual learners that respond to the demands of the labour market. Significant evidence that have been collected and published by Joy Playfoot (Playfoot, 2010) suggests that many education systems are failing to adequately prepare learners to be active, positive and resilient members of the society and the knowledge economy. The emerging new economic crisis, mass globalization, environmental development uncertainty and the societal unrest have changed the role of the education in position of a vehicle that should shape the next generation of creative thinkers, scientists, artists and leaders. The new generation is expected to be capable to think openly, to adapt, to innovate, and to collaborate. In most countries and regions the employers identify these qualities as being unavoidable for any successful type of business or organization. These are the skills required in the 21st century. The found evidences by the same author suggest that the current education systems rarely attempt to directly teach these skills and that the tools used in the current systems are mainly traditional. The world of business emphasises the need and the importance of creativity but as well its complexity and that is expected to increase in future years. The single most important quality that future business leaders will need in order to deal with this complexity is creativity.

Video-based computer simulation games are considered to have an important role in teaching and learning creativity and in building the necessary skills. “Serious games” is the accepted term for games with an educational intent and they are a modern phenomenon within the area of the multimedia computer applications. Their reach and popularity are growing exponentially as new devices and new complex tools are being offered enabling learners to learn through gaming where they want, how they want and with whom. The growth of serious educational gaming – that is, games that have a purpose to educate while entertaining the learner – is reaching into many areas of modern life including education, health and the environment. Teaching has a better

chance of success if it can be done with the use of serious gaming (Wawer, Milosz, Muryjas, & Rzemieniak, 2010). The importance of the gaming role in successful education was provided recently by a PISA (Biagi & Loi, 2013) study. The empirical results that were found in the study showed that the relationship between the domain-specific PISA (Biagi & Loi, 2013) test scores of the surveyed students and the measure of the intensity of the students' gaming activity was the only ICT indicator that is positively correlated in the majority of studied European countries for mathematics, science and the language of instruction. These findings indicated that further research is needed to discover the role of computer gaming in achieving better educational results. Pedagogy principles exist and no parameters have been developed to assess their learnability.

1.1 Motivation and Purpose of the Thesis

Today, in line with the abundance of serious game solutions, many definitions and ways of classifying them with respect to their relationship to the real world and the underlying technology have appeared. Some view them as a continuum of educational computer technology development (Aldrich, 2009) while others see them as a different category of the same thing (Sawyer & Smith, 2008). "Serious games" is an accepted term for games with an educational intent with inbuilt ICT technology. Their popularity in the last decade has increased significantly and continues to do so (Arnseth & McFarlane, 2010).

It is widely accepted by educators that the games used in education should be engaging, although not necessarily fun, while the learning can be either implicit or explicit. Despite the fact that many of the games to be used in education are now readily available, commercial, off-the-shelf products, no uniform game pedagogy principles exist and no parameters have been developed to assess their learnability that should lead to the achievement of education goals. This includes the lack of an adopted framework in the field and a missing exhaustive taxonomy defining properties and classification to be used in game evaluation and design. One of the basic requirements in any of the scientific or application fields is the definition of the area taxonomy. The development of taxonomy in a particular domain is a tedious and long-term process. Serious games used in the modern educational process have been studied and analysed in recent years by many scientists, however none of the suggested taxonomies has been widely adopted by experts in the field. The last one, which appeared in 2013, by Greco et al. (Greco, Baldissin, & Nonino, 2013) seemed to be one of the most complete as it was built on previous isolated attempts, however this taxonomy is not complete, which is recognized by the authors who say that further contributions and refinements are required.

The purpose of the dissertation is to study and analyse the serious games used in an ICT-supported educational process, analyse their properties and upgrade the current serious game taxonomy with elements that cover the games' learnability by defining learnability attributes required for the achievement of the educational objectives of a particular domain or a teaching subject. It is supposed that these properties should be based on and originates from learning theories recognized in the science field of education. Another aim of the dissertation is to provide a deep evaluation of the proposed learnability parameters experimentally on some existing popular games and in the course of a new game design developed as an education tool for teaching. The area of serious games to be studied is business, management and ICT engineering, more specifically the area of digital forensics. A further purpose of the dissertation is to analyse

three hypotheses that are analysed through the research work carried out to prove their correctness. The hypotheses are:

H1 – Current serious games taxonomies used in the assessment and classification of the games do not consider sufficiently the learnability parameters required in the process of game selection by educators.

H2 – The learning theories have not been properly considered in the serious games design building process.

H3 – The learnability parameters of serious games need to be considered in the process of game selection and in the course of game development.

The correctness of this set of hypotheses was proved by the use of **methodologies that consisted of the following known** approaches in this field of research:

I. Theoretical study of the field, study of literature, approaches and methods

A comprehensive study of the current research activities in the area was completed together with a review of the current approaches and methods in the area of ICT-supported learning, more specifically within the area of serious games. Two fields of serious game application have been studied: management and engineering. The approach enabled technical assessment of the characteristics and parameters required for classification and game assessment to be provided in the form of a classification tool.

II. Methods used for development and upgrading of the game taxonomy

The missing parameters of the recently published game taxonomy were developed with an intensive research of several learning theories and their relevance to ICT-supported learning and training. The applicability of the elements found was assessed **and evaluated with known approaches used in this field, such as** surveys and observation.

III. Experimental and technical assessment

The developed new branch of Greco's taxonomy was assessed and evaluated on several serious games by including educators and students at the university level of study. The assessment results were then applied in the course of game design and development. A classical engineering approach based on requirements and scenarios for game design considering known design models (Killi, 2006) and set rules of applications was applied.

1.2 Problem Statement

The term “serious game” was used long before the introduction of computer and electronic devices into entertainment (Djaouti, 2011). Clark discussed this idea and used the term in his 1970 book *Serious Games*, published by Viking Press (Clark C. , 1970). In that book, the author was primarily focused on the use of board and card games, yet he gave a useful general definition that is still considered applicable in the computer age: *“Reduced to its formal essence, a game is an activity among two or more independent decision-makers seeking to achieve their objectives in some limiting context. A more conventional definition would say that a game is a context with rules among adversaries trying to win objectives. We are concerned with serious games in the sense that these games have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement.”* Clark defines further that these games

are games “that have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement” (Clark C. , 1970).

The enormous growth of the serious game popularity, increased significantly and influence further the inclusion in the educational process (Arnseth & McFarlane, 2010). The problem of a more exact evaluation of their educational outcomes and proper classification became a focus of research in different subdomains of the field. It followed from research’s results of Arnseth & McFarlane that the games used in education should be engaging, although not necessarily fun, while learning must be present but can be either implicit or explicit. This finding was also accepted by the educators. Despite the fact that many of the games to be used in education are now available, commercial, off-the-shelf products, still no uniform game pedagogy principles have been developed and no exact parameters have been identified to assess their learnability. With scholars like Gee (2003), Egenfeldt-Nielsen (2006) and Squire (2011) that have extolled the pedagogic potential of computer games for some time, and with several generations having grown up with gaming as a commonplace facet of their existence, there exists a need to explore how they teach, or otherwise influence, those who have played them all their lives. Furthermore, by understanding of how games influence students’ accomplishment in the higher education process, it will become possible to report on games’ capacity to motivate, engage and promote collaborative practice in order to be more exactly defined and evaluated. This thesis represents a contribution to this problem in the specific area of ICT based on serious game research.

1.3 Contributions

The contributions provided in the thesis follow from the research focused on the provision of proof of the three hypotheses. One of the basic requirements in any of the scientific or application fields is the definition of a taxonomy that provides the field with a classification of the objects constituting the field and the aligned attributes. The development of field taxonomy is expected to generate a result that will be adopted by field experts. This endeavour is a tedious and long-term process. Serious games used in modern educational processes have been studied and analysed by several scientists (Blažič & Arh, 2013), however none of the suggested taxonomies has been considered complete and this is one of the reasons why they were not widely adopted. One of the published attempts (Blažič & Novak, 2015) to classify them based on several properties including technical and the purpose of use was developed within the research work of this dissertation and is presented in Chapter 3.

The last proposed taxonomy in the field, which appeared in 2014, by Greco (Greco, Baldissin, & Nonino, 2013) seemed to be one of the most exhaustive and complete (it contains more than 80 parameters in five categories), however even the authors of this taxonomy claimed in their published paper that further contributions and refinements of their work are still required. By exploring the taxonomy defined by Greco and co-authors, it became obvious that this recent approach needed further refinement as the included categories do not cover, in sufficient depth, how the games help to accomplish the educational objectives. These findings are further described in the following chapter, where the hypothesis No. 1 was confirmed by a literature review, which shows that an upgraded taxonomy is needed for further classification of business simulation games. The accomplishment of the learning objectives evaluated through the students’ performances and results achieved during and after the game play are a crucial and necessary factor in the evaluation of any educational tool to be used in the learning or training process and

should be considered in game assessment and in game design. Based on these findings and on the exhaustive analysis of the three most recognized learning theories used (described in Chapter 4) as a new subcategory to be added to the Greco taxonomy. The new subcategory contains 14 properties that are relevant and usable for the assessment of a game's learnability. The evaluability of the new subcategory was tested within experiments including surveys with students and educators' observations (Blažič & Blažič, 2015). The results confirmed that the selected 14 parameters do provide a good footing for the assessment of game learnability and confirm Hypothesis No. 2 that learning theories have not been sufficiently considered in the building process of serious games. In addition, this contribution partly confirmed Hypothesis No. 3 as the developed taxonomy subcategory appears to be a necessary tool to be applied in the selection process of serious game tools intended for use in the educational process if the set educational or training goals are clear and their achievements are highly desirable. Greco acknowledged the upgrading (Greco, Baldissin, & Nonino, 2013) with satisfaction.

The next research question to be answered within the dissertation was to find out whether the learnability parameters can be incorporated during the game design process. The topic selected for the design of a new serious game was training and educating in the area of digital forensic investigation. The efforts in this part of the problem research resulted in the serious game called FOREVICA. The game teaches through 11 learning lessons how to carry out demanding digital investigation procedures based on the digital forensic tool X-Ways. The game design followed the Killi (Killi, 2006) flow design model and the design rules set by Tang and co-workers. In addition, in the course of the design all learnability parameters were incorporated in different phases of the game flow. The presence of these properties was proved by similar assessment methods used in the assessment of the two known serious games in the area of business and management. The experiment confirmed that the specified learning elements can be incorporated during the game design by following the learnability properties specified in the taxonomy subcategory branch denoted as Game Learnability, which confirms the second part of Hypothesis 3 of the dissertation. Furthermore, this contribution work and the content of Annex 2 (the "FOREVICA" game scenario and the learning lessons) clearly confirm that the learnability properties of an educational game are universal and applicable to the business and engineering domains of educational games.

1.4 Thesis Organization

The thesis is organized in seven chapters. The Introduction is followed by Chapter 2, entitled "ICT-supported education", which provides the basic concepts of ICT technology-enhanced education and introduces the field of serious games by providing a brief history of the field, the main definitions and concepts and ends with a description of the basic schemes applied in the development of serious computer games. The third chapter, entitled "Serious games analysis and the development of the classification tool", provides an insight into the different terminology used in the field and an analysis of business serious games with a focus on educational areas. The chapter presents and discusses a set of nine selected business games that are later studied and classified according to their properties with the developed classification tool. The fourth chapter, entitled "Extending the taxonomy of business simulation games", provides a study of the attempts to build a serious game taxonomy and an analysis of the recently published taxonomy by Greco and co-workers. The chapter presents Greco's taxonomy and the missing subcategory that was developed based on the three learning theories that provide

information about the learning processes. The chapter provides an evaluation of the extended taxonomy through analysis of the games Virtual Leadership and Sharkworld based on the 14 identified learning parameters. The analysis is accompanied by experiments and surveys carried out with students and educators. Associated documents, the questionnaire and the survey results are provided in Annex 1. The fifth chapter, entitled “Game design and the learnability attributes incorporation”, presents the development of the FOREVICA game for learning and training digital forensic investigation. The game flow is presented in Annex 2 of the thesis. An assessment of the game’s learnability is provided using the same method as the method applied for Virtual Leader and Sharkworld. The results can be found in Annex 1. The thesis ends with Chapter 6, entitled “Conclusion”, followed by References in Chapter 7 and the two Annexes.

Chapter 2

ICT-Supported Education

Access to information is essential for learning and for instruction. If we look at the last millennium, in the nineties, learning methodologies began to rapidly change. Recently, the constructivist approaches to learning was introduced as a replacement of the instructional methods. These methods moved the focus from the teacher and turned it to the individual learner. This movement was influenced by the use of ICT technology in education, or e-learning as was found by Catchan and Gardner (Catchan, 2013; Gardner, 2012).

Definitions of e-learning can be found elsewhere on the Internet or in the academic literature. For many authors the adoption of electronic media in a learning scenario is already sufficient to be declared as e-learning (Moore, Dickson-Deane, & Gaylen, 2011). This definition is clearly too broad and too simple. For example, the use of a microphone during lecturing cannot be excluded by the suggested definition about e-learning. So the simple use of electronic media is not sufficient the learning to be considered as e-learning. A proper definition should be based on the an evidence that electronic media provide specific support to the learning process itself, which most probably can not be achieved by other media (or else this would be a case of electronic media that emulate the traditional media). According to several authors(<http://www.jisc.ac.uk/elearning>)

e-learning can be defined as “learning facilitated and supported through the use of information and communications technology”. It can cover a spectrum of activities from the use of technology to support learning as part of a ‘blended’ approach (a combination of traditional and e-learning approaches), to learning that is delivered entirely online. Whatever the technologies, learning is the vital element.”

There may be other definitions, but the following definition of e-learning is considered in this thesis (also known as e-learning or eLearning). The definition reads: “e-learning is delivery of a learning, training or education program by electronic means. E-learning involves the use of a computer or electronic device (e.g. a mobile phone) in some way to provide training, educational or learning material” .

E-learning especially in case of on-line training can involve vast variety of equipment. On-line here is understood as an education that uses the Internet or an intranet. CD-ROMs and DVD are also electronic media that provide an ICT based learning materials (<http://www.derekstockley.com.au/elearning-definition.html>) but here the Internet is not involved. The new ICT technology that enables distance type of education to be applied provides the main basis within the education process for the development of e-learning. E-learning can be “on demand” as it overcomes timing, attendance and travel difficulties (<http://www.derekstockley.com.au/elearning-definition.html>).

E-learning is a concept that has been, and is still, popular. It is researched in various disciplines including psychology, pedagogy, and computer and information science. E-

learning today is a more general term that refers to any type of computer-based learning. It does not always imply the need for entertainment or fun in the learning process. The general advantage of e-learning is that it enables remote learning enabling the learner groups distributed over different locations to learn the same subject in non-parallel or asynchronous way. E-learning brings flexibility of learning in time and space. When using the broadest possible definition of e-learning as computer-based learning the experts in the field include serious games as a subcategory of e-learning (Koubek & Macleod, 2004). Accordingly to this understanding, all forms of serious (digital or video) games are considered as subtypes of e-learning. Another label that overlaps with the serious games understanding is that of game-based or digital game-based learning, which corresponds to the characteristic of e-learning as “any learning on a computer or online is a type of e-learning” (Prensky, 2007).

According to Djaouti et al. (2011) the idea of using games for purposes other than fun or entertainment was first formulated in the book entitled “Serious Games” by Clark C. (1987). When he introduces the subject of his book, he states: “We are concerned with serious games in the sense that these games have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement” (Clark C. , 1987). The term “serious game” as it applies to digital games was brought later by Ben Sawyer in his 2002 paper on the potential of using digital games for policymaking (Sawyer & Smith, 2002).

Shiffer’s (Schifter, 2014) study has also shown that well-designed computer/video games can teach players on innovative and creative ways of thinking, enabling deep understanding of complex academic content, and valuable forms of real-world skills. Many authors have found that Games are capable of providing rich, complex and compelling virtual worlds (Adams, 1998; Barab, Hay, Barnett, & Squire, 2001). Today, the term “serious games” is becoming more and more popular. When we hit the Google search on Google search button with key word “serious games”, it renders about 115,000,000 hits (3 November 2015).

Serious games are also a growing market and are also an interesting area for inter- and multidisciplinary academic research. In 2008, Ben Sawyer (2008), co-finder of the Serious Games Initiative, stated that the serious games market is now worth 20 million USD, and digital gaming is a 10 billion per year industry (Van Eck, 2006). The market is expected to grow over the coming decades (Brauer & Bente, 2010).

2.1 Brief History of Serious Games Development

“Serious games” is an accepted term for games with an educational intent despite the lack of supporting evidence about their measured effectiveness in the learning process. Their popularity in the past decade has increased significantly and continues to do so as was found by (Arnseth & McFarlane, 2010). It is also widely accepted by the educators that the games used in education should be engaging, although not necessarily fun, while the learning can be offered implicitly or explicitly. Despite the fact that many games to be used in education are now readily available, commercial, off-the-shelf games, no uniform game pedagogy has yet been developed. For that reason it is safe to state that in the literature, in-depth research that links games to various properties with the type of learning is missing (Wilson, et al., 2009). Some experts have found that earlier games tended have shown similarity with the behaviorist model of learning but in the same time there were other games that have incorporate experiential, situated and sociocultural pedagogical models (Amory & Seagram, 2003). Among the researchers in the field, it was widely accepted that the learning outcome, when games are incorporated

in the educational process, is dependent upon the appropriate pedagogy and the underlying game mechanics (Suittie, et al., 2012).

The primary purpose of the games dedicated to education and not for entertainment, appeared in the military area. Military officers were using war games for training strategic skills. Early example of a serious game is a 19th-century Prussian military training game called Kriegsspiel, the German word for “war game” (Wikipedia, 2014).

Today there are many definitions of the term “serious games”. However, by considering their main purposes it should be noted that the educational purpose as was defined by Abt’s does not necessarily needs to be in the game’s design, but still the game can be labeled as educational through the context embedded in it. This is usually illustrated by the example of a board game originally designed for fun but this game is used in a military training context to teach strategic thinking and the principles of tactical warfare.

Zyda (Zyda, 2005) provided an update and offered a logical approach to this term in his article published in 2005 in the IEEE Computer journal entitled “From Visual Simulation to Virtual Reality to Games”. Zyda’s definition begins with “game” and proceeds as follows: “game is a physical or mental contest, played according to specific rules, with the goal of amusing or rewarding the participant.” and the serious game definition according to Zyda reads : “a mental contest, played with a computer in accordance with specific rules that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives” (Zyda, 2005).

The “Serious Games Initiative” that was launched in 2002 suggested the computer games to be made for education and not for non-entertainment purposes. However, the failure of the edutainment component and the lack of the expected profitability, plus the growing technical abilities of the ICT technology that enabled the games to provide realistic settings, led to a re-examination of the concept of serious games in the late 1990s and in the next decade. During this time, a number of scholars like Brauer and Bente) (Brauer & Bente, 2010). began to examine the utility of games for other purposes. This contributed to the growing interest in using games to some new purposes. Additionally, the ability of games to contribute to training expanded at the same time with the appearance of the multiplayer gaming. The “Serious Games Initiative” that was launched by the Woodrow Wilson International Center for Scholars in Washington D.C. then encouraged further the development of games that address policy and management issues. More focused groups of experts began to appear in 2004 that have developed other type of games that focus on social issues and social change and games for health, which addresses health-care applications. These new application followed from the capability of serious games (SG) to contextualize a player’s experience in a stimulating realistic environment. Games are effective because the learning takes place within a meaningful context. What the learner is expected to learn is directly related to the environment in which the learner learns. Learning that occurs in meaningful and relevant contexts is more effective than learning that occurs outside of those contexts, as is the case with most formal instruction. Researchers refer to this principle as “situated cognition” and have demonstrated its effectiveness in many studies over the last 15 years. According to Van Eck (2006) the researchers in this field have found out that play is a primary socialization and learning mechanism common to all human cultures and many animal species (Van Eck, 2006).

SGs were initially conceived to train people for tasks in particular jobs, such as training army personnel or salesmen (Bellotti, Berta, & De Gloria, 2012). Typically they were concerned with acquisition of knowledge and/or procedural skills. The diffusion of the games with the new devices (e.g. smartphones, tablets, various types of consoles), a

variety of SGs has emerged for different types of users (students, adults, workers, etc.) and different applications/goals (instruction, training, advertising, politics, etc.). They were also implemented as different genres of games (e.g. arcade games, first-person shooter games, etc.). (De Gloria, Bellotti, Berta, & Lavagnino, 2014) discuss a number of examples of learning games, showing that SGs now “span everything from advancing social causes to promoting better health to marketing (De Gloria, Bellotti, Berta, & Lavagnino, 2014). Typical example is the Advergaming as a popular form of advertisement that delivers commercial messages through games.

SGs are also used as part of the treatment of some mental disorders such as the attention deficit disorder in children, used as a tool to train them to maintain attention for longer periods (Navarro, et al., 2003). Several authors also point out that games can be used to improve self-monitoring, problem recognition and solving, decision-making, and short-term and long-term memory, and increase social skills such as collaboration, negotiation and shared decision-making, as pointed out in the project ELSPA (ELSPA, 2015; Mictchell & Savill-Smith, 2004).

From an educational perspective, games are considered to be motivational and learning tools (Garris & Ahlers, 2002), a link between abstract concepts and real-world problems, a “learning by doing” or “hands-on” approach to learning as pointed out by (Martin, 2000; Kolodner, Gray, & Fasse, 2003). With the emergence of new technologies on a continual basis, they become an imperative in modern education (Ben-Zvi & Carton, 2007) Today, many institutions report that they integrate these new technologies and the learning tools in their curriculums. The success of SG within an educational environment is, amongst other factors, due to their engaging and entertaining nature. Learners are also more comfortable with gaming technologies because they are already familiar with similar technologies (computers, PlayStations, Internet, tablets) on a day-to-day basis (Roodt & Joubert, 2009). In order for educational institutions to take full advantage of the opportunity presented by digital serious games in terms of their potential as complementary educational tools, an evaluation must be conducted before integrating these games into the classroom and across the curriculum.

SGs are considered by Squire (2003) to be an important response from education technologists to the “digital natives”, which is a generation of students who are raised on digital gadgets and interactive games. For them, the expectation of having interactive experiences in the education media seems very natural.

2.2 Serious Games and Related Concepts

According to the study published recently by Djaouti, Alvarez and Jesse (Djaouti, Alvarez, Jesse, 2011) “SG” is a term that meets several definitions. It was agreed that the first formal definition and its concept have been introduced by Clark (1970). In his book, Clark describes simulations and games as tools that improve education, both in and outside the classroom. The examples Clark has provided are either using “mainframe computer” or “pen-and-paper”, as the video game industry in that time was not yet properly developed. Clark’s book influenced other teachers, like Jansiewicz (1973), who published another book in which he describes the game he invented that teach US politics. Several years later, the concept of the “serious game” was redefined in a white paper written by Sawyer & Smith (2002). They have updated the understanding of a SG by using the idea that connects the transfer knowledge and the ICT technics. The joint work of Smith and Sawyer (Sawyer and Smith, 2002) helped the shaping of the “serious games” industry by cooperating within the Serious Game Initiative project, and linked conferences like the Serious Game Summit and Games for Health (Sawyer &

Smith, 2008). Nowadays, most recent definitions of SG, like one proposed by Chen, Michael (2005) and Zyda (2005), seems to be influenced from the Sawyer's work. Although the general definition of "serious game" is nowadays shared by many people, the domain boundaries of the SG field are still subject to debate in the academic and training community. Corti (2006) claims that the "serious game" industry brings together participants from a wide range of fields, such as education, defense, advertising, politics, etc., who do not always agree on what is and what is not a part of the SG industry. To reflect these differences, some "domain-specific" definitions are used to force a limited view of the nature of "SGs" (Sawyer & Smith, 2008). However, a common footing for all involved can be drawn across all fields despite these field dependent debates. Serious game designers nowadays exploit the people's interest in video games to capture their attention for a variety of purposes that go beyond pure entertainment.

The brief overview of the literature presented above reveals that there many definitions available and many actors are acting in the field, but most contemporary experts as reported in Wikipedia (2014) agree on a core meaning that SGs are (digital) games used for purposes other than mere entertainment. Wikipedia's (2014) definition of SGs reveals that they are the simulations of real-world events or processes designed for the purpose of solving a problem. A SG can be entertaining, but still its main intention and purpose is to train or educate users, though it may have other purposes, such as marketing or advertising. A serious game will sometimes sacrifice fun and entertainment in order the player to achieve the desired learning progress. SGs are not a game genre but a category of games with different purposes. This category also includes educational games that are known as "advergames", "political games" or "evangelical games" as specified by Djaouti, Alvarez and Jessel (2014)..

Another definition provided by Dreager (2014) describes SGs as a term that encompasses games intended for more than entertainment.

The most important question of interest in this area concerns the claimed positive effects of SGs or of applications from related and sometimes overlapping areas such as e-learning, edutainment, game-based learning and digital game-based learning. This is the reason for the abundance of definitions as pointed already by Corti (2006).

On the Internet, a number of additional definitions could be found in most of the articles dealing with SG. Based on that someone could argue that there is no strong need to seek to common definition as the purpose is purely academic. However, it was noticed earlier that when different groups of experts use the very same term they also appear, at the same time, to address different things. So as a consequence a clear definition is still needed. In a report on PIXELearning (Corti, 2006), the author describes SGs as a simulated environment (on the user support desk), a simulated system (e.g. production line) or a realistically recreated a play scenario (e.g. project team meeting in building area) that allows learners to experience something that is in the real word costly, risky or even physically impossible (e.g. managing project in China) to be achieve in the real world.

Brauer and Bente (2010) claim that Abt's definition is still acceptable and valid if the current definitions of SGs are considered. Game designers Michael and Chen (2005) define an SG as a game in which education (in its various forms) is the primary goal, rather than entertainment (Michael & Chen, 2006). This definition, however, can only be considered valid within a very broad understanding of the education.

Tang et al. (2007) describe SGs as interactive software content that takes advantage of game technologies for non-entertainment purposes but that can become part of an educational context and training. They pointed out that SG can have the potential for both, with an educational part, which focuses on the development of the mind, and a training part, which focuses on the development of specific skill. They also claim that

these modes of learning may offer different lessons and can be used in parallel in the classical teaching for provision of intellectual and skills development. In addition, SGs may be used for game-based learning depending on the appropriateness of the educational subject content. For the purpose of this dissertation we will close this overview and we will rely on a broader definition of SG that reads: “serious game is as any piece of software that merges a non-entertaining purpose (serious) with a video game structure.”

It should be noted here that in the literature, many authors refer to SGs as a term that overlaps domains such as e-learning, edutainment, game-based learning and gamification. For this reason, these domains are briefly introduced later in the text of this chapter based on Susi et al.’s (2007) report and the definitions there for presentation of the related concepts:

Edutainment – this term refers to any kind of education that also entertains, although it is usually associated with video games with educational aims as proposed by Michael & Chen, (2006). In their work they primarily studied preschool and young children, with a focus on reading, mathematics and science. However, edutainment software failed to be successful as it resulted as a “boring games and drill-and-kill learning” (Van Eck, 2006). Computer video games for non-entertainment purposes were developed long before the edutainment era. Edutainment itself has failed to be profitable. But during the late 1990s the concept of SGs was re-examined. In general terms, SGs have become associated with “games for purposes other than entertainment”. It was agreed that SGs encompass the same goals as edutainment, but extend far beyond teaching facts and memorization, and instead they all must include aspects of education – teaching, training and informing for all ages of learners

Gamification – this term was defined as the use of game design elements in non-game contexts by several authors (Kapp, 2012; Charsky, 2010). Gamification means using game-like elements in non-game contexts to promote learning and engagement and help an individual to engage in problem solving (Deterding, Sicart, Nacke, O’Hara, & Dixon, 2011). According to Kapp (2012) gamification is entering into education with an intention to motivate and engage students in the learning process. The effectiveness of this approach known as use of the “instructional games”, has been evaluated against the classical tools used for instructions, both at colleges and universities. It was found that gamification offer more interaction in the classroom and leads to student engagement. Additionally, gamification enhance collaborative through the ICT based learning environments. However, it should be noted that gamification is a different process from game-based learning.

Game-based learning – Wikipedia describes game-based learning (GBL) as “a branch of SG that deals with applications that have defined learning outcomes” (Wikipedia, 2014). Others consider GBL and SG to be more or less the same (Corti, 2006). According to Corti (2006), the referenced sources of GBL are described as learning tools that has the potential to improve training activities through engagement, motivation, role playing and repeatability of the process in relation the expected achievement (meaning that they can be modified and tried again). Digital game-based learning (DGBL) is closely related to GBL, with the additional restriction that it based on digital or video games only. According to Prensky (2007) DGBL is the “newest trend of e-learning” as it is based on two key premises:

- *“The thinking patterns of learners today have changed, that is, today’s students are “native speakers” in the language of digital media.*
- *This generation has experienced a radically new form of computer and video game play, and “this new form of entertainment has shaped their preferences*

and abilities and offers an enormous potential for their learning, both as children and as adults” (Prensky, 2007) ”.

Some authors like Dreager (2014) argued that the definition of game-based learning almost appears too obvious and self-evident like the game itself. He claims that *“By playing through the video game, the learner masters his/her skills or knowledge, as the game is designed to teach”*. According to Dreager *“digital game-based learning has the benefit of being more immersive and visually appealing, and providing analytics tracking. In the corporate sphere, game-based learning readily applies to employee training and development”* (Dreager, 2014)”. Another expert with his collaborators, Tang et al. (2007) suggest that in “game-based environments, learners should be that the learning material should be introduced in the form of narrative and storytelling way. The student should learn through game playing and studying the in-game components and taking decisions and solving problems in the defined game scenario” (Tang, Hanneghan, & El Rhalibi, 2007). In the literature by the authors referenced above the following properties are attributed to the GBL:

- Motivating and engaging but not necessarily entertaining;
- Requires participation from learners;
- Has clear learning objectives defined in the game play and scenarios presented while knowledge can be imparted through storytelling and narrative;
- Scenarios defined are reflective and transferable to the real-world experience;
- Provides freedom to interact in the game world through a set of defined actions;
- Provides clearly defined feedback for every action taken;
- Both assessment and lesson can take place during game play;
- Matches learner’s pace and intellectual ability;
- Highly scalable so it can be used for educating large numbers of learners concurrently.

The relations between gamification, game-based learning, digital game-based learning and SGs are illustrated in Figure 2.1.

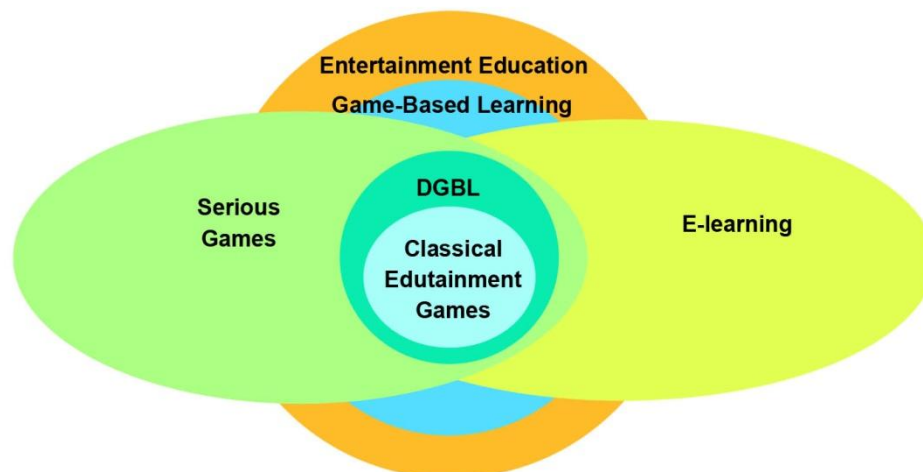


Figure 2.1: The relations between SGs and similar educational concepts. (Tang, Hanneghan, & El Rhalibi, 2007).

2.3 Basic Design Schemes in SG

Close ties between games and learning existed during the past centuries. The traditional, Western, classroom-based education become interested in using games for education in the beginning of the 20th century. Some learning theories that integration both the knowledge transfer and the experience, often included games and playing (Shelton, Satwicz, & Caswell, 2011). The current level of ICT development supports many types of social gaming activities and they have become pervasive to an extent that it is considered nowadays ubiquitous. For that reason the educational activities and gaming activities are gaining new level of importance that was not present in the first decades of the 20th century (Clark, Nelson, Sengupta, & D'Angelo, 2009). With the emerging level of the ICT development the design concepts of an educational game became very important. Katie Salen and Eric Zimmerman in their book *Rules of Play: Game Design Fundamentals* proposed how to define the goal in the game design: “A game is a system in which players engage in an artificial conflict defined by rulers, that results in a quantifiable outcome” (Salen & Zimmerman, 2004).

Tang et al. (2007), considered as well that the game design is a production of (video) games that need to be interactive software applications created primarily for entertainment purposes). Their definition looks very appropriate: “Computer games as software artefacts combine multimedia and other computing technologies such as networking that enable players to experience goal-directed play in a virtual environment”(Tang, Hanneghan, & El Rhalibi, 2007). In that context a computer game can be presented by the three primary design schemas defined by Salen & Zimmerman (2004) and Zimmerman & Linder (2010). In their conceptual framework it reads:

RULES – They formally represent the “mechanics” or operational constraints within the game construct, which in turn governs the level of interactivity within the game.

PLAY – This activity represents the experiential aspect of the game and is communicated to the game player through activities that are distinctively categorized by Crawford (2003) as interactivity, challenge and conflict.

CULTURE – This component refers to the beliefs and norms represented in the game world, which are often portrayed to players through artificial characters, objects and settings via aural and visual representation of the game world, and through storytelling (Zichermann & Linder, 2010).

According to Tang and co-workers (2007, 2009), RULES and CULTURE in the game design define the technical and intrinsic representation of some virtual “playground” to support the activity of the play.

As computer games and SGs have common technical features the difference that make them a separate group lay in the intended use and consequently in the embedded content. Computer games are produced for amusement and entertainment while SGs are developed for transfer of knowledge or skills acquiring. However, they still share some educational properties and they both are entertaining the users. Tang et al. (2009) have suggest that the real distinction between computer games and SGs can be explained through the above presented schemas PLAY, RULES and CULTURE that follows from the defined purpose.

PLAY in the context of computer games is perceived as an activity of enjoyment, amusement or recreation without any serious or practical purpose. In contrast to computer games, the “Play” scheme within the SG is considered as meaningful learning activities that promote the formation of new concepts and the development of cognitive skills. The activities in the playing a SG are provided through interactions that help to educate learners through the principle of cause and effect. RULES and CULTURE properties are involved in the play direction defined for both game groups. However many well-designed computer games are found to be educative, although they do not integrate knowledge transfer and training skills. RULES that govern the playing of the game in SGs are usually linked to the measurable learning objectives. Tang et al. (2009) give as an example the game called Grand Theft Auto (www.grandtheftauto.com) which is popular game in the game industry with controversial content. The player playing the game has the role of a criminal, lives in a big city, and is acting in occasional criminal activities, such as bank robbery and assassination. This play is an example of the RULES that contradict the norm in the society. These rules can also be in the form of challenges or decision solving problems that are cognitive and require hand-eye coordination. These challenges exist in the computer games but most frequently they are presented in a fictitious context irrelevant to any real-world context. Contrary to that, the RULES underlying the play in SGs could be either very simple or very complex usually in cases of simulation of the real world such is the flight simulator.

According to Tang et al. (2009) the details of CULTURE in SG depend somewhat on the subject matter and the designed learning objective. Ideally SG should exhibit norms from some real-world scenarios to facilitate knowledge. However, most SG has the world set in a fantasy environment as this may increase the intrinsic motivation of learners according to Malone (1980). In this context belief and norms should be defined in line with the learning objectives and in within the story truthfulness that reflect the real world for sustaining the SG educational values that makes the major difference and distinction to the computer games. **Storytelling** approach is often used to set the scene and immerse game players into the game both in the computer games and in the SGs.. The difference lies in the defined events driven by the story, whether the events are meaningful activities that help game players to understand the subject or a playground for having fun.

One example of an SG is the so-called E.2010 – Power to Energetika (<http://www.takomat.com/en/games.html>), which was developed by scientists and experts from the German Space Agency, University of Stuttgart and Institute for Plasma Physics. The game has educated more than 2000 energy experts. They mastered the challenge of the government and created a sustainable energy scenario for Germany until 2050. Another example is the game called CyberSIEGE (<http://cizr.nps.edu/cyberciege/>), which is a computer game that teaches computer and network concepts. It enhances information assurance and cyber security education and training through the use of computer gaming techniques. Players spend virtual money to operate and defend their networks, and watch the consequences of their choices to use protection, while under a cyber-attack.

DragonBox (www.dragonboxapp.com) is another game that teaches children algebra by solving equations. The game turns algebra into an intuitive and motivating game. With a series of icons on a game board, a player’s goal is to replace them with numbers and variables until the real equations are solved.

Here are some more of the few examples of SG (<http://diva-portal.org>):

The Triple A Game Show (<http://scil.stanford.edu/news/game4-06.htm>): a game about ecosystems that uses a learning-by-teaching strategy to enhance learning.

A Force More Powerful (www.afmpgame.com): a simulation game that teaches the strategy of non-violent conflict.

Food Force (<http://www.food-force.com>): a simulation game that teaches the strategy of non-violent conflict.

Futurelab – Racing Academy (<http://lateralvisions.co.uk>): a teaching game about physics and mechanical engineering in a virtual community.

NanoMission (<http://www.nanomission.org/>): an educational serious game that aims to teach players about the concepts of nanoscience through real practical applications.

The differences between computer games and SG are presented in Table 1.1 (Tang et al. 2009).

Salen & Zimmerman (2006) and Tang et al. (2009) in their works state that the focus of computer games in the entertainment area has always been the play activity governed by the set of formal rules. From a pedagogical point of view, the play activity that players experience is technically a loop of doing, receiving feedback and reflecting. The doing is designed as an action that motivates the learners to solve problems or take decisions as this enables learning and absorbing information effectively contrary to receiving information in a passive manner (Roussou, 2004). This belief is part of the “activity theory”, which assumes that human consciousness and activities are inseparable.

Table 2.1: The difference between entertainment games and SG (Tang, Hanneghan, & El Rhalibi, 2009).

	Computer Games	Serious Games
Purpose	For entertainment purposes. Context is presented mostly with fiction or fantasy features.	For learning and skills development purposes. May be a form of entertainment based on the interpretation of the learner.
Play	Interaction designed primarily for entertainment purposes with directed objectives that can be driven by storytelling; interactions resemble real-world interaction in a simplified or abstract approach	Interaction designed for learning purposes with meaningful responses and measurable outcomes. Knowledge is disseminated through events triggered by specially designed interactions and dialogue.
Rules	Rules are designed to accommodate the play activity, and are often tuned for playability rather than reflecting the real world.	Rules are designed for specific learning outcomes that can be used to measure the interactions during “serious play”. Rules can be simplified or made complex to support the play activity.
Culture	Rules are designed for specific learning outcomes that can be used to measure the interactions during “serious play”. Rules can be simplified or made complex to support the play activity.	Beliefs, norms and world setting presented visually and via narrative that are related to the knowledge domain reflect truthfulness and have direct and explicit relations with real-world events. Game world maybe set in an imaginary world.

Games should be motivating – and can be successfully employed with this aim. However, instructional effectiveness involves other aspects that can be analyzed only in the light of pedagogical and learning. This topic of the dissertation is more elaborated in chapter 4. Digital or video (in our case, computer) games have the potential to change the landscape of the education from the current state. . From the early isolated reports in conferences and books reflecting on the possible applications of computer games for learning, more and more practitioners and researchers have embraced the idea of GBL (Pivec, 2007). The design and use of computer games have a certain theoretical foundation in the constructivist learning theories, which stress that knowledge is created through experience while exploring the world and performing activities. Implications for game design involve the creation of virtual environments, typically 3D, where the player can gain knowledge through exploration and practice (e.g. manipulating objects), possibly in collaboration with other people (De Gloria, Bellotti, Berta, & Lavagnino, 2014). At this point we may conclude here by confirming the experts findings that computers and SG differ which follows from the fact that the area of GBL and SGs is still in its infancy but it is advancing very fast. The following chapters represent a contribution to the fundamental recognition of the classification, assessment and design of SG.

Chapter 3

Serious Games Analysis and the Development of the Classification Tool

3.1 Introduction

The games known as business simulation games (BSGs) that support training and learning focused on the management of economic processes are considered to represent the largest growth in the serious game domain. BSGs bring effective methods of learning and experience through business challenges that students usually need to meet before setting foot in the real world (Blažič, Ribeiro, Fernandes, Pereira, & Arh, 2012). In a business simulation game, the participants can select different decisions without any fear of a real loss to the organization in cases where participants make mistakes. Participants can select actions and can gain experience regarding the consequences of those actions (Blažič & Arh, 2013). The results of this chapter are published in a chapter book by Blažič and Novak ((2015).

The selection of BSG for assessment purposes presented in this chapter has been done with the intention of demonstrating what kind of business knowledge and skills can be acquired through the gaming in the concerned domain. The discussion that follows, and the game assessment, reveals the limitations of the selected game set. Overall, with the game parameters presented and assessment discussed, the chapter attempts to bring educators closer to the real expectations they can have, regarding the achievement of the learning objectives, when an adequate combination of BSG and training is applied in a particular education process.

BSG are not new phenomena. By the beginning of the 1960s, 89 different business games had been developed by industrial firms, business associations, educational institutes or governmental units (Greenlaw, Herron, & Rawdon, 1962). They have been used mainly for teaching management (Andlinger & Krathwohl, 1958) nowadays, they are regularly used at universities with business and management programs, and in particular at the world's major business schools. As an example, the University of Washington has been using BSGs in classes since 1957 (Saunders, 1996). As an educational tool, BSGs have grown considerably in the past 50 years and have moved from being a supplemental exercise in business courses to a central mode of business instruction (Faira, Hutchinson, Wellington, & Gold, 2009).

Up to the present time, numerous educational business games appeared to be of different types or genres. Adequate comparison between all of them and the provision of an exhaustive selection in order to conduct a survey is almost impossible due to the expanding list of BSGs, as new games are appearing from day to day. In accordance with the available data in the studied literature and other Internet resources, the studied literature and Internet reviews, this chapter attempts to present a survey of several games found to be typical of the business environment and most popular in higher level educational institutions, as they cover the most important educational content from business and management studies that can be gamified. The survey is then used for assessment by the developed classification methodology based on the game properties. At the end a classification table (generated with the classification tool) is provided as the final adjustment of the assessment process.

3.2 The Classification Framework and the Used Terminology

BSGs are usually presented as a training technique in which participants consider a sequence of problems and are required to solve them or to take decisions. The main component of most of the games is the simulation of the ecosystem. They model the realities of the business world by simulating basic – and in some cases advanced – business theories and practices in controlled game environments. Because they simulate the real-world system, they are often used as a teaching tool for executive education as well (Farkas, 2007). The benefits of business simulations lie in the opportunities for the students to experience and to test their knowledge in situations before encountering them in real life. Business simulations give them the chance to experiment and to test hypotheses. Within the business simulations offered within a serious game, the subjects seem much more “real” to the students or the learners than when taught passively from PDFs, PowerPoint documents or from blackboards. BSGs are used very frequently in the professional world. The games applied are usually based on a request for sequential decision-making exercises structured around a hypothetical model of the operations of an organization. The participants can select different decisions without any fear of a real loss to the organization if mistakes are made. Participants gain experience through the consequences of those actions, which can be positive or negative depending on the game purpose or goal. The learners/students use their newly acquired skills and knowledge by applying them to a competitive challenge provided within the game.

BSGs are also used in experiments related to learning and cognition. The experiments and the studies that have revealed that people often have positive attitudes towards mastering systems without the need to comprehend the underlying principles (Hogart, 2001). As a consequence, business education was criticized for being mainly theoretically driven and without a component that triggers critical thinking, creativity and innovation (Ben-Zvi & Carton, 2007; Hughes, O'Regan, & Wornham, 2008; Snyder & Snyder, 2008). The properties, which are considered major challenges in university-level education nowadays, were found to be missing in many graduated students. As the process of the globalization and liberalization of the business world has changed the types and qualities of the human capital required by the corporate sector, business graduates are expected to have not only a theoretical understanding of business but also communication and thinking skills (Suittie, et al., 2012), in addition to the ability to apply the multidisciplinary knowledge acquired during their study. The current popularity of BSGs in education follows from these findings. The interest in using simulation games is also driven by the effectiveness in presenting knowledge and theory. Instructional simulation researchers believe that a game-based method is effective because of the full-mind involvement in the learning process (Feinstein, Mann, & Corsun, 2002). The activities in

simulation games used in the area of business teaching usually involve observation and reflection, the creation of concepts, the integration of observations into theories and the application of theories into decisions and problem solving. Students learn through the sequential process of cause and effect, and by doing. The underlying sequential processes are intended to motivate students to explore, to experiment and to learn independently (Abdullah, Nanafiah, & Hashim, 2013).

According to the variety of literature in this area, several mixed responses about the definition of BSGs and their terminology can be found.

Wikipedia (2014) gives the following description of business simulation games: “They are games that generally focus on the management of economic processes, usually presented in the form of a business process. They allow students to practice business by use of relevant economic terminology and concepts. In most cases, the term business (simulation) game and management (simulation) game can be used interchangeably and there is no well-established difference between these two terms.” Wikipedia also mentions the approach of Greenlaw et al. (1962) in game definition as a sequential decision-making exercise structured around a model of a business operation, in which participants assume their role of managing the simulated operation offered in the game. Keys and Wolfe (1990) defined a management game as a simplified simulated experimental environment that contains enough illusion of reality to enable real-world-like responses by those participating in the exercise.

Greco et al. (2013) reported that the word “management” as synonymous to “business” is used in many definitions that have been offered in the business game-related literature. This claim can be reasonable: games focused, for example, on the management of an airplane (e.g. Microsoft flight simulator X), a lawsuit (e.g. Objection!) or negotiation with terrorists (e.g. The Negotiator) should not be considered a BSG. Using different words, we can assume that equating the two is acceptable only when users/players virtually manage, for example, a commercial firm, a non-profit organization, a financial portfolio, a department or a team working in the business area. While this list is not exhaustive, it helps to show the broader meaning that we attribute to the word “business”. Greco et al. (2013) continues by explaining the word “business” as a term used also with reference to business organizations, managing commercial enterprises or as non-profit and state-owned organizations.

Baldissin et al. (2007) define BSG as “Management games that are simulations used to support managerial learning through an experience that features competition and rules in the socio-economic environment”. Many articles due to this definition use the term BSG identically to business games. Ruohomaki (1995) states that simulation and simulation games can be distinguished as follows: “Thus we conclude that business games are serious games in a business environment that can lead to one or both of the following results: the training of players in business skills (hard and/or soft) or the evaluation of player’s performances (quantitatively or qualitatively). For the purpose of this chapter, the term “BSG” is used for business games.

On the other hand, there is also much debate going on about whether entertainment-oriented games that have been developed without any “serious” purpose rather than entertainment can improve the business choices that simulate the ongoing practices of a company or institution. In order to classify such games as business games, the skills improved by playing such a game should be seen as being useful within everyday business settings. A typical example is the game Roller Coaster Tycoon (https://en.wikipedia.org/wiki/RollerCoaster_Tycoon) where a player is playing the role of a roller coaster manager. Can the management of a roller coaster be considered as doing business? According to the extended meaning of “business” that was introduced above, managing a zoo is actually doing business (even though non-profit). However, it is

unlikely that a real roller coaster manager would use the game to improve his/her skills or to train himself/herself before undertaking such a job. Since there are not enough sources to evaluate the players of such “Tycoon-like” games, we consider BSGs to be only those games that are capable of training players directly in skills that can be useful within a business setting. For example, playing a series of “DOOM” games (https://en.wikipedia.org/wiki/Doom_series) can increase a player’s reactivity and multitasking skills, which can also be useful in a business scenario. This is a collateral effect of a game in which the purpose is not tied to “being useful in a business scenario”. This effect is called “indirect training”. A game that provides indirect business training should not be considered within the domain of BSG (Greco, Baldissin, & Nonino, 2013).

There are also other views that contribute to the conclusion that there is no pure agreement regarding the definition of what exactly can be defined as a BSG. However, in this chapter for the purposes of the study the following definition is used: BSGs are considered to be a type of SG that focuses on simulating management or business processes, using economic terminology and real-life business environment simulations.

3.3 Educational Areas of Business Game Application

BSG are used in several educational areas; however, their purpose is to provide effective training. Schurr (1994) and Thole et al. (1997) state that the usage of BSG is mainly focused on acquiring skills as they permit students to experience and test themselves in situations before they encounter them in real life; in addition, they permit students to experiment with business hypotheses and test them. Faria et al. (2009) state in their study based on a review of 304 business simulation education and learning articles that the capabilities/properties of BSGs are related to the provision of:

- Experience gained through business games
- The strategy aspects of business games
- The decision-making experience gained through business games
- The learning outcomes provided by business games
- The teamwork experience provided through business games.

Each of these properties can be found in more than 20% of the business education and learning articles published in the leading journal in the field of simulation and gaming (Faira, Hutchinson, Wellington, & Gold, 2009). However, other authors, e.g. Whicker and Lee (1991), argue that BSGs are used merely to enhance students’ decision-making skills, especially under conditions defined by limited time and information. They vary in their focus from how to undertake a corporate takeover to how to expand a company’s share of the market. Typically, the player feeds information into a computer program and receives back a series of optional or additional responses that are conditional upon the player’s initial choices.

BSGs can potentially also be used to manage skills mediation. Riedel and Hauge (2011) pointed out two types of skills that can be mediated or promoted by the use of games for business and industry: soft skills (team building, communication, interpersonal skills, negotiation skills, creativity, collaboration skills, learning skills) and hard skills (product/service knowledge, sales, discipline-based training, customer service, project management, decision-making skills, innovation, risk management, health and safety). Here it should be mentioned that: “the increased usage of the BSG (Faira, Hutchinson, Wellington, & Gold, 2009) has been influenced by the usage of the emerging technology of the Internet and computer technology power.”

Other researchers of BSG focusing on students' entrepreneurs have found that BSGs enable participants to adopt the following skills (Wawer, Milosz, Muryars, & Rzemieniak, 2010):

- The usage in practice of the business rules known from the theory,
- Strategic and analytical thinking,
- Ability to work in a team,
- Interpersonal communication,
- Working in the conditions of hard competition and under time pressure,
- Effective activity in the situation without full information.

The Internet as a vehicle combined with inexpensive hosting and memory storage services has triggered the proliferation of distributed computing including multiplayer games that occur on a national and even international level. This perspective of BSG development enabled the grouping of business games as web-based and desktop-based BSG groups. BSGs may also come in different shapes and sizes. Some BSGs are small and require no download from the Internet and can be played online. These types of games are run by modern browsers that have the latest JavaScript enabled or freshly updated Flash Player. Some of them can be played on the user's computer once they have been loaded. In this group, there are examples of small business simulation games that do not require a download process and are often described as web-based games. There are also other BSGs that need to be downloaded in order to be played. These come in two types: the stand-alone games that users play by themselves once they have downloaded the game and installed it on their computer (often described as desktop-based), and the multiplayer business simulations that players play online with others once they have downloaded the game. These BSGs are the most intricate, well designed and engaging. To manage and to play this kind of BSG, the following is required: the game has to be downloaded (with the purchased license, if the game is a commercial type) to the user's computer and afterwards an installation must be done. Once the user has the game installed on his/her computer, the playing is enabled. The other type of game requires the user's computer to be connected to the game's server online; the multiplayer environment is created by other users and sometimes over 100,000 users or more can be playing one of the popular BSGs at a given time.

In some cases, when players want to play a massive multiplayer business simulation game that needs to be downloaded and installed, they are usually asked to set up their profile on the game's website first, before they download the game. When the game connects to the game's site for the first time after it was installed, the software recognizes the user's computer and the game is ready to be played. However, not all BSGs are available for download; some are available only in the form of a CD-ROM or DVD format accompanied with an installation guide and game tutorial.

The proliferation of accessible BSGs has enabled educators to be capable of setting up and conducting business simulation exercises easily and at almost no cost. Student access to the Internet is pervasive, which makes the administration of BSGs easy. In addition to the technical advantages offered by Internet-based simulation games, students are at the same time accustomed to communicating and playing on the Internet. They interact within social networks such as Facebook and LinkedIn. They play MMOGs (massive multiplayer real-time online games), including the well-known World of Warcraft (www.worldofwarcraft.com), which has become a very popular game in the entertainment industry. Faria et al. found that students expect and prefer computerized simulation games to be administered in this fashion (Faira, Hutchinson, Wellington, & Gold, 2009).

3.4 The Classification Problem

In recent years, much debate has taken place among experts about the classification framework for business simulation games designed for teaching and training purposes (Djaouti, Alvarez, & Jean-Pierre, 2011). In fact, many teachers or tutors who are using business games as an educational tool for teaching business knowledge or skills often need to carry out a preview or assessment of the game in order to determine whether the game will fulfil their learning goals. Since most SGs require constant interaction, teachers are faced with the problem of selecting a game that is an appropriate training tool with properties that can meet their curriculum targets and the learner's needs.

Since the first adoption of business games, their classifications have been constantly changing due to the changeable forms and origins of business games, and the development of technology. One of the first classifications in terms of design characteristics was introduced by Elion (1963) and Greenlaw et al. (1962). They classified BSGs as follows:

- As part of a general management training program;
- For teaching new techniques or procedures for selling;
- For conducting research (e.g. on the behavior of systems, and on the decision making processes of individuals);
- Or for studying the interaction of individuals within a team.

Important work in this area was conducted by Keys and Wolfe (1990) in their attempt to classify computerized business management simulations. They produced an overview of business games based on their work. However, an important finding in this work was the identification of the multidimensional character of business games and the possibility of classifying them in a number of ways. Later, many authors tried to classify BSGs according to their content environment and their educational goals. For example, Wolfe (1993) established his classification of BSG using three main fields of application:

- Top-management games
- Functional games
- Concept simulation games

In the top-management simulation games, participants take on the roles of the top executives of a company and are responsible for the operation of the entire organization. The functional and concept simulations have a much narrower focus on a specific function or area of the company. A functional simulation game emphasizes one business operation such as marketing, production or finance. Concept simulation games usually focus on one business operation. The concept games concentrate on traffic management, sales management, advertising management, sales or personnel management (Faira, Hutchinson, Wellington, & Gold, 2009). Gredler (1996) divides the experimental simulations into four categories:

- Data management simulations
- Diagnostic simulations
- Crisis management simulations
- Social-process simulations

BSGs are most often belong to the first group of data management simulation. A participant in a data management simulation typically has the role of a member of a team of managers or planners. Each team manages a company that allocates its economic resources to any of several variables in order to achieve a particular goal. BSGs

are intended to enhance students' decision-making skills, especially under conditions defined by limited time and information (Whicker & Sigelman, 1991). They vary in focus from how to undertake a corporate takeover to how to expand a company's share of the market. Typically, the player feeds information into a computer program and receives back a series of optional or additional data that are conditional upon the player's initial choices. The game proceeds through several series of these interactive, iterative steps. It should be noted that this definition does not consider continuous (real-time) processing as an alternative (Wikipedia, 2014).

With new technologies and the development of information and communication technology (ICT), BSGs have been re-modeled. The emerging technologies have contributed to new "agent-based" games that use avatars. In this context Internet-based games can be classified into the following three main groups: pervasive games, leadership games and financial games.

Intelligent software agents, called avatars or virtual characters, are embedded in the recent simulation games. Intelligent software agents are an outgrowth of the research carried out in the field of artificial intelligence (Summers, 2004). Virtual characters are becoming crucial in the "modern era" of simulation games, where they can interact with each other and their environment to produce new states, information and events. Virtual characters (avatars) not only provide information but also affect the environment and influence the flow of the simulation. The avatar may take the form of an animated character, representing a human player, thereby creating an emotional engagement for the game participant (particularly because some avatars can show emotion). Given the capabilities offered by artificial intelligence and the "agent-based" simulation games, an additional potential effect exists in these games that enables the capture of the pedagogical benefits embedded in computer games (Faira, Hutchinson, Wellington, & Gold, 2009).

Pervasive learning games are games that are built on the framework provided by commercial video games and the pedagogical design and practice as developed over the years for educational simulation games (Thomas, 2006). Pervasive games use multiple media platforms such as mobile phones, PDAs, computers, newspapers and TV players (Xbox 360) to deliver real-time game content. They offer the advantages of being continuously available (they are available 24 hours a day, offering dynamically changing conditions); they have no set state but are always in a state of flux as noticed by Faira et al (2009). These games place emphasis on the game journey rather than on the end outcome. They can be played anywhere, at any time, using PDAs, "Java-enabled" mobile phones and iPads (Faira, Hutchinson, Wellington, & Gold, 2009).

Leadership simulation games teach students/learners leadership skills and develop players' experience with leadership-oriented or task-oriented simulations that are presented in the business working environment. In the leadership simulation, the students/learners or participants focus their learning on how to gain power through formal authority, informal authority and political influence. Formal authority is the power that results from one's position in the hierarchy. Informal authority comes from the group's perception of the leader, whether the group respect and like the leader. Political influence is the power that results from building coalitions and partnering with leaders with greater formal authority.

Financial games usually feature simulated environments designed to familiarize participants with financial concepts and terms. Simulation games usually place students in a scenario involving a company. Students typically begin by reviewing the previous year's financial data, including sales figures, profit-and-loss statements, balance sheets and cash flow. The challenge then becomes to achieve performance targets by making good financial decisions (Duggan, 2013). From the current studied literature, it becomes

obvious that a complete classification of the business games is not yet developed. The classification that will help educators to select the most appropriate game should classify games based on their different dimensions such as technical properties, usability properties and knowledge transfer properties.

Based on the consideration of the problem presented above and the presented BSG properties, the next chapter introduces the classification tool used later for classification of the selected set of BSGs.

3.5 The Classification Tool and the Game Assessment

The classification of BSGs and the associated tool is based on Keys' and Wolfe's (1990) and Biggs's (1990) proposal and later further developed by (Jerman & Novak, 2015). The classification properties are presented in two major groups. The first group – the technical classification – presents the properties derived from the technical data that describe the business simulation game; and the second group – the usability classification – presents the variety of dimensions that describe the types of usability characteristics important for the training and education processes. All properties are presented in Table 3.1 (Blažič & Arh, 2013).

Table 3.1: The properties and their description (Blažič & Arh, 2013).

Technical properties		
Property	Explanation	Value
Web-based/Desktop	Whether the game can be played via modern browser or with installation package.	Web/Desktop
Distribution	Name of developed team	Entity responsible for redistribution
Year of publishing	The year that game was released and became available for the public.	Number
Dimensions	Whether the gameplay is in 2D or 3D environment.	2D/3D
Single/Multi user	Whether the game can be played by one or many players	Single/multi
Platform	The operating system	PC windows/mac/Linux
Usability properties		
The time period simulated	E.g. day/week/month	Number
Industry specific or generic	In industry specific games, the authors attempt to replicate closely the actual industry. In generic games only general business relationships are replicated	Generic/Specific
Degree of	Game decision input variable complexity,	Low/Medium/High

complexity	or the computer model complexity	
Functional or Total enterprise	Designed to focus specifically on problems of decision-making as seen in one functional area or designed to give participants experience in making decisions at a top executive level and in which decisions from one functional area interact with those who are made in other areas of a firm	Functional/Total enterprise
Competitive or Non-competitive	Whether the decisions or participants influence the other participants or not	Yes/No
Feedback systems	Whether the results are shown by gained scores, experience points, upgrade level or a summary report	Various description
Deterministic or stochastic	The stochastic alternative is probabilistic, including chance of elements	Deterministic/Stochastic
Briefing systems	The level and usability of briefing screen	Various description
Learning objectives	Types of learning skills that can be obtained. E.g.: business strategy/strategic management/finance	Various description
Background knowledge	Whether a basic/advanced or no business knowledge is recommended or required in order to play a game	Yes/No

3.5.1 Selected games and content

The list of BSG that can be found on the Internet and that can be a subject for classification is countless. Wikipedia (2014) provides a list of several hundred business games ordered in alphabetical and chronological order. The problem of this list is the fact that they are considered to be more entertainment-oriented than edutainment, and as a consequence, their use as a learning tool is questionable. A game used in education has to be realistic, engaging, motivating, popular and user-friendly and with a clear educational objective (Blažič & Arh, 2013).

The selection of BSG analyzed in this thesis was based on a review of business game-related articles that address managerial educational problems and issues related to particular business simulation environments. The selection was influenced by the results of two EU FP7 projects: the COSIGA project and the GALA project (<http://www.elios.dibe.unige.it/gala>). Two other authors (Riedel & Hauge, 2011) listed another selection of 39 SG that address some business educational topics such as finance, management, product management, industry management, leadership, etc. The revision of the lists enabled the selection of games that can be considered as representatives within the business domain. The particular topic addressed is considered important in the area of management education as well as in general politics. Once the selection was completed, the research continued by playing them. This step was followed by the

classification based on identified properties and later by their assessment. The next section presents the selected games and their content.

3.5.1.1 eRepublik

eRepublik (www.erepublik.com) is considered a massive multiplayer online strategic game that combines social networking elements (Facebook, LinkedIn, etc.). It was developed by Republik Labs. It was launched in October 2008 and has been translated into 18 languages. The game itself is a free-to-play web-based game, which means it can be played absolutely for free via the Internet (the registration is required), and it runs in most modern Internet browsers. It was developed and programmed using PHP program language and the Symfony framework. eRepublik has spawned a number of similar games due to its commercial success.

The game is set in a mirror world called the New World. The players take the role of citizens where they can participate in daily activities. As the citizens of the New World they can choose which country they wish to join. Each country is named after an actual country in the real world, and is generally located similarly according to the real world. The player who has a German nationality will probably join Germany, Italian Italy, etc. After joining their desired country, players can act as employees, where they can own a business, run a factory, start a political activity, form a political party, write newspaper articles, run for president, become members of Congress or country presidents, where they can help formulate national economic and social policies as well as initiating wars with their neighbors (as virtual versions of real-life countries) and/or tread the path of a private citizen working, fighting and voting for their state. At the beginning of the game each player has to seek employment at a company within the country he has joined that will provide him with a monthly salary and their daily needs. On becoming an employee, he/she is offered the opportunity to be trained as a soldier for his/her country. Training and working at a company is done on a daily basis. The game has an official eRepublik wiki (wiki.erepublik.com) and official blog (blog.erepublik.com) where players can obtain all the information that may help them to get deeply involved in the game of eRepublik.

To begin a game, each player can get a mentor (or watch a video tutorial), who guides him/her through the introduction of eRepublik and provides an explanation of the basics of the game. The game consists of four modules, which are: My Land, Politics Module, War Module and News Module. In My Land a player has a patch of land where they can construct various buildings (farms, factories, storages, etc.) that can be constructed with a local currency or gold. The effectiveness of economy buildings depends on the natural resources that the nation (country) has. In the Politics module a player can join a party, when they reach a certain level. If his/her political party or party campaign becomes successful, he/she can take on a higher role such as a congress member or a president of the nation he/she belongs to. On the fifth of every month eRepublik holds presidential elections, on the 15th congressional elections. All activities that are connected to warfare systems are situated in the War Module. When the president or the congress of the country proposes a natural enemy law, a war on other countries can be declared. Players are able to train as a soldier and be ranked up in the military by fighting battles or go to war when he/she signs up to the army of his/her country. Wars play a potentially essential role by increasing the economic or political power of the country. A nation that has experienced and battle-hardened citizens can become a global power and grow a global economy business. The role play of the world of eRepublik consists of combining the capabilities of the above modules to reach goals and become leaders in one or more domains. Using newspapers in the News Module, they can

share their political ideas and change and shape the directions of political systems and beliefs. The congress of a country sets taxes to enforce economic policies. To wage successful wars, the economy of a country has to sustain them and citizens have to be motivated.

With regard to the graphics, the game has no advanced or attractive graphical interface. It is created with just a few visual elements and is primarily text-based in nature, yet overall the game is nicely illustrated. The game also has a sleek interface, so it is very easy to find what you are looking for. eRepublik aims to do its best to reflect the nature of the 21st-century business/political world and 21st-century life in general. But as a player you will not be able to learn your business “know-how” abilities and processes as the time allowed for playing is limited (the game can be played for between 10 minutes (14 minutes’ equals one day in the eRepublik world) and 15 minutes per day). The nature of the business in the game is politically oriented. The workflow functionality of the game is a basic simple click-to-do, but it provides a great source of income for a player. Regular “working” increases players’ experience level and the higher the level, the more things you can do. The game requires “long-term” regular playing where players embrace the full role of managers and politicians. The main problem that can be noticed is the lack of specific situated business or business project tasks that could be potentially involved.

On the other hand, the game of eRepublik provides some interesting psychology aspects. One nation can be in favour of the real life being either a political or economic situation in the New World. For example, in the real world, Slovenia and Croatia have been negotiating for years over an Adriatic open-sea border agreement, which potentially causes political and economic tension between them. The potential players solving this problem can simply declare war and take over the other country through military invasion or choose economic destruction of the weaker country.

Overall, eRepublik does a great job of being a multiplayer simulator from the current world, based on a website and textual elements with a search for easy navigation, reflecting a version of the real world where citizens of different countries interact.

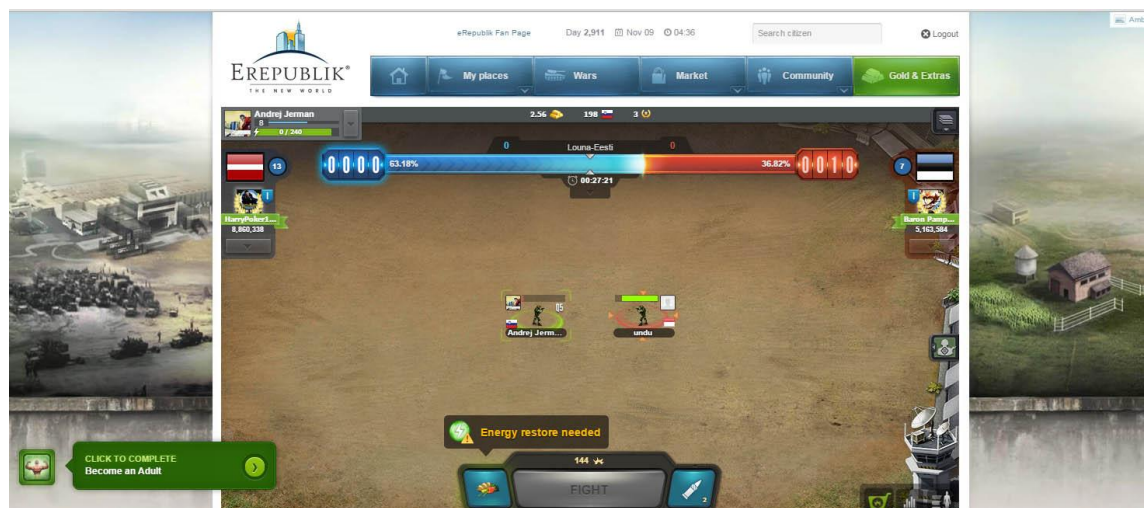


Figure 3.1: A screenshot of the eRepublik game presenting the current war between the Republic of Macedonia and Italy.

3.5.1.2 Virtonomics

Virtonomics is another business strategy-oriented online (web browser) game, played as an MMOG game where the basics of management are tested. It is an Internet game with a massive number of players that reflects a wide range of interests. It has been developed by Russian developers and was launched by the Virtonomics team in May 2009. For three years of its existence the project managed to link more than 400,000 users in Russia, Ukraine, Germany, Belarus, Kazakhstan, the Baltic States and other regions (<https://en.wikipedia.org/wiki/Virtonomics>). It is designed for fans of economic and strategic games, and to study the basics of management. The game itself requires an understanding of the laws of real-life economy, business and finance, yet players do not need a deeper understanding of economics or any special background education to take part in this game. The game is helpful for meeting interesting people with common interests and making useful connections (Blažič & Arh, 2013). The game can be presented as a unique business community where participants can find new business partners and potential employers. Economic experts can find Virtonomics an inexhaustible source of useful observations and a place where they can try different business strategies. Virtonomics is versatile. It combines logical and business gaming, real economy simulation and economics strategy. This is a game where players' knowledge and efforts are a source of real income. There are a few fields of economy represented in the game, which has more than 100 different products. New countries and manufacturing sectors are introduced as well as products and productions. The main aim is to manage a company, where a player has to compete with artificial intelligence agents as well as with other players participating in the game realms from all over the world. Currently there are 700,000 registered users <https://en.wikipedia.org/wiki/Virtonomics>, 2010) (Virtonomics has been translated into English, Spanish, German, Russian, Chinese and French among others). It is integrated with popular social networks (Facebook, LinkedIn, Twitter etc.). Players from all over the world can cooperate, compete, form a partnership and have price wars over products, which they sell etc. It is a unique system for business training. All the possible real-economy industries are represented in the game: agriculture, mining, the retail trade, scientific research and others. Each player is free to choose their own strategy: whether to build a complex holding and participate in several market competitions, or carve an individual and original way.

When starting a game, a player can choose and participate in the game realms where he/she will run his/her successful business. Currently the game has five realms – Vera (Russia), Olga (Russia), Mary (England, France), Lien (England, Canada) and Anna (England, France, Canada, Russia). Each realm has its current characteristics: the number of current companies involved, the turnover value, the technology level and the countries that are participating in the game realm. Dynamic movement is tested; when slowing down with the business, the chances of bankruptcy are increased. Quick decisions are players' key to success. For those who like everything exclusive and equal game opportunities, there is a separate game world (the Anna realm) functioning according to the principles of a subscription model (free of charge for 10 days; after that the subscription starts from 8.25\$ per month). All achievements depend on players' capability in terms of planning, thinking and implementing. The fight for survival begins at the very first moment when a player registers his/her own company and creates the working office. For beginners, Virtonomics offers players a gift: a company left from “your uncle”, with all the capital needed to start in a full-progress business world. It does not matter which strategy a player chooses (adapting an old business or starting a new one), the main goal is to establish and make a profitable and successful business. The opportunity is given to a player to become a tycoon, in order to develop his/her own

company, competing with thousands of real components, winning new markets, and providing a financial and political power to its corporation. To do this a player has to engage in trade, manufacturing, research, exploration of natural resources, agriculture, trade in the currency market, personnel management, finance, marketing, logistics and other business processes. In controlling the corporation, a player must hire and train staff, establish sales, monitor the activities of competitors, improve the quality of his/her products, enter into business alliances and more. The game runs on virtual money. Every player receives a sum at the very first registration. This fund is used for the construction of business units, the payment of expenses and investments. Money that is earned can be used for the development of the company. The game can constantly grow. New countries can be created; new industries and new products added, and new types of productions can be implemented.

Virtonomics, like any other MMOG game, takes place in its own game world as a mirror of the real world. The game world is built from cities, woods, fields and farms. Several cities with similar taxation create a region. Several regions with similar custom duties create the biggest economic unit – a country. All the rules from real-world business are present, such as the correlation between export and import duties expresses development priorities for each country. The game is turn-based, which means it can be played without staying online all the time. Visiting the website once a day for 30 min gives enough time to complete reviews of the player's business status and face the challenge of the new tasks. The game is a sort of business simulator, where to a regular player it can offer the possibility to obtain different specific skills in management, marketing, economic cooperation, business optimization, finance control etc.

Graphically, the game is very poor. Virtonomics is a strictly text-based game with minor graphic elements. Visually it looks like a wide complex forum community. The lack of realm maps and city maps is very apparent. The menu bar consists of seven sections: Company, My Office, Markets, Game World, Community, Help and My Earnings. Each section has a sub-menu bar. Most activities deal with the first three sections. In the "My Office" section a player can read messages, change the profile, restart a business, monitor the realm, study the reports, manage the paid service etc. In the "Market" section, a player deals with markets such as the enterprise market, State enterprise market or Franchise market, or participates in Enterprise auctions, award auctions, gift shops and deposits.

Virtonomics is not just a web-based online game; it can also be considered a training system. It might be very useful for students of business schools and economic colleges, as well as for already graduated managers who want to know more about economic principles in practice and test themselves in various business situations. There is market research that needs to be done (studying and reviewing reports to begin with), managing the retail and suppliers of products, as well as training staff and pricing the players' purchased goods with reference to existing market sales (both local suppliers and competitors), quality and the brands of the goods. All these characteristics can contribute to the overall review that would describe the game as a "not-so-user-friendly" web-based business game. Many business schools and universities recommend Virtonomics as a unique business training simulator for modelling various business strategies and tactics, and solving business cases, as well as a unique business community where users can find new business partners and potential employers. Economic background knowledge is strongly recommended, but it is not necessarily required.

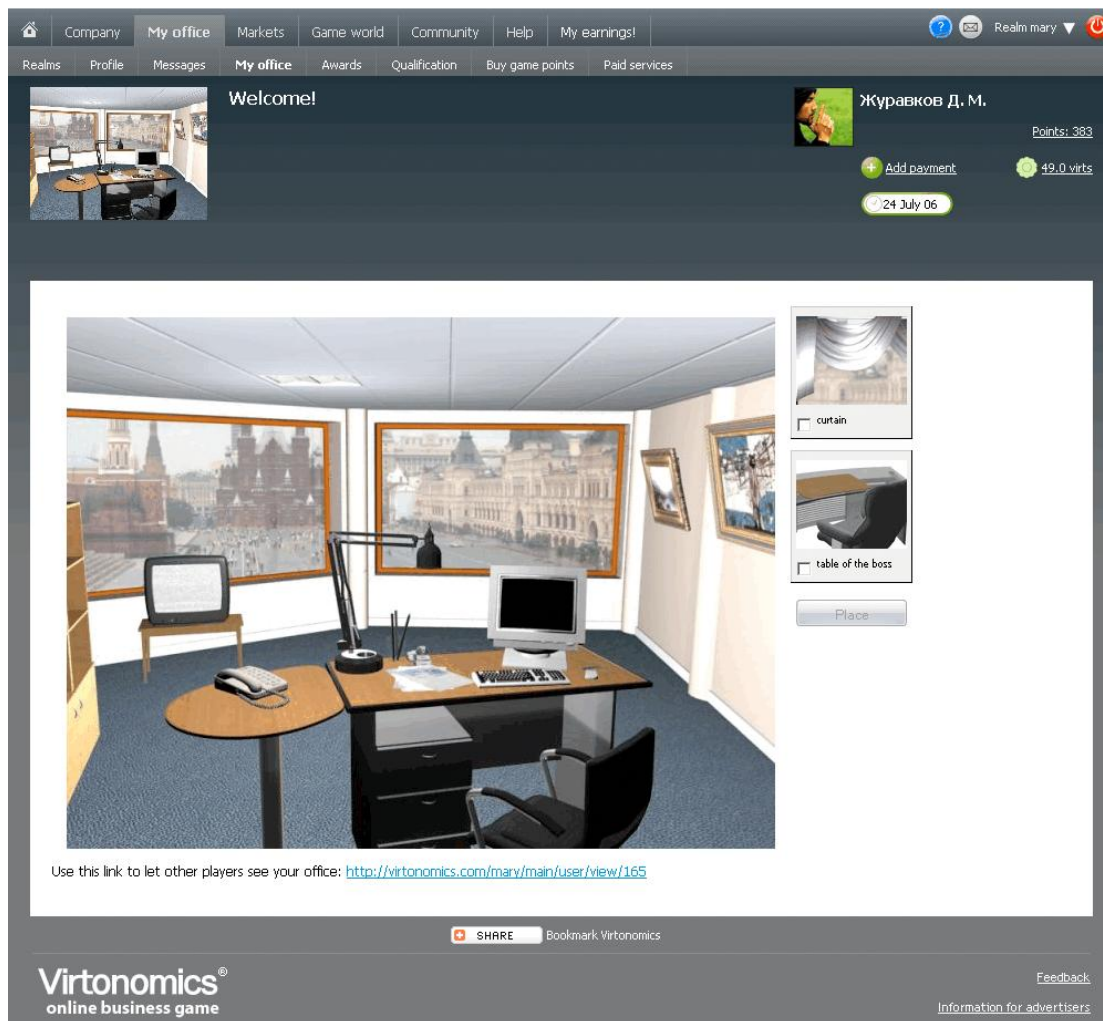


Figure 3.2: Virtonomics (screenshot from online game Virtonomics – player's equipped office).

3.5.1.3 Business Tycoon Online

Business Tycoon Online (bto.dovogame.com) is an innovative well-known massively multiplayer online game that originated in Asia. The game supports thousands of players simultaneously. The game was developed and launched in 2010 by Dovogame. Playing a Business Tycoon Online (BTO) game is absolutely free of charge with no installation required. It can be played on almost any computer with Internet connectivity and a modern browser supporting Adobe Flash Player 10.0. It is designed as a business simulator where players must rise to the top of the social ladder as industrial tycoons. The players take the role of entrepreneurs who make their way by living in Liberty City. In the tough business world a player starts his/her own business and breaks through constant challenges to eventually end by building up a universal corporation or a powerful business empire. BTO includes a variety of business items that are simulated through the game: realistic financial accounting, business interaction, trading and commerce processing, designing empire buildings, and even “shady” business deals and corporate sabotages.

At the very beginning of creating a company in the world of Liberty city, players can open more than 100 different kinds of stores where their success or failure is in their

hands. In addition to opening the stores and running them successfully, the players need to recruit employees and arrange their training. Every day, it will be required to attend different kinds of business meetings. In order to become well-connected socialites of Liberty city and expand their network, players are obligated to widen their social circles and interact with the other entrepreneurs around them. When faced with fierce market competition, the player prepares for any challenges that come his/her way.

The game itself is played in a strategy-oriented nature where the business decisions and leadership are tested as the game progress. Recruiting smart secretaries brings you benefits whereby they can help you to improve working efficiency. On the other hand, with good leadership skills a player can increase his/her own company's revenue. The objective is to create your very own company in one of four industries (entertainment industry, sales industry, catering industry, service industry), from a single shop to a major large company with hundreds of employees. In the entertainment industry a player deals with managing entertainment such as jazz clubs, arcades and billiard halls, while casinos and horse racing courses await entertainment tycoons. Management in the sales industry can be difficult but brings a big payoff. The player's engagement involves dealing with open markets, bookshops, gift shops and eventually shopping malls. In the catering industry, the player meets the world of the hotel and resort business. The service industry involves the management of service-related stores such as hairdressers, massage parlours and tattoo shops. Depending on which industry a player chooses, he/she is limited to a handful of stores he/she can open, and special benefits are tied to each store. For example, if a player chooses the sales industry, he/she will enjoy a 5% production and raw material supply rate increase from the player's factory.

By gaining more experience and success the player receives level points and rewards. Being a successful businessman in Liberty City, is not based on solving easy tasks as the game requires, but managing complex systems like factories, stores and human resources, including employee training, building relationships with media and with the local government. The media system also takes an important role in evolving a player's business strategy. Through the media (newspapers, TV, radio, Internet) a player can publish comments to promote their companies or to attack their competitors.

BTO is structured as a real business-oriented web-based game involving a building aspect that also makes it a construction and management simulation. As with most of these games, players start with an "easy-to-use" tutorial system, which guides them through the general features and game play mechanics players will need to become familiar with. In the meantime investors also play a big role during the game where they provide you with a series of missions to walk you through step by step. Each mission accomplished is not just one step closer to establishing a business empire, but also a position where a player receives some good treats, such as money or gold, which plays a major part in the game.

Overall the game doesn't require economic or business background knowledge but is very well received. It is easy to play and lots of "real-life" plot twists and interesting spins on traditional business simulators are presented.

Graphically the game seems to do a good job in comparison to other web-based strategy games or simulations. However, the menu system has rather too many features, which can make players confused at the very beginning, and the "web design" gives the impression of an "online poker portal". In order to really enjoy the game, some studying, spending money and learning "how to be patient" and "forgiving" will be required. But as feedback BTO gives the player a variety of directions on how to obtain some good strategy skills and management decision processes that can mirror the "real-life" world.



Figure 3.3: Business Tycoon Online (screenshot of BTO user interface).

3.5.1.4 INNOV8 2.0

INNOV8 is a serious game that was developed by IBM as part of their Academic Initiative program. It is basically a role-playing game that simulates business process management in a 3D environment. The IBM SOA (self-oriented architecture) team originally created the game to help educate potential SOA clients. The initial version was only open to the academic community and has been in use at over 1,000 universities and colleges (as far and wide as Beijing and Manchester) since its launch in 2007 (Jerman & Arh, 2013). The 2.0 version was released in May 2009 and has two extra scenarios – smarter supply chain and smarter traffic – in addition to the original customer service track. The original scenario of the game deals with a call center where the players use the call center environment to develop more efficient ways to respond to customers. In each of these three scenarios a player's goal is to model a new business process in order to come up with solutions that improve the efficiency. An online version of the game is also available and is open to the public.

The game employs a first-person role-playing approach where the player assumes the role of a consultant within a company that is experiencing challenges. The player is given a goal that he/she must achieve in order to successfully complete the game. The goal is to re-engineer a call center process for the company in order to make it more efficient and effective. In order to achieve this goal, the player has to complete certain tasks, which evolve as the game progresses. The game starts at the very first moment when a player takes the role of a female virtual character that has been hired by the After Incorporate Company. A player's mission is to invent a critical process from the inside of the organization that deals with customer service. The goal is clear: improve customer service and maximize profits while running a call center. A player uses drag-and-drop graphics to advance through the game. Since the main parts of the game take place in a 3D environment, the game gives an impression of "first-person-shooter"-like game play.

While different tasks are completed the game tries to “force” the players to make decisions as they seek more efficient ways to manage a call center and respond to customers. When the business meeting takes place, a player has to play with different variables of business modeling and see how their changes vary the outcome, preparing them for the day they need to make real decisions.

The game focuses on the experience to be gathered by individuals that are starting to learn about business project management and about the processing of information and decisions. There are three levels to Innov8 2.0: process discovery and process modeling, collaboration-driven simulation and iterative process improvement, and real-time business management. INNOV8 2.0 also gives players the option to collaborate to map out business processes, identify process bottlenecks and explore what-if scenarios. Some parts of the game, which even has virtual characters in the shape of heroes and villains, use “Second Life-like” graphics.

Graphically the game is very rich. At the beginning of every scenario a short movie scene is provided, where the objective is explained. It has virtual avatars (characters) that have an audio voice when a player has a meeting discussion. The interface includes no menu bar tools. The GUI (graphic user interface) mainly concentrates on point-to-click and drag-and-drop issues, where a player sets the parameters to simulate the right solution for the business process management problem that is being issued. The overall visualization of the game gives the impression that the game originates from the commercially designed game market.

Overall INNOV8 is an interactive, 3D business simulator designed to teach the fundamentals of BPM. BPM enabled by Service oriented architecture team for provision to provide life cycle improvement, and drives innovation in the business process and business model. Capabilities of both the software and the expertise follow a logical life cycle approach for modeling, optimizing, designing, deploying and managing business processes.



Figure 3.4: IBM Innov8 (screenshot of 3D environment of Innov8 game).

3.5.1.5 Wall Street Survivor

Wall Street Survivor (www.wallstreetsurvivor.com) is a web-based financial (stock market) game with real market data, real stock symbols and real market tracking, all tracked and accounted for on an impressive simulated trading platform. It simulates real-time bid/ask trade fills, streaming profit and loss pages. The “virtual stock market” site offers a fantasy stock-trading platform, real-time quotes for the most realistic paper-trading experience, as well as educational articles and forums. In addition, to play the advanced version a subscription with payment is needed. Wall Street Survivor is considered the “biggest simulated trading game on the Internet with thousands of people learning the ropes of trading every day”. It was launched in September 2011, and has currently up to 350,000 registered users and 3.5million page views per month (www.finovate.com, 2011). Players can interact in the platform to share trading tips and make new connections as they learn how to trade and gain confidence in their decisions.

In order to play a game, a profile account needs to be created and registered. Once a user is registered at Wall Street Survivor, he/she receives an account of \$100,000.00 in simulated money to trade with. The account also includes a margin, meaning that a player can use up to twice the amount of money in the account for trading, i.e. \$200,000.00. As a safeguard to help a user to learn, Wall Street Survivor does not allow more than 25% of users’ balance to be traded in any one position at a time. Players (investors and traders) can also win prizes if they land on the top gainers’ category. The game also has a resource section on their website that is full of articles explaining the most important trading topics, including stocks, options, futures and other important trading ideas. Wall Street Survivor also gives out \$100,000 in prizes every year to its players, which is a very nice thing for them to do. It’s easy to navigate around the website, which makes Wall Street Survivor different from other stock market simulations.

Getting help at Wall Street Survivor is as easy as click and send. The FAQ page is well supplied with helpful data when the users log in to in this simulated stock market game. One of the most important lessons that one can learn in Wall Street Survivor is that a player cannot play unless he/she understand the dynamics of the stock market. Wall Street Survivor articles, which are regularly uploaded on the official page, do not guarantee you higher gains, but they guide you toward important skills, such as choosing the best deals, comprehensive usage of the best strategies, and finding hints regarding hot or preferred stocks to be bought.

However, when placing a trade at Wall Street Survivor, the quotes shown for a particular stock are delayed by 15–20 minutes. This delay matters a lot in real trading but for the sake of learning day-trading strategies, this delay might be justified in order to make the most of Wall Street Survivor by using different strategies or position sizing methods. This also enables a player to learn how to close out positions. At the end of each day, Wall Street Survivor makes users realize that practice can move him/her further up the ladder of success. Perhaps being conscious that no money, and therefore no emotion, is involved allows users to practice the game without any bad consequences (www.wallstreetsurvivor.com).

http://www.wallstreetsurvivor.com/pdf/Investing101_eBook.pdf

Graphically, the game is strictly text-based with a view of different types of charts with various technical indicators.

Wall Street Survivor is not for every user. For users that have no desire to learn about the stock market or get involved in the real stock market world, it is strongly not recommended, but for people who want to “hone” their trading skills, and simulate real trading before doing real business with real money, Wall Street Survivor is a good place to start.

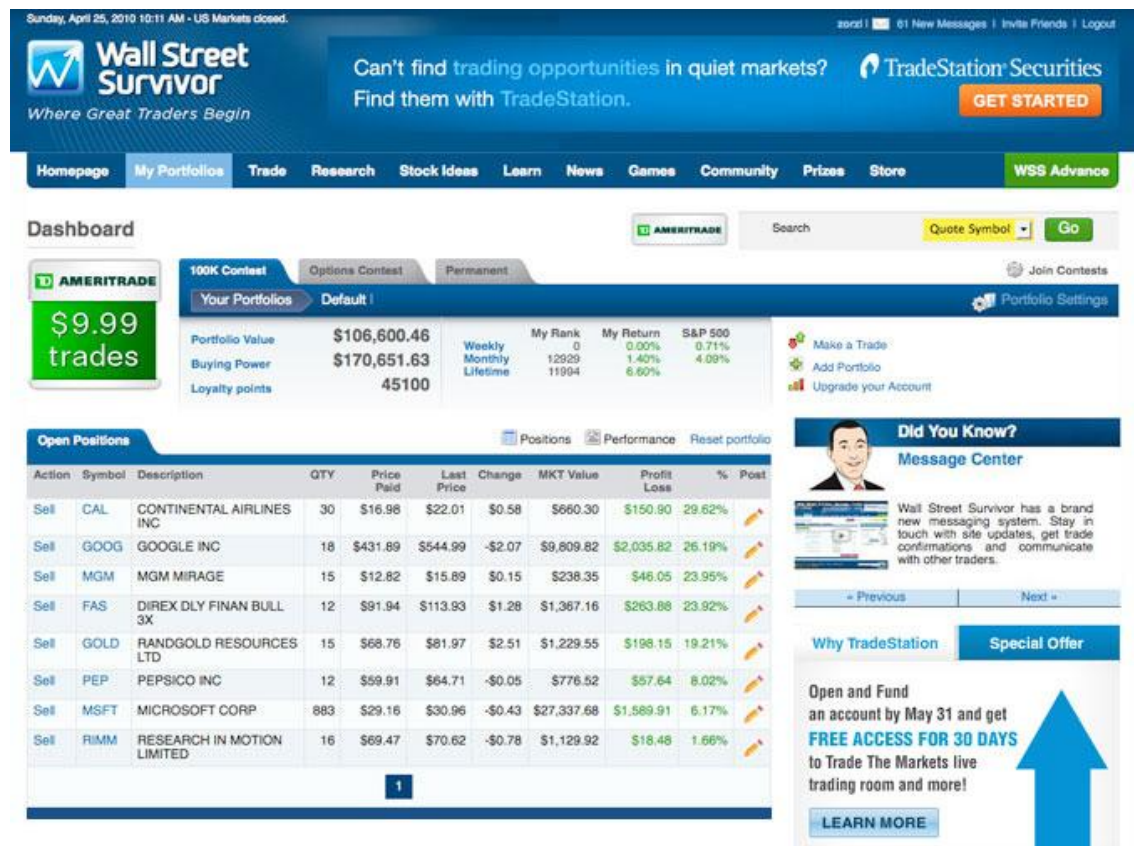


Figure 3.5: Wall Street Survivor (screenshot of online Wall Street Survival virtual shock).

3.5.1.6 Big Oil: Build an Oil Empire

Big Oil: Build an Oil Empire is a business strategy game where users take the role of an oil baron who is set in times of the oil industry pioneers, in order to build his own oil empire by taking control of the entire oil business process, from surveying, drilling and extracting to refining, selling and market investments. The game was released in July 2006 and developed by Try Synergy. The game can be played in a single player mode or multiplayer mode online or via a local network with up to six players (Blažič & Arh, 2013).

Big Oil lets users build an oil empire by drilling for oil, shipping it to refineries around the world, and eventually processing it into products that can be sold to the public. To play a game the player can choose from more than 15 scenarios based on historical events such as the Oil Crisis, Lenin's death, Apartheid, the World Wars or the Great Depression (Blažič & Arh, 2013). Each of the scenarios has unique rules and conditions for success. A player can also choose a free play campaign, where he/she starts from scratch and builds oil wells and refineries; researches new technology to improve transportation and create new products; and develops cities that provide more workers. There are two difficulty modes to choose from: easy mode and advanced mode. When choosing the easy mode, the player receives constant help from a virtual assistant that guides the player through the so-called "getting familiar" process with the user interface and makes recommendations concerning the user's decisions in order to automatically undertake certain menial tasks, like sending a virtual team to test a potential oil field, with the user's permission. Big Oil is commercial-strategy-game like. With all the functionality that is provided, Big Oil is very similar to the game Dune 2000

(<http://www.gamespot.com/dune-2000/>) or the series of war craft games (<http://eu.battle.net/wow/en/>) where the competition with your opponents is running all the time. The player's progress is shown by the money budget he receives in order to indicate how his/her oil business is growing.

Like any open-ended game, there are a large multitude of choices to be made that allow for a different game play experience each time. However, with the high initial difficulty curve of the game, as well as the underwhelming experience of playing it after getting a handle on it, Big Oil game will probably spend more time in the desk drawer gathering dust than in the CD drive. Big Oil starts with a generally unappealing premise and goes downhill from there. The game is difficult in terms of the controls as they are somehow hectic and boring. At the same time, they are packaged in an uninspiring shell of semi-poor graphics.

Overall the game itself is only oriented to the oil business, which means that if users are not passionate about the world of the oil business they can easily be confronted with the hectic learning curve and subsequent extreme dullness that Big Oil offers. However, for "oil tycoon wannabes", there is a distinct possibility that they might find the game endlessly fascinating.

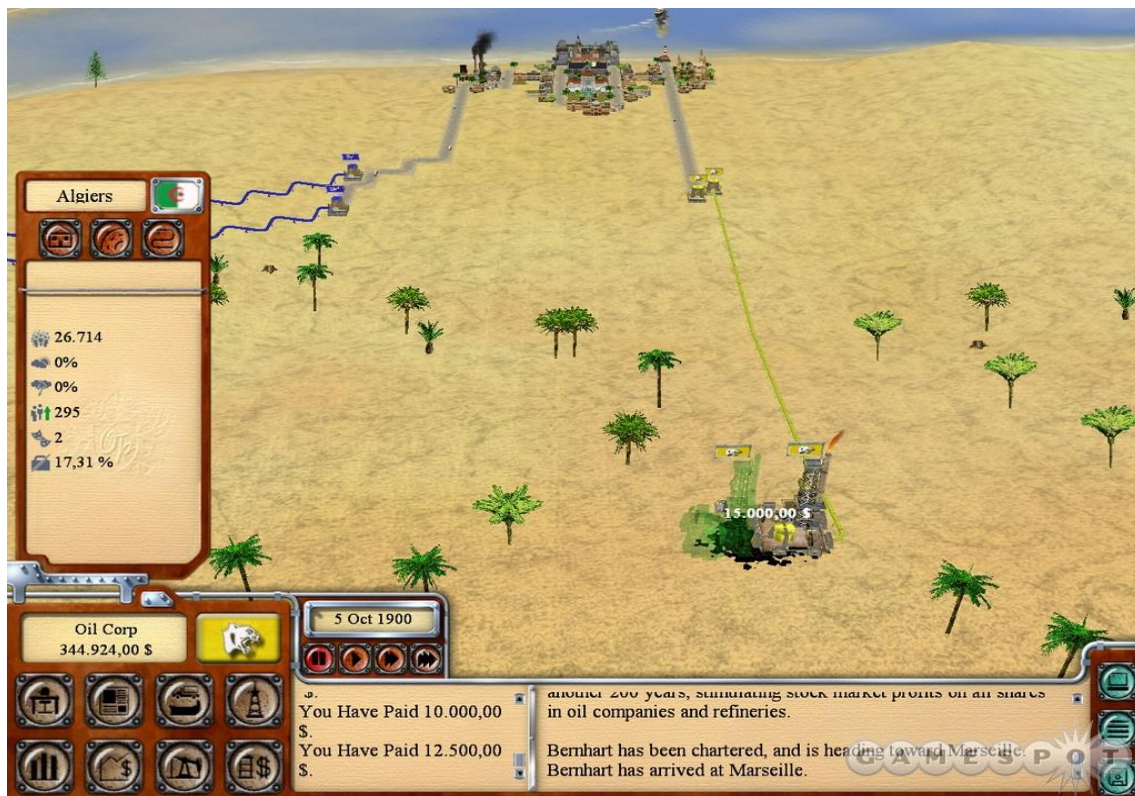


Figure 3.6: Big Oil: Build Oil empire (screenshot of GUI of Big Oil: Build Oil Empire).

3.5.1.7 Virtual Leader

An important area in management education is the building of leadership. Training in that context is possible with the Virtual Leader game. The game is dedicated to acquiring leadership skills. Being a good leader is considered to involve the capacity to have suitable power in influencing employers to create an effective and productive atmosphere that will enable successful accomplishment of the task and the project at the end. This can be achieved by many components in the form of communication and increasing awareness of verbal and non-verbal communication cues. Virtual Leader as a

simulator provides a user with step-by-step practices, through preset communication dialogues over the course of several sessions or one long session with virtual co-workers. It uses a meeting environment to allow users to interact with other characters. There's also a well-written guide that describes the theories behind the content.

Virtual Leader is a stand-alone game, which means that when the game is installed to a computer it can be played. Once the game starts, users need to register and create their account and begin to play. At the beginning the player is given short introductions about leadership fundamentals and a framework showing how communication affects the principles of leadership. In addition, the player can choose two other options: either to begin the learning of the principles through tutorial practices or to be engaged in the simulator through a variety of leadership scenarios. The player takes the role of a character named Corey that Nordic Enterprise have hired to work as a sector leader at the customer service call center. It is all about getting work done. Virtual Leader uses meeting scenarios where Corey gets to interact with virtual characters to get the right combination of ideas. At each meeting session, the goal is to introduce ideas, support them and make them happen after finishing the meeting. To achieve the goal, the user must create the right amount of tension and use the right amount of gained power, to make the virtual character accept and support the leader's ideas. All these components of maintaining power are constantly monitored in the shape of a three color graph that can be seen as a practice mode. When the meeting is finished, the learner is given a summary of how he/she used the key tenets of leadership skills to manage the expectations of the meeting. A set of graphs and numbers is presented where players can analyze how to improve the strategy of increasing or decreasing the elements of good leadership. Virtual Leader does not try to simulate a real-life conversation. The learning objective is mainly to focus on creating a learning experience to develop intuitive skills so that people can, without hesitation, understand other people's intent in a real-life situation.



Figure 3.7: Virtual Leader (screenshot of business meeting in Virtual Leader simulation).

3.5.1.8 Shark World – a PROJECT Management Game

This game is considered to be an excellent addition to the basic project management training. The main focus is on experimentation and gaining experience in key aspects of efficient project management in a highly entertaining and motivating setting. The game is played online, thereby enabling the creation of a convincing virtual environment, close to the reality in which a particular project is developed in real time. The game proceeds in an interactive way that urges students to react when things go wrong, or preferably before they happen. The game can be played both through online and mobile channels, which makes the game accessible at any time and in any location. Projects are developed in (accelerated) real time (24/7) so players have to keep up with the fast pace and act or intervene almost immediately. The game is propelled by an underlying suspense story that blurs the line between reality and fiction. The game offer lifelike content as a test case for inspiring trained future project managers. A screenshot from the game is presented in Figure 9.

Shark World combines simulation elements with a story and characters, to create an engaging project management experience. With the help of picture and video material, players are taken on a trip to China. Once they arrive in China, players start to manage their project. They can use conversation, chat and email, in order to take care of the interests of the boss, the client and the team. They also make project schedules and project budgets. The choices that players make during the game decide whether the project becomes a success or turns into a disaster (www.ranj.com).

The game play is based on the usage of various media such as emails from game characters, newspapers and TV news in order to give extra depth to the experience. When players are not behind the computer, they get texts and voice messages from game characters on their mobile phones.

Once the user is registered (created their profile and entered their mobile number) the game is ready to be played. The game begins with an automated mobile call, where the virtual female assistant lets the player know that she is waiting to pick up the player at Shanghai airport. After the game has started, the introduction video begins, where the female assistant meets the player at the meeting spot (Shanghai airport) and explains the background story and the aim of the project to be processed. She describes the challenges the player should expect during the game. At a location near the city of Sha Cheng a large-scale shark aquarium is being rebuilt and is combined with a swimming paradise named “Sharkworld”. A virtual Dutch (international) installation company called “Spector Install” has acquired the project. The company is experienced in building swimming pools, congress halls, hospitals and dolphin aquariums, but has never worked with sharks before. Their corporate website provides a nice overview of several installation and construction projects in both utility and industrial fields, with diversity of cases, but without any shark aquarium.

The game continues with the news that the appointed project manager on site has mysteriously disappeared and the player is a person that applies for his job, gets the job and is sent to China immediately. The player lands in the middle of an ongoing project and must bring the project to a good end. What the player does not know at the start of the game is that not everything in the game is what it seems to be. Some things, e.g. obstacles, will turn out to be set-ups as they are designed to test the player’s project management abilities (www.sharkworldgame.com). During the game, a player is expected to achieve and display essential soft skills, by having conversations with people who are involved in the project. When a player has a dialogue with the game characters, the “mood icon” of the characters appears in the upper right corner of the GUI (graphical user interface presented in Figure 9. When the game character is satisfied with the

player's answer, the "mood icon" shows a "happy face", and in contrast, when the game character doesn't like the answer or the step undertaken, the "mood icon" changes into an "angry face". During the game, a player must maintain three very important types of atmosphere:

- Team satisfaction
- Boss satisfaction
- Client satisfaction

The levels of these attributes are shown on the status bar, with a little pointer that shows where on the scale of satisfactory presented skills the player is. For example, if the pointer is colored green, the satisfaction is high, and a red color indicates low satisfaction. In order to bring the project to a successful end, all three satisfaction types have to get the highest satisfaction levels, meaning that the pointer has to be in the area of a green color on the scale bar. The performance of solving problems is also followed during the game. Whenever in a game a challenge comes up a player must perform a task in order to solve the problem presented as a challenge. The player provides a solution to the problem through calculation of the data information gathered during the game for an assessment of the risk management. Depending on a player's decisions, the results of the challenges are shown in the project overviews. After the accomplishment of the task the game displays the achieved performances in problem solving, which are categorized as extremely poor or professionally successful.

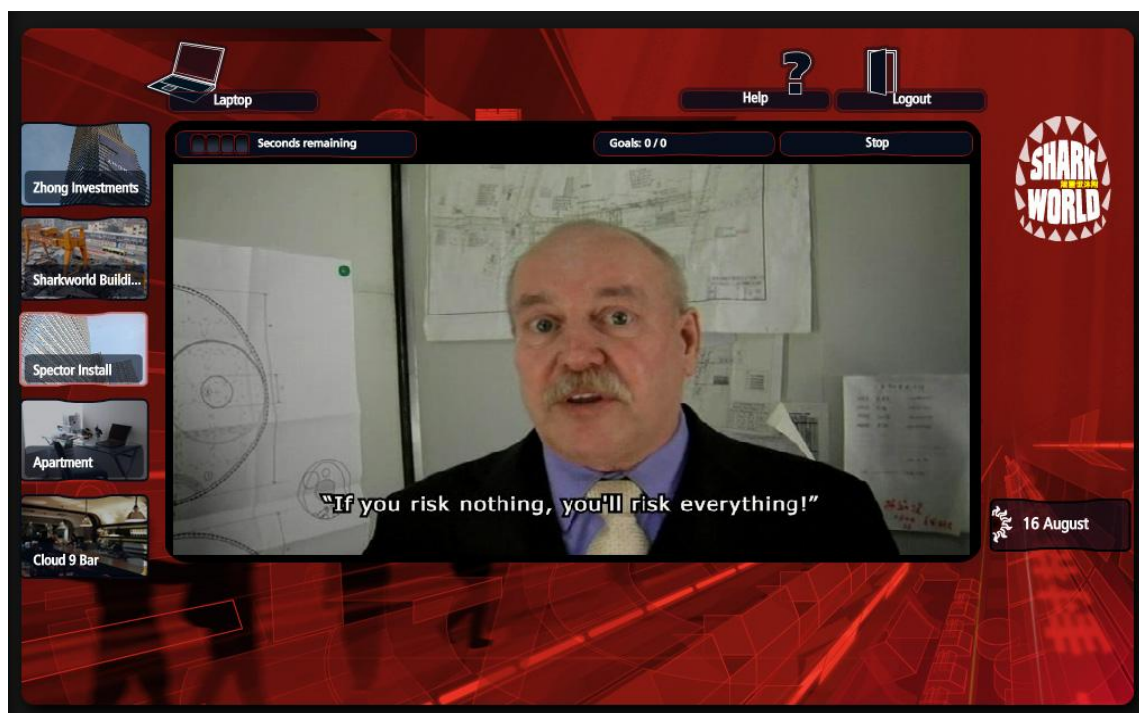


Figure 3.8: Shark World (screenshot of graphical user interface).

3.5.1.9 Beer Distribution Game

The Beer Distribution Game, also known as The Beer Game, is a role-play supply chain simulation game that lets students experience typical coordination problems of (traditional) supply chains without information sharing and collaboration. It was created by Professor Jay Forrester at MIT Sloan School of Management (Business School of Massachusetts Institute of Technology in Cambridge, Massachusetts) in the early 1960s.

The purpose of the game is to understand the distribution side dynamics of a multi-echelon supply chain used to distribute a single item, in this case cases of beer. The aim is to meet customer demand for barrels of beer through the distribution side of a multistage supply chain with minimal expenditure on back orders and inventory.

A range of different versions of the Beer Game have emerged over the years. The original Beer Game was realized as a board game. In this report the online version of the game is presented, which is available online at <http://www.beergame.lim.ethz.ch/>, and it requires the latest JavaScript version.

The Beer Distribution Game simulates a supply chain that consists of four stages (retailer, wholesaler, distributor and factory), each of which is played by one player. A supply chain can be played by a minimum of four players that are currently online. When no players are available, a computer plays the stages. The task of each supply chain is to produce and deliver units of beer: the factory produces beer and the other three stages deliver the beer units until it reach the external customer at the downstream end of the supply chain. In doing so, the aim for the players is as follows: each subgroup has to fulfil the incoming orders for beer. The retailer receives an externally predetermined customer demand and places orders with the wholesaler; the wholesaler sends orders to the distributor, who orders from the factory; the factory finally produces the beer. Each individual faces a decision-making challenge involving how they manage their current stock inventories. Each participant in the game seeks to minimize their total cost by managing their inventories in the face of uncertain demand. The orders flow in the upstream direction, while deliveries flow in the downstream direction of the supply chain. An important structural aspect of the game is delay (i.e. time lag) in order to account for logistics and production time. Each delivery (and production order) requires two rounds until they are finally delivered to the next stage. The game is played in rounds, which simulates business weeks. In each round the following steps have to be carried out by the players: 1) receive incoming orders, 2) receive incoming deliveries, 3) update play sheets (outstanding deliveries and inventory), 4) send out deliveries, and finally 5) decide on the amount to be ordered. In doing so, deciding on each round's order amount is effectively the only decision that players are able to make throughout the game; everything else follows a set of fixed rules.

With the Beer Distribution Game players enact a four-stage supply chain. The task of this supply chain is to produce and deliver units of beer: the factory produces and the other three stages deliver the beer units until they reach the customer at the downstream end of the chain. In doing so, the aim of the players is rather simple: each of the four groups has to fulfil the incoming orders for beer by placing orders with the next upstream party. Since communication and collaboration are not allowed between supply chain stages, the players invariably create the so-called “bullwhip effect”. “Bullwhip” means the effect that the amount of periodical orders amplifies upstream in the supply chain towards the production end, thereby causing a range of operational problems. The bullwhip effect is a well-known phenomenon and a prominent symptom of coordination problems in supply chains.

Graphically the game is very basic. Each of the four units is presented as a factory unit, and when the order is placed a truck with beer barrels arrives at the “wooden stage” where the beer barrels are stored. In terms of the game functionality is nothing much to do. The Game-play is basically as follows: inputting the number of beer units that the player needs to send to costumers.

While the original goal of the simulation game was to research the effect of system structures on the behavior of people (“structure creates behavior”), the game can also be used to demonstrate the benefits of information sharing, supply chain management and Collaboration in the supply chain.

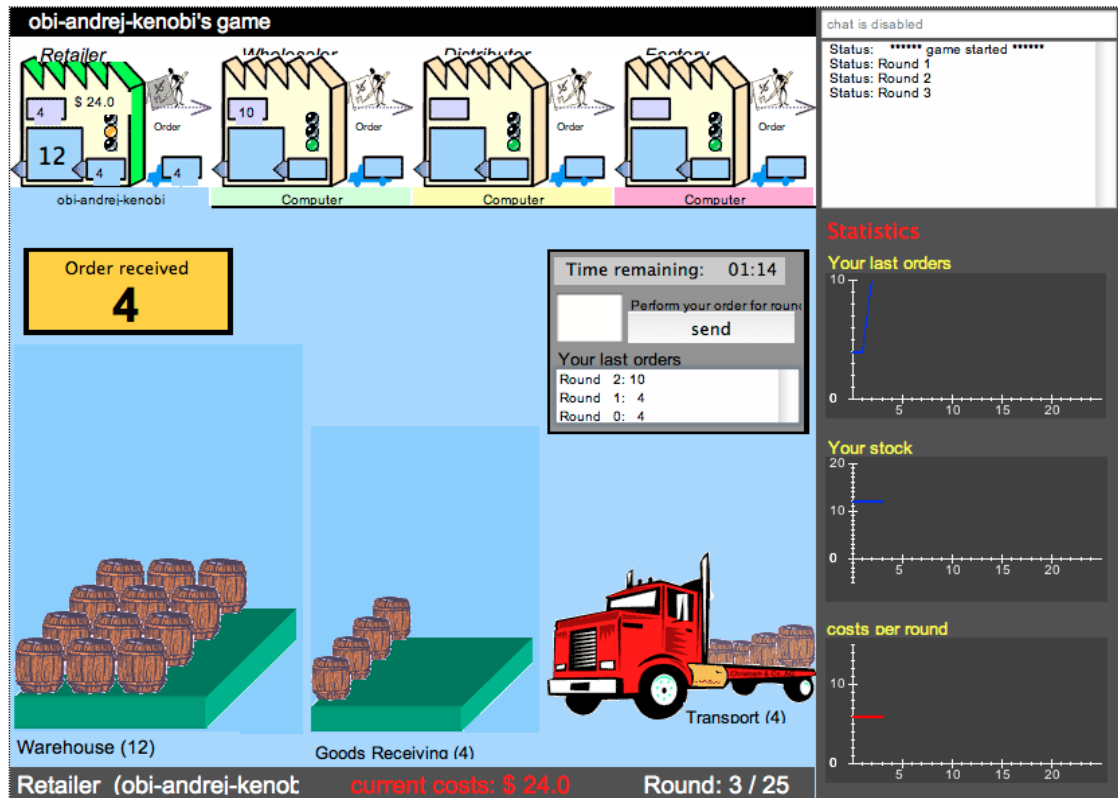


Figure 3.9: Beer Distribution game (screenshot of graphical user interface).

3.6 The Classification Results and Game Assessment

After the exploration of the nine selected games that represent the most frequent topics applied in business education, the following value of each of the properties was given for each game and presented in Table 3.2.

The assessment of selected BSG properties from Table 3. Could be used for some summarized findings. The parameters that assess the properties for the achievement of the educational goals from the group “usability” are considered to be most important, which means that the game scenario meets the educators’ and the learners’ expectations. Games that answer this requirement usually have highly developed segments or levels of reality. The game leads the player through several situations that require decision-making. Games are also expected to help the learner with proper guidance and explanation. Games with these properties enable faster transfer of experiences, acquiring skills more easily and good educational outcomes. By inspecting Table 3 it can be concluded that the Sharkworld game appears to represent the real-case situation most effectively when compared to the others. The game provides an excellent underlying storyline (which in turn is also entertaining), the fictional characters are played by real actors and the video material is a very nice attempt at a simulated environment that makes the players feels like they are part of a real business project in a real-life environment. In contrast to that, the game eRepublic provides scenarios in a fictional war situation where users gain economic power; however, this is most likely not to happen in the real world.

Table 3.2: The assessment of the selected games.

	eRepublik	Virtonomics	Sharkworld	IBM innov8	Virtual Leader	Big Oil	Wall Street	The Beer Game	Business Tycoon Online
Web-Based/desktop	Web-based	Web-based	Web-based	Desktop	Desktop	Desktop	Web-based	Web-based	Web-based
Distribution	Republik Labs	Virtonomics team	RANJ	IBM	SimuLearn	Try Synergy	Wall Street Survivor	MTI Sloan	Dovogame
No. of users	**400,000	**550,000	n/a	n/a	n/a	n/a	350,000	n/a	**600,000
Year of publishing	2008	2009	2008	2009	2003	2006	n/a	n/a	2010
Dimension	2D	2D	2D	3D	2D	3D	2D	2D	2D
Platform	Any	Any	Any	PC Windows	PC Windows	PC Windows	Any	Any	Any
Free of use	Yes	Yes	Purchase required	Registration approved	Purchase required	Purchase required	Yes	Yes	Yes
Time period	Min. 1 month	Min. 1.5 month	Min. 1 month	2 to 4 hours	6 to 9 hours	8 to 10 hours	Min. 1 month	1 to 1.5 hours	Min. 1 month
Industry or generic	Generic	Generic	Industrial	Industrial	Industrial	Industrial	Generic	Industrial	Industrial
Degree of complexity	Low	Medium	Medium	Low	Medium	Low	Low	Low	Medium
Functional or enterprise	Enterprise	Total enterprise	Total enterprise	Enterprise	Enterprise	Functional	Functional	Functional	Total enterprise
Competitive or non-competitive	Competitive	Competitive	Non-competitive	Non-competitive	Non-competitive	Competitive	Competitive	Competitive	Competitive
Feedback system	Experience points	Virtual money income	Customer influence	Points received	Statistic charts	Points received	Virtual money	Statistic charts	Points received
Deterministic or stochastic	Deterministic	Deterministic	Deterministic	Deterministic	Deterministic	Deterministic	Stochastic	Deterministic	Stochastic
Briefing systems	Tutorial video of personal mentor	Poorly supports with mail from virtual administrator	Supported with mails from virtual administrator	The virtual note support	Text instructions and audio/video tutorial	Virtual assistant provided	Text tutorial	Text tutorial	Text tutorial
Learning objectives	Strategy skills, project-management skills	Strategy skills, project-management skills	Project management skills, hard skills, soft skills	Business process management skills	Leadership skills	Business strategy skills	Financial skills, stockbroker skills	Coordination, logistic skills	Strategy business – decision-making skills
Background knowledge	No	Yes	Yes	Yes	No	No	Yes	No	No
Interactivity type	Yes	Yes	Yes	No	No	No	No	No	No

The way of presenting the game content, the game scenarios and the users' satisfaction are also important aspects. Another good example among the selected games

is IBM's INNOV8. This game is based on very rich graphics, cut scenes, scenarios and an attractive walk-through. It gives a good opportunity to explore how to learn the basics of the management of business processes and how to collaborate with participants of any business process, how to identify the process bottlenecks and how to explore what-if scenarios when a decision is expected to be taken by the player. The game provides a clear and easy-to-learn player's interface that enables easy control of the game. In contrast, the game Virtual Leader gives a poor impression in terms of the properties required in the player's training and learning. This game play focuses on the selection of the right set of dialogues with the virtual characters. Functionally, there is nothing much to do within the presented scenario. With no sufficiently presented scenario, players are more likely to be confronted with a hectic learning curve and subsequent extreme dullness. However, it should be noted that the game is an excellent example for imitation of human behavior and for practicing tenets of three-to-one leadership with simulations of business meeting sessions that can be mirrored in real-life situations.

The technical properties studied in the games, e.g. the GUI (graphical user interface), the screen briefings, and the tutorial support, also differ from game to game. IBM's INNOV8 and Sharkworld are good examples as they contain a clear and easy-to-learn player's interface, while the Big Oil game (Build an Oil Empire) requires the player to spend a lot of time learning the usage of the game's GUI.

On the other hand, the massively multiplayer online (MMO) business games (Virtonomics, eRepublik, Business Online Tycoon) have proved to be bad examples regarding user guidance. Players need to learn the whole functionality of the game's "menu bar" and the game's GUI tool bars, without any comprehensive tutorial support in the background. These games are time-consuming and are dealing with players' motivation and satisfaction. We may consider them as helpful in some cases as they demonstrate some aspects of business strategy learning, decision-making processes, and business management and organization activities.

In general, the selected set of games can be used as a demonstration sample that helps with the game selection for particular business education, as they demonstrate aspects of business strategy, decision-making processes, business management and organization activities that help in changing the learner's attitudes and improving performance. They also provide user experience in the application of statistical and analytical methods that are used as an economic study. Games are absorbing, provoking and interesting, when participants are "soaked up" to become engaged in effective learning. Unfortunately, for future research, we should bear in mind that these properties are lacking from most of the studied games, as they involve only quantitative variables while ignoring human elements of organization. Such limitations in the use of BSGs in education are described as:

- Considerable simplification of reality
- Lack of player responsibility for his/her decisions
- Necessity of engagement of area and hardware resources
- Limitation of education in the scope of the game
- Game is treated as an entertainment rather than as education
- Behaviours and postures of game participants differ significantly from their behaviours and postures in real life

3.7 Conclusion

Research on modern students' education methods and techniques has proven that education based on practical usage of knowledge and training in a target activity environment is the most effective way of learning and educating (Valenčič & Vogrinc, 2010). BSG are developed to implement different real scenarios and virtual worlds with the intention of motivating the learner. They especially try to make a good attempt at capturing and combining the virtual reality technologies and engaging components of video games for simulating real ecosystems. The presented study is a contribution to the assessment of BSGs, which are perceived to be an interesting and desired form of gaining experience for professional practice (Wawer, Milosz, Muryjas, & Rzemieniak, 2010).

These findings imply that the field needs further development and additional research.

However, as our study has presented, BSGs can be allocated to different game types or categories, based on the variety of "learning" content and their technical capabilities. In that context, it becomes obvious that inbuilt learning properties are very important for game assessment. The present study is a contribution to this area of research. However, the studied BSGs taken from the current market offering and the presented results cannot cover the whole knowledge area that can be found in business education (Blažič & Arh, 2013), but should be considered as complementary to the current research in this field. When a combination of BSGs is adequately set up within a particular educational process, this becomes a practical teaching-related arrangement that successfully combines the natural predisposition of the players with the planned and directed knowledge acquirement from the curriculum. With most other teaching methods, this is rarely the case.

The contribution presented here has also pointed to the fact that different games provide different skills and practice and that is one of the reasons why the selection of the most appropriate game should be based on defined criteria for property evaluation. By deciding/selecting which "field" of business education needs to be "trained", a suitable set of games can be selected with the use of the proposed classification tool. As the market changes from time to time, some BSGs can also be out of date. These market (dis)advantages should be carefully considered, and as a consequence, assessment of newly designed games will always be necessary.

With all the positive effects found in training with BSGs, it is necessary to point out that digital learning games, on the other hand, can also have some negative aspects. Games and gaming behaviours can in many ways be fundamentally incompatible with the institutional education environment. As Caillois (2001) outlines, this can be formulated based on the five formal qualities of games regarding incompatibility with the institutional environment:

- Freedom
- Separation (from events outside of the game world and the structure of the game)
- Uncertainty of outcome
- Non-productiveness
- Make-believe (not real)

Freedom of action means that the games are time-consuming and diffuse, tending to frustrate attempts to focus efforts on a single, measurable curricular element. Separation of the gaming world from the outside world may make it difficult to connect gaming

outcomes to established learning standards, and the uncertainty of outcome can make it difficult to measure formal learning in any case.

Non-productiveness can be presented as the issue where games do not fulfil all the required productive or learning aspects as it does not create any good goals for the player to meet his/her expectations. For example, games that are based on simple point-and-click game play increase the dullness for the player. The make-believe aspect also implies game settings and simulation of real-world situations that cannot be real or can't exist in a real world. Rules in the games don't meet close imitation of real-life rules. For instance, in eRepublik, the factory can be built in 30 minutes and only a few workers need to be hired in order to build the fictional factory. Wars are the only thing driving the economy, which doesn't show the real aspect in the simulation of modern life where political systems such as capitalism and socialism contribute to real-life economy systems.

Game designers in that case need to reassess business games in order for the business models to be rebuilt for more realistic simulation of the market situations. Moreover, a properly designed game should allow one to generate results that would show the increase in the knowledge gained during the game in the normal course of game usage (during the game).

We may conclude here that BSGs make great attempts to seize technologies for presenting virtual reality and the entertaining components from the digital games world and to place those in the education process. By capturing the massive amount of resources and technology from the video games industry, business games can bring learners into a new environment where business (management) processes can play a major role in everyday life.

This chapter does not provide solutions for "how to select" a business simulation game for a particular educational case. Neither does it provide advice as to which level business games should be used in the game-based learning environments. But it does provide ideas about the appropriateness of several indicative games and how to assess some aspects of their educational capabilities. This chapter contributes to the widening of educators' horizons and opens a window to the "massive world" of the continuously rising world of BSGs. The chapter has also shown that the "great teacher-designers" need to step forward together with people with vision in the area of e-learning in order to exploit more efficiently the benefits from the wide range of the business simulation game world.

Another concluding remark refers to the suggestion that simulation games should be used as didactic tools within the new learning methods, that is, they are extremely precise in the simulation of the business market realities. Game developers should monitor continuously the everyday business ecosystem, so they can adequately present the predicted market situations that make the virtual world as close as possible to the real world.

Chapter 4

Extending the Taxonomy of Business Simulation Games

4.1 Taxonomies and Classification

The classification of SGs is still the subject of research. Since 2002, several methods and tools have been introduced to classify SGs. Most of the work so far in this dissertation has been dedicated to BSGs. The reason lies in the demand of the educational market. In this chapter we focus on this large group of SGs. Each of the suggested classification methods addresses the issues of its predecessors. However, no classification system has yet achieved a level of general acceptance (Djaouti, Alvarez, & Jean-Pierre, 2011).

Sawyer and Smith (2008) pointed out that the classification system for SGs should be based on one single criterion or game property. This means the classification model is divided into two categories: market-based classifications and purpose-based classifications.

4.1.1 Market-based classification

These classification systems are designed to index games according to the “markets” that use them (i.e. the kind of people who play them). Here are some examples of market-based classifications:

Zyda (2005) divided SGs into five main domains: Health care, Public policy, Strategic Communication, Defence, and Training & Education.

Michael and Chen (2006) made the next attempt by classifying SGs according to markets. They divided SGs into eight different categories: Military Games, Government Games, Educational Games, Corporate Games, Health-care Games, Political Games, Religious Games, Art Games.

Later, in their 2008 study, Alvarez and Michaud (2008) identified seven SG markets, quite similar to those mentioned above: Defence, Training & Education Games, Advertising, Information & Communication, Health, Culture and Activism.

It is important to stress here that first, due to the discovery of new markets for SGs, their boundaries continue to expand. Secondly, these classifications are based solely on the applications of SGs rather than on the games themselves. In other words, market-based classifications are only able to provide information about the uses of SGs, not about their content (Djaouti, Alvarez, & Jean-Pierre, 2011). Our approach in Chapter 3 tries to classify and assess the games according to their properties.

4.1.2 Purpose based classification

When the classification approach is based on the intention of an SG to satisfy some “purposes”, then the classification is purpose based.

Bergeron (2006) proposed seven “purpose” categories: Activism Games, Advergaming, Business Games, Exergaming, Health and Medicine Games, News Games, Political Games.

In a 2008 article, Despont (2008) proposed a typology of four SGs: Advert Games, Institutional SGs, Business Games and Learning Games. This typology is based on the previous typology by the same author, which identified six “serious intentions”: to increase awareness, to simulate, to train, to inform, to teach and to influence.

Alvarez et al. in their paper (2007) also introduced six “purpose” categories for SGs: Edugames, Advergaming, Newsgames, Activism Games, Edumarket Games, and Training & Simulation Games.

While this classification is still based on a single criterion, purpose-based classifications are harder to apply than market-based ones. In each of the above models, the proposed categories seem heterogeneous. For example, “Health and Medicine Games”, “Institutional SGs” and “BSGs” are tied to the “targeted market” of the game, while categories such as “Edugames”, “Learning Games” and “Exergaming” are clearly based on the “purpose besides entertainment”. Overall, these systems are an interesting step towards understanding the purpose of SGs. They encourage separating “purposes” from “markets”, which at first is not an obvious distinction. Unfortunately, they suffer from heterogeneous categories that prevent them from being a reliable source for general classification. Hopefully, these systems opened a path for multiple criteria classifications and contributed to the appearance of attempts at taxonomy for SGs. They introduced models that went further than a simple market analysis of the game, and more importantly, they helped to shift the classification focus onto the “contents” instead of the “uses” or the usability.

4.1.3 Multipurposed criteria for game classification

De Gloria et al. (2014) suggested that SGs should be categorized in a multiple proposed criteria classification of SGs. The next categories based on the psycho-pedagogical and technical level of games highlight the following dimensions:

- Purpose – ranging from fun/enjoyment to training/learning.
- Reality – ranging from imitation of real and fictitious contexts to proving abstract visualizations such as in games like Tetris.
- Social involvement – ranging from single-player games to massively multiplayer games.
- Activity – ranging from active game types (e.g. action games or – even with a physical dimension – the Nintendo Wii game play) to passive game types (where at the end of this continuum the passive perception of a movie is situated).

Proposing the SG classification (<http://www.serious.gameclassification.com/> 2880 featured games, as of January 2014) is a collaborative classification of SGs, which is becoming a reference at world level. The selected classification and dimensions, which are a clear extension of the Sawyer and Smith (2008) model, are:

- Game play (game-based vs. play-based – games have fixed goals to achieve; core rules represented by bricks constituting a game)
- Purpose (Education, information, marketing, subjective message broadcast, training, goods trading, storytelling)
- Market (Entertainment, State & Government, Military & Defence, Health care, Education, Corporate, Religion, Culture & Art, Ecology, Politics, Humanitarian & Caritative, Media, Advertising, Scientific Research)
- Audience (Type: General Public, Professionals, Students; age groups)

Based on that general approach structured databases of SG have been built in recent EU-funded projects such as: Imagine1 (<http://www.projectimagine.eu/>), Engage learning2 (<https://ec.europa.eu/digital-agenda/en/news/engage-platform>) and GaLA Society (<http://www.seriousgamesinstitute.co.uk/applied-research/GALA.aspx>). The GaLA SG Knowledge Management System 5 includes a number of descriptors that are useful for conducting SG studies as it provides the first attempt at developing a taxonomy, Belloti et al (2012) have described the following attempt with next properties:”

- *Description/classification (genre, platform(s), application domain, learning curve, effective learning time, play mode, player assessment, provision of feedback, etc.).*
- *Analysis of game components (UI, rules, goals, entity manipulation, assessment), for a detailed specification of the game mechanisms.*
- *Pedagogy. The GaLA taxonomy is organized into two major sectors:*
- *Theoretical frameworks: constructivism, objectivism, personalism, etc. and 2) Outcomes: cognitive (Anderson & Krathwohl, 2001), psycho-motorial (Harrow, 1972), affective (Krathwohl et al, 1964) (Krathwohl, Bloom, & Masia, 1964), Soft skills (Pellegrino & Hilton, 2012).*
- *Deployment (“use of the game”), specifying settings such as: target users (age, specific categories of persons, school level, etc.); target topics; prerequisites for use (if any) (cognitive, content-related, domain-related, psychomotor, etc.); context of use (e.g. formal education, corporate training and other).*
- *Technologies employed for the development: game engine, development tools/platforms, AI algorithms.”*

It is also worth mentioning in the same context Djaouti et al.’s (2010) SG Classifications based on the G/P/S model, where it is pointed out that an SG is composed of both a “serious” and a “game” dimension.

They describe the G/P/S model, which relies on three aspects:

- Game play, which refers to the type of game play used. This aspect is intended to provide information about the game structure of the serious game: how it is played.
- Purpose, which refers to the designed purpose. This aspect accounts for the eventual purpose(s) apart from entertainment intended by the designer of the serious game.

- Scope, which refers to the targeted application(s) of the title. This aspect suggests the actual use(s) related to the serious game: the kind of market, the audience who uses it.

They suggest that these three aspects, defined in the G/P/S model, can be used to build criteria suitable for the classification and assessment of any video game. The model places serious and entertainment games on the same footing, i.e. any video game can be defined by a game play structure, a targeted scope of use and an optional “purpose” apart from entertainment.

4.2 Business Simulation Games and Their Taxonomy

Since the SG market is constantly changing, the classification of SGs can be a time-consuming research process. The list of existing SGs is quite diverse and the selection of SGs can become an area of endless evaluation. In order to limit this exercise, a generally accepted taxonomy for SGs is necessary. Since BSGs are a valid part of SGs, the focus in this chapter is on the recently developed taxonomy for BSGs.

Summarizing the studies presented above led to the conclusion that since 2002 there have been several attempts to classify educational business games; however, there is not one that is rooted in a generally based framework. Each of the proposed classifications fills some gap left by previous attempts or addresses dimensions that were neglected by its predecessors. As a result, in this area no classification system has yet achieved a level of general acceptance or has been taken as a standard, despite the long list of studies and models intended to introduce the relevant instructional strategies and theories into the design and use of BSGs (Squire, 2003; De Freitas & Oliver, 2006; Aarseth, Smedstad, & Sunnanå, 2003; Imrie, 2008; Sawyer & Smith, 2002; Djaouti, Alvarez, & Jean-Pierre, 2011). The same applies to the attempts to build a taxonomy for SGs. As mentioned above, the most recently proposed, exhaustive taxonomy of BSGs was compiled by Greco et al. (Greco, Baldissin, & Nonino, 2013), and it is known as Greco’s taxonomy. By exploring the multidimensional properties of business games, the authors created a comprehensive definition of such games that can be considered as sufficiently general to be used more widely. They identified most of the game parameters that classify the games according to their characteristics and properties. The main objective of their exploratory research was to generate a sufficiently successful taxonomy that will facilitate the comparison of different game-based educational tools, while also directing future application-based research toward a game’s most learning-related components. The main focus of their research was oriented to a search for answers to the following questions: How can we provide a business game definition that covers all the business games in the literature? What are the most relevant characteristics of educational business games? How can they be classified? The main outcome of their attempt was a proposed framework for building a comprehensive database of SGs to be used in management and business education. This database is expected to help the selection of games by educators and to enable the further development of business games with dimensions that are not satisfactorily covered within existing game collections. In their taxonomy proposal, Greco and co-authors (Greco, Baldissin, & Nonino, 2013) adopted and used a combination of:

- Classification of games: using the work of Aarseth (Aarseth, Smedstad, & Sunnanå, 2003) and later refined by Elverdam (Elverdam & Aarseth, 2007)

- Taxonomy for Computer Simulations: using Maier’s work, enriching it with new additions that address their objectives (Maier & Größler, 2000).

The exploratory taxonomy of Greco consists of five main categories, based on different classification parameters, as follows:

- **Environment of the Application** (Characteristics of business games’ spatial and temporal environment)
- **Design Elements of the User Interface** (Characteristics of business games’ user interface)
- **Target Groups, Goals Objectives & Feedback** (Characteristics of business games’ target and reinforcement mechanisms)
- **User Relation/Community** (Relational characteristics of business games)
- **Model** (Characteristics of the simulation model within business games)

By considering the study, the results in the current literature and the Greco-suggested taxonomy, it can be claimed that the latter certainly represents advancement. It is built on previous studies and is complemented by an additional dimension that leads to a more general basic framework. Greco and collaborators introduced some important elements that were not present in the earlier classifications. Most of the previously proposed taxonomies focused on methodical and structural aspects and did not include many crucial components that are important in game classification. Two of them can be listed as an illustration: didactic goals specified as soft, conceptual or hard skills, which were added to the Maier and Größler (2000) category “Target groups, objectives” and debriefing, feedback and feedback degree as extensions to the “Struggle” category, introduced by Aarseth et al. (2003). Below we present Greco’s taxonomy using five main categories for classification of BSGs in Figure 4.1.

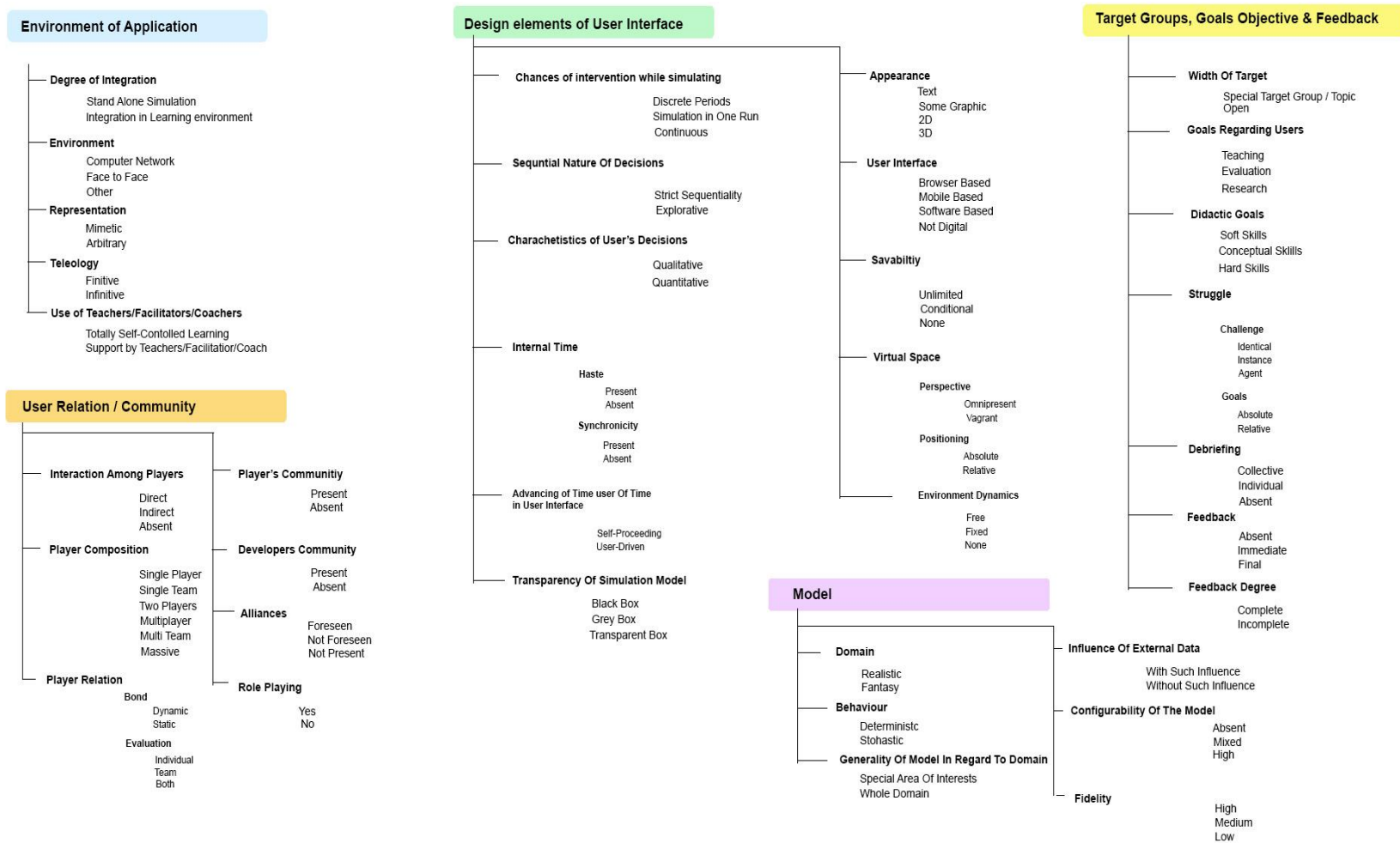


Figure 4.1: Greco et al.'s proposed taxonomy of BSGs (Greco, Baldissin, & Nonino, 2013).

4.3 Identification of the Missing Elements in BSG Taxonomy

By exploring the taxonomy defined by Greco and co-authors (Greco, Baldissin, & Nonino, 2013), which implements the previously defined categories for a BSG classification, we came to the conclusion that this recent approach to BSG classification needs further refinement. An in-depth analysis of the state of the art of the BGS industry, both past and present, which is currently aiming to provide BSGs that provide answers to new educational objectives and needs, has shown that the taxonomy categories do not cover, in sufficient depth, how the games help to accomplish the educational objectives. Greco's taxonomy, which is relatively exhaustive, was designed to help in understanding the current state of the art of the game market and the underlying evolutionary technology path used or inbuilt in the design of BSGs. A careful examination of the assessment results presented in their work has indicated that the accomplishment of learning objectives evaluated through students' performances and results achieved during and after the game play is a crucial and necessary factor in the evaluation of any educational tool, but it is not sufficiently elaborated and present in the assessment process (Greco, Baldissin, & Nonino, 2013). They have used the properties "skills and target groups", but did not elaborate them further in the assessment process. The assessment of the learning outcome is usually performed with the use of procedures based on known taxonomies for good practice (Imrie, 2008). According to the work of Imrie (2008), an indication of a good taxonomic approach to assessment provides a framework for the accountability and quality assurance of the applied educational curriculum or the used educational tool. As Greco's taxonomy addresses only to a small extent the learning aspects and values of the business game, it was a natural step for these properties to be further developed as a complement to the existing ones. With a further detailed analysis of the mentioned learning elements, we found that important elements identified in the work of Wilson et al. (2009) and Staalduinen (2011), who studied the relationship between the learning outcomes and the game's attributes, are missing in the Greco taxonomy. Based on these findings, we may claim that Hypothesis No. 1 is true, as the current taxonomies and classification do not address the learnability attributes of SGs.

These elements are especially important when considering the use of the games at different levels of education. The positive association found in the PISA study between the intensive use of gaming and the test scores indicates that the gaming stimulates, during the learning, the building up of necessary skills, competences and abilities, such as problem solving, strategic thinking, memory, fantasy, interaction and adaptation to the learning subject, which are elements well captured by the standardized tests, such as those used in the PISA survey. On this point, it is very important to note that similar relationships were found between the gaming attributes and the learning outcomes in the study results reported by Wilson et al. (2009). Another important study that linked the expected learning outcomes with the game design elements was provided by Staalduinen and De Freitas (2011). The efficiency of game-based learning over traditional methods, if appropriate learning components are present, was also found by Kato (2008). These studies clearly confirm Hypothesis H1 that current SG taxonomies used in the assessment and the classification of the games do not consider sufficiently the learnability parameters required in the process of game selection by educators. The same findings supported our idea to develop an additional category for the classification of the game's properties that is focused on teaching, learning and the achievement of educational goals. This new

subcategory is suggested as being complementary to the existing Greco's taxonomy. The next section presents the approach taken in the development and the results.

4.3.1 Learning theories and learnability

An important consideration in curriculum or teaching-tool design is the completeness in terms that ensure that there are all the possible interactions needed for engaging the learner and the player in order to achieve the learning outcomes. When selecting an educational tool the assessment and the learning outcomes are usually performed by the educators, who try to link the educational objectives and the performance of the tool. The assessment is then used as a standard process for improving the quality of the performance or for assessing an outcome that is critical for the learning skills and elevating the learner's performance (Cottrell, 2013). The distinction between the assessment and the evaluation of the outcome is as follows: the assessment provides feedback about the knowledge, skills, attitudes and work products when elevating future performances and the evaluation determines the level of the quality of the performance or the outcome, while at the same time it enables decision-making to be conducted based on the level of the demonstrated acquired quality (Cottrell, 2013). Both processes are complementary and necessary in education. In that context, the assessment of a student's performance provides a domain of interaction between the students and the educational tool being used. The level and the quality of the performance are demonstrated by the correct student decision-making in the course of the game and this indicates the quality of the learning tool being used. Using taxonomies in that context provides an accountable framework for the evaluation and assessment (Imrie, 2008). Some authors (Wilson, et al., 2009) have already pointed to the positive relationship between the assessments of known learning components enabling an evaluation, and they have aligned them with the corresponding game's attributes. These learning components are made up of cognitive abilities, skills and motivation.

Cognitive abilities (knowledge creation, organization and application) are mainly related to games that present solvable problems and challenges when obtaining a specific learning outcome. They are designed to be adaptable to the skills and the level of the learner's knowledge. The learning components associated with technical or motor skills are related to the game's attributes, known as the learner's participation and interaction, learner engagement, control and navigation. Motivation has positive relations with respect to the game's attributes that specify the game's goals and rules, inbuilt fantasy and the provision of specific feedback to the learner.

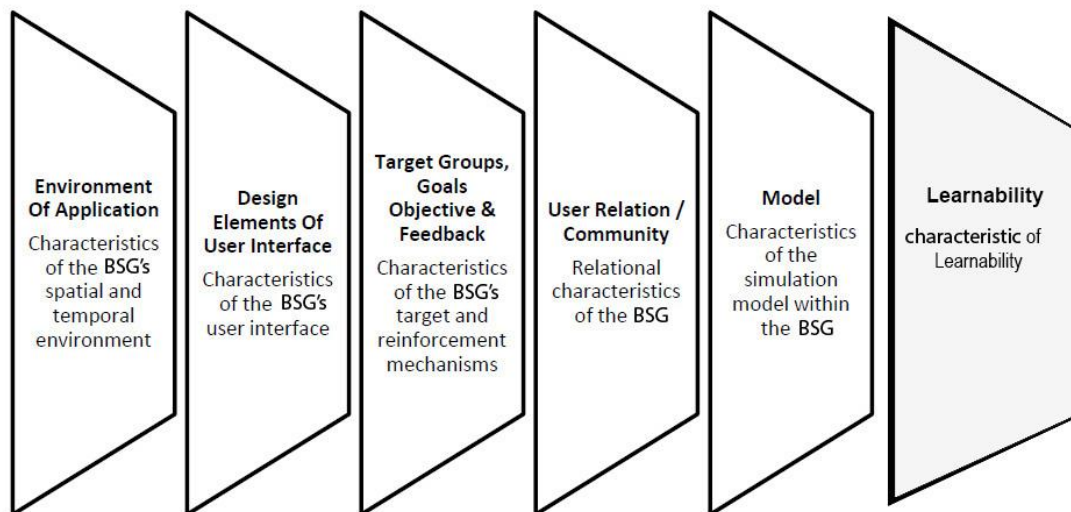


Figure 4.2: Overview of the new, additional category (Learnability) added to the existing categories of the taxonomy.

The problem of learnability as a category in the specific area of the BSG taxonomy was initiated by Roodt and Joubert (Roodt & Joubert, 2009). They used the theory-based “Evaluation Taxonomy” approach while assessing the IBM business game Innov8 in their paper “Evaluating SG in Higher Education” (Roodt & Joubert, 2009). Based on their findings and on an exhaustive study of the taxonomies used for assessment and evaluation in other fields (Ažderska & Jerman-Blažič, 2011) we have developed an important new subcategory and we are proposing that it should be added in order to complement the Greco taxonomy, as is illustrated in Figure 4.2.

During the development of the new taxonomy elements we considered the well-known theories of learning known as the “transfer of learning”, the “metacognition” or “the personalized theory of learning” and the “constructivism” or the “theory of active learning”. It is well known that the transfer of learning occurs (Perkins & Solomon, 1992) by way of two rather different mechanisms. The reflexive or low-road transfer involves the triggering of well-practiced routines by stimulus conditions, and the mindful or high-road transfer involves a deliberate, effortful abstraction and a search for connections. The current conventional educational practices often fail to establish such conditions, either for a reflexive or mindful transfer (Perkins & Solomon, 1992). To overcome this, both authors suggest instructions that include both the “realistic experimental character” and the other, i.e. the “thoughtful analytical character”, for the promotion of both the low- and high-road transfers of learning. Most of the SGs used in education provide an experimental environment and have inbuilt hints that provoke thinking and analysing. Another learning theory known as “constructivism”, which originated from the science of psychology, tries to describe how learning happens (Gagne, Briggs, & Wager, 1992). The focus here is on the learner’s concept of personal development and understanding (Siemens, 2005). This suggests that effective learning should be constructed through play, exploration and discourse with others. Learning objectives presented in a constructivist learning environment represent an everyday-life situation and are embedded in the learning context (Amory & Seagram, 2003). The other learning theory known as the “metacognition theory of personalized learning” suggests methods that improve the students’ own thinking, learning and performance. The instruction here is advised to allow students to take control of their own learning, as this will help them to enhance the planned achievements and will foster the students’ ability to learn independently

(Andrews & Goodson, 1980). The basic metacognitive processes enhanced in this approach are based on the students' motivation, the retention of knowledge, performance and anxiety reduction. The main characteristics of the motivating learning environment were discussed early on by Malone (1981), who found that they can be described by the following properties: challenge, fantasy and curiosity. Later, the property denoted as "control" was added to these characteristics and altogether they were presented later as the "engagement" theory of Moser (2000). All these properties can be found in most BSGs. The other learning theory known by the name "Theory of Active Learning" is close to constructivism, as its basic claim is based on the construction that "people learn by using what they know to construct a new understanding". So, according to this basic constructive statement, learning mainly involves a transfer that is based on previous experiences and prior knowledge (Recker, 2013). Supporters of this theory advocate discovery-based instruction that implies situations being presented to the learners, enabling them to discover ideas and knowledge by themselves. This approach is known as "discovery learning" or "learning by doing", which is a property present in many educational business games (Dickey, 2005). Most of these approaches were studied as game attributes by Wilson, with the intention being for the game attributes to be aligned with the learning outcomes. The authors of this exhaustive study found that matching the desired outcomes with the game's attributes or rather selecting the game's attributes to produce the desired outcomes is necessary, but it is a very difficult task to perform. However, they also found that an analysis of the potential learning outcomes aligned with the game's attributes can be considered to be desirable indicators for an evaluation of the game's learnability. An important conclusion in their exhaustive game study was that the larger the overlap is between the instructional objectives and the game's attributes, the more effective is the instruction itself. The findings confirm Hypothesis H2 that the learnability properties have not been properly considered in the building process of SG design. Based on these findings and conclusions we decided to propose a new category to complement the Greco taxonomy and to name it "Learnability". This new category is presented in the next section.

4.3.2 Extending the BSG taxonomy with learnability

The problems related to learning outcomes and the quality assessment of the taxonomy were studied by Imrie (2008). He summarized the domains that represent the major part of the assessment taxonomies and classified them into three groups: the cognitive domain, concerned with knowledge and comprehension; the affective domain, dealing with areas such as valuing and responding; and the third domain, addressing the psychomotor elements, such as readiness, confidence and complete responses. These domains were applied in the assessment of students' outcomes within the study of the PISA survey (Biagi & Loi, 2013). The survey was looking for correlations between the cognitive abilities, the technical or motor skills and effective outcomes. It should be noted here that the exhaustive PISA study was addressing the outcomes of the classic method of school teaching and learning and the domains used for the assessment do not provide the sufficient completeness required for an assessment of the learning capabilities dealing with business game learning, but the basic finding that computer gaming is positively associated with learning outcomes was very indicative. In developing the new taxonomy category, we considered many more properties to be involved, since in this way we can ensure that all the relevant aspects reflecting the multidimensional nature of BSGs are considered during the assessment.

By considering all these studies and the game elements that contribute to the learning identified by Van Staaldunin and De Freitas (2011) and Wilson et al. (2009), then taking into account the motivational aspects of learning identified by Malone and Lepper (1987) and the engagement theory applied by Moser (2000) and Moreno-Ger et al. (2008), we designed the new taxonomy additional category from elements selected in a way that complements the Greco taxonomy. This new, upgraded taxonomy is presented in Figure 4.3. The elements of the new category are intended to provide information regarding the desired property and to answer the questions appearing in the game selection process, e.g. which game will provide the best learning outcomes for a particular teaching target. We studied 25 game properties with an impact on learning, as suggested by Van Staaldunin De Freitas (2011) and Wilson et al. (2009). In addition, 39 game descriptors proposed by Garis and Ahlers (2002) were evaluated as well, however only a few of them were determined as being acceptable as elements in the learnability category according to the premises of the learning theories. From the 39 descriptors proposed by Garis and Ahlers (2002), only 12 of them were found to be statistically significant by Wilson et al. (2009) and these findings also influenced the selection of the game property.

The selected elements of the proposed taxonomy category were carefully evaluated and grouped into three groups. The basic selection criterion was their capability to help find answers to the main questions dealing with the game's learnability, e.g. the ability to achieve the learning outcomes by enabling the building of competency (which can be learnt in the game), the ability to provide learner control and interaction (how the game employs experimental/self-guided learning) and the ability to motivate the learner (engagement). These three categories are presented below:

- Building competency and cognitive abilities (enabling low- and high-road knowledge transfer in an experimental environment (Learning theory: transfer of learning)),
- Interaction and control (enhancing the ability to learn independently, through one's own thinking (Theory of active learning)),
- Expectations and motivation (enhanced motivation, performance and anxiety reduction (Learning theory based on metacognition)).

The content and the meaning of the suggested taxonomy elements are graphically presented in Figure 4.3.

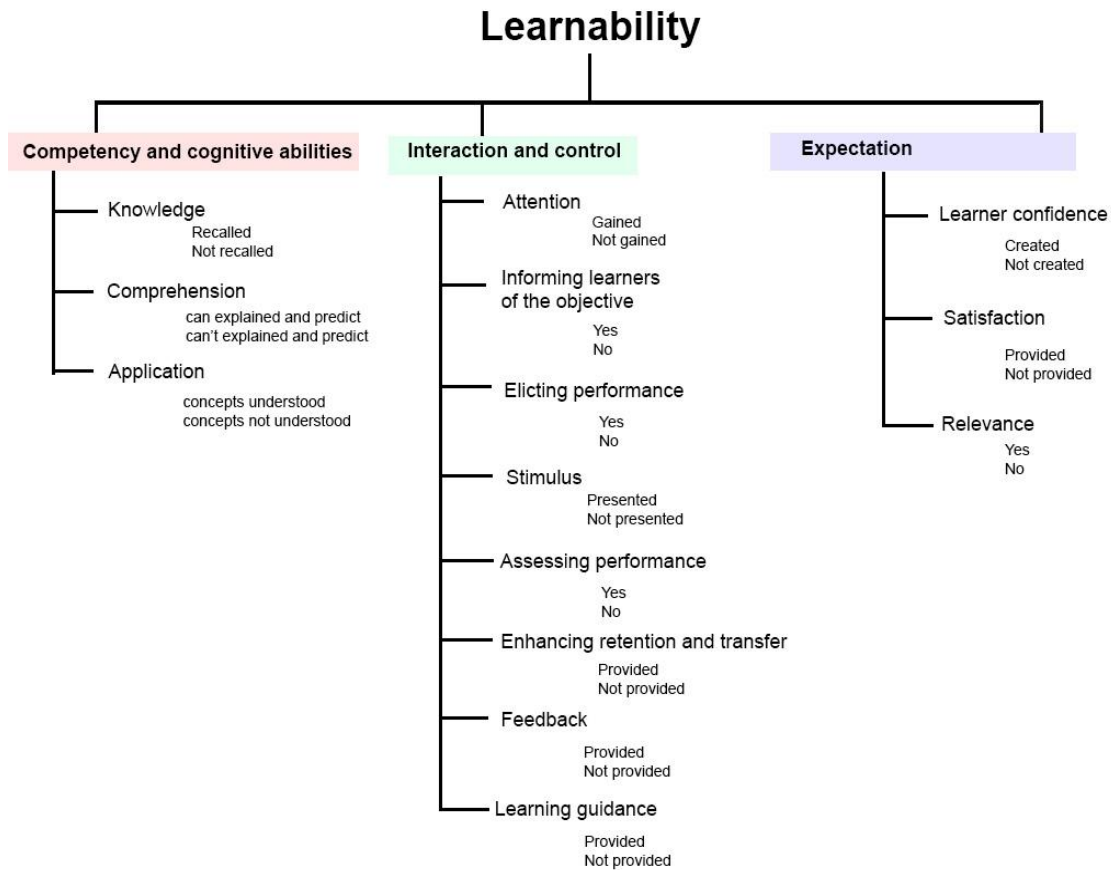


Figure 4.3: The tree view of a new additional category (Learnability).

In the next section we present an overview of the proposed three categories, which are presented with an explanation that follows from the background provided within the learning theories. We selected the three known assessment frameworks as the starting point in the design of this new category, which are: Bloom's Revised Taxonomy (Anderson & Krathwohl, 2001; Krathwohl D. , 2002), Gagne's Nine Events of Instruction (Gagne, Briggs, & Wager, 1992) and Keller's Attention Relevance Confidence and Satisfaction (ARCS) (Keller, 2006; Poulsen, Lam, Cisneros, & Trust, 2014)

4.4 The Learning Theories

4.4.1 Bloom's Revised Taxonomy – competency and cognitive abilities

The taxonomy of educational objectives is a framework for classifying statements of what teachers can expect or intend students to learn as a result of instruction. The framework was conceived as a means of facilitating the exchange of test items among faculties at various universities in order to create banks of items, each measuring the same educational objective.

Bloom's Taxonomy (in full: "Bloom's Taxonomy of Learning Domains", or strictly speaking: Bloom's "Taxonomy of Educational Objectives") was initially (the first part) published in 1956 under the leadership of American academic and educational expert Benjamin S Bloom. "Bloom's Taxonomy" was originally created in and for an academic context (the development commencing in 1948), when Benjamin Bloom chaired a committee of educational psychologists, based in American education, whose aim was to develop a system of categories of learning behaviour to assist in the design and assessment of educational learning.

Bloom's Taxonomy underpins the classical "Knowledge, Attitude, Skills" structure of learning method and evaluation, and aside from the even simpler Kirkpatrick learning evaluation model (Krathwohl, Bloom, & Masia, 1964), Bloom's Taxonomy of Learning Domains remains the most widely used system of its kind in education particularly, and also in industry and corporate training. It is a simple, clear and effective model, both for the explanation and application of learning objectives, teaching and training methods, and measurement of learning outcomes.

Bloom's Taxonomy provides an excellent structure for planning, designing, assessing and evaluating training and learning effectiveness. The model also serves as a sort of checklist, by which it is possible to ensure that training is planned to deliver all the necessary development for students, trainees or learners, and a template by which we can assess the validity and coverage of any existing training such as a course, a curriculum, or an entire training and development programme for a large organization.

Bloom's Taxonomy model is built in three domains, or "overlapping domains".

1. Cognitive domain (intellectual capability, i.e. knowledge, or "think")
2. Affective domain (feelings, emotions and behaviour, i.e. attitude, or "feel")
3. Psychomotor domain (manual and physical skills, i.e. skills, or "do")

These three categories can be seen in greater detail in Table 4.1

Table 4.1: The basic Bloom's Taxonomy.

Cognitive	Affective	Psychomotor
Knowledge	Attitude	Skills
1. Recall data	1. Receive (Awareness)	1. Imitation (copy)
2. Understand	2. Respond	2. Manipulation (follow instructions)
3. Apply (use)	3. Value (understand and act)	3. Develop precision
4. Analyse (structure/elements)	4. Organize personal value system	4. Articulation (combine, integrate related skills)
5. Synthesize (create/build)	5. Internalize value system (adopt behaviour)	5. Naturalization (automate, become expert)
6. Evaluate (assess, judge in relational terms)	6. Make judgments about the value of ideas or materials	6. Planning/producing (categorizes, combines, compiles, composes, creates, devises, designs, explains)

Furthermore, due to its long history and popularity, Bloom's Taxonomy has been condensed, expanded and reinterpreted in a variety of ways by Bloom and other contributors (Anderson & Krathwohl, 2001). Bloom's Taxonomy of Learning Domains remains the most widely used system of its kind in education particularly, and also in industry and corporate training. It's easy to see why: because it is such a simple, clear and effective model, both for the explanation and application of learning objectives, teaching and training methods, and measurement of learning outcomes. For the purpose of the proposed subcategory to the existing Greco's BSG taxonomy, we propose using the elements of the Revised Bloom's Taxonomy for the cognitive domain due to cognitive abilities that can be enhanced by playing BSGs. In the next figure 4.4: the revised Bloom's taxonomy is presented:

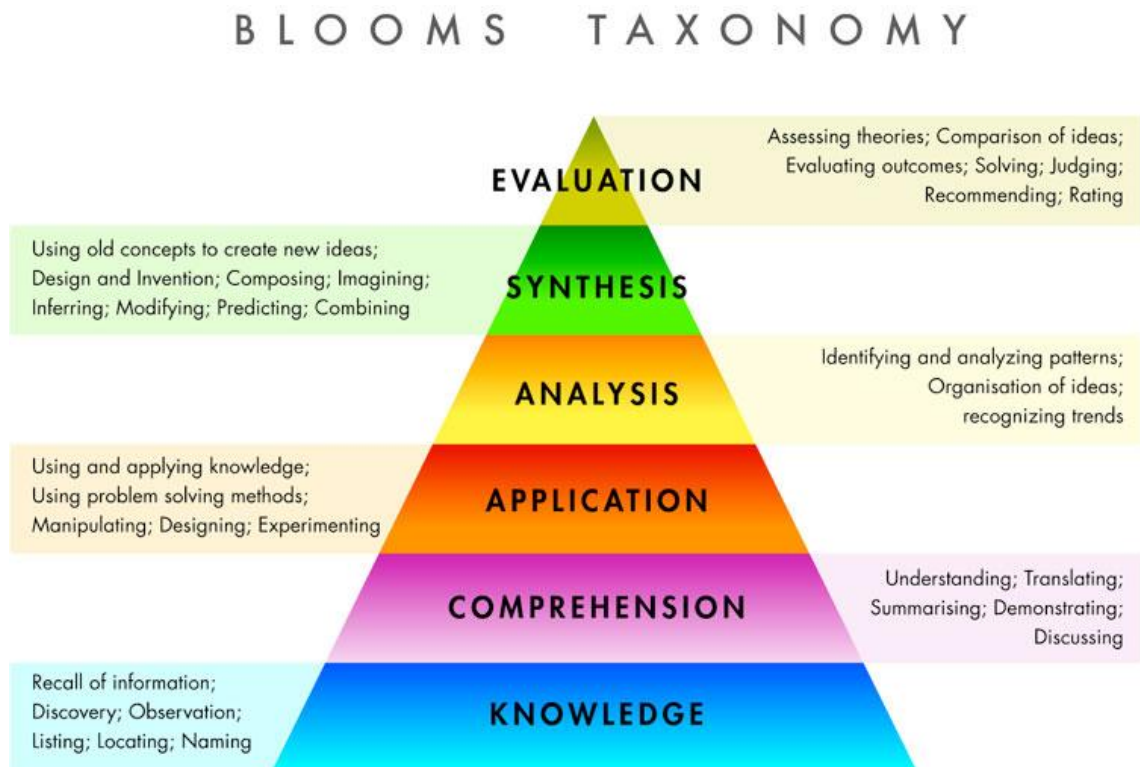


Figure 4.4: Revised Bloom's Taxonomy of cognitive domain (Anderson & Krathwohl, 2001).

The basic six elements enable an assessment of the cognitive learning objectives and the capacity for building capabilities (Anderson & Krathwohl, 2001; Athanassiou, McNett, & Harvey, 2003). The evaluation of a curriculum or a teaching technique according to Bloom's Taxonomy ensures that the learning occurs beyond a superficial level. However, for the purpose of the business game taxonomy with the additional subcategory proposed only three of the six elements will be presented. The other three elements have already been found in Greco's Taxonomy. The chosen elements are:

- **Remembering:** In our case, a player can recall information pertaining to task completion in the business game simulations (the things that can be learnt and the things actually learnt).
- **Understanding:** Where the player is expected to create a series of decisions or selections based on the information gathered earlier in the game (things that must be learnt to finish the game).
- **Applying:** Where this element addresses the capacity of the player to perform some actions by considering the possibilities offered in the game and thereby showing that the player is able to solve problems and use information. At this level, the player is expected to be able to apply a concept, to solve a problem by using or examining collected/retained knowledge. Here, the motivation of the player has an important role in acquiring the desired competency and cognitive ability. An increased motivation positively influences the retention of knowledge, the recall of learnt information and the focus of attention.

4.4.2 Gagne's Nine Events of Instructions – Interaction and Control

A couple of recently published works (Biagi & Loi, 2013; Kato, Cole, Bradlyn, & Pollock, 2008) put forward the hypothesis that gaming might indeed stimulate the enhancement of skills, competences and abilities such as strategic thinking, memory improvement, fantasy development, interaction and better adaptation. Based on previous studies in this field, we constructed the second group of the proposed taxonomy subcategory from elements that address the learning properties known as **Interaction and Control**. The selection was based on the theory that the learning happens when the existing knowledge is activated and newly presented knowledge is applied by the learner. Both are expressed through interactions and control of the game flow. The fact that interactive gaming leads to greater cognitive outcomes has already been discovered and evidenced by Vogel (2006). According to him, learners become more engaged in the learning process when they are required to interact with it. Learner control or the ability of the learner to dictate the pace and sequence of learning activities has also been shown to have a more positive impact on teaching (De Rouinn, Fritzsche, & Salas, 2005). The optimal amount of control is in the empowering of the learner and making the game more interactive and engaging. By applying Gagne's Nine Events of Instruction (Gagne, Briggs, & Wager, 1992) we have constructed the eight elements that represent the necessary interactions that an educational game should provide, together with possibilities for the learner to control the game's course and his/her final outcomes. These elements are as follows:

- **Gaining attention:** Attention is gained by ensuring learners interact with the game and by ensuring their participation so that it enables self-conducted learning. This means that the game should be engaging and entertaining, and should enable and promote active participation. An important aspect here is the engaging of learners' imagination through acting in designed scenarios and keeping the attention focused on the game and the game's environment.
- **Informing learners of the objective (expectancy):** The motivation to start using the game must be ensured by attractive information presented to the players about the content, the actions required for playing and the potential educational outcome. The appeal of the game can also be ensured by the flow states induced from clear goals, which encourage the learner to become personally more involved.
- **Eliciting performance (practice and responding):** The game is expected to activate student processing, to actively participate in the gaming process and to enable independent learning. The game should maintain a consistent level of information presentation and practice by taking into consideration the current knowledge and the skill level of the learner. By taking this into account, the game should maximize the amount learnt. The level of the game's difficulty should be gradually increased in line with the level of acquired knowledge.
- **Presenting stimulus:** The steps leading to the end of the game should stimulate the player to complete them in order to advance. The game should enhance the learner's performance and his/her own thinking. A challenging game with a presented stimulus is based on multiple, clearly specified goals, progressive difficulty and providing competition by creating barriers between the current state of play and the goal state.

- **Assessing performance (retrieval):** In order to evaluate the effectiveness of the game the learning outcomes should be assessed. In addition, the achieved advancement should be evaluated during some steps of the gaming. Assessment is critical for learning, as it provides learners with a clear picture of how he/she is doing and learning. The performance achievement in some steps of the game should be based on previously stated objectives.
- **Enhancing retention and transfer (generalization):** For developing expertise, players must generalize their new knowledge. Methods for helping learners to internalize new knowledge include paraphrasing content, or generating examples based on the knowledge acquired from the game, or design concept maps or outlines that should be present as an exercise in the game. This enables the transfer of knowledge.
- **Providing feedback:** This property enables feedback for the student after the selected decision and acts taken during the playing. It allows closer following of the advancement in the course of the game and consequently information about the successful performance of the player. Giving feedback and providing feedback information and support are internal attributions for success. Clear realism from the feedback process leads to more positive learning outcomes as it enables a personal impact assessment and attitudinal valuing.
- **Learning guidance:** This property provides guidance to the learner during the game playing. It enables self-learning and the more active involvement of the game's participants. Helpful hints and other cues mean that the player is quickly informed about the aspects of the game that will lead to a successful completion.

4.4.3 Keller's ARCS Model – Learning theory based on expectations and motivation

The ARCS Model of Motivational Design was created by John Keller while he was researching ways to supplement the learning process with motivation. The model is based on Tolman and Lewin's expectancy-value theory, which presumes that people are motivated to learn if there is value in the knowledge presented (i.e. it fulfils personal needs) and if there is an optimistic expectation of success. The model consists of four main areas: Attention, Relevance, Confidence and Satisfaction (Poulsen, Lam, Cisneros, & Trust, 2014). We used the principles of Keller's model (Keller, 2006) to build the subcategory Expectation and motivation. The model suggests that learning occurs most effectively when the learners are engaged throughout the entire learning process and strategies that could be put in place ensure that this engagement is carried forward through the task completion. Four steps for the promotion of motivation in the learning process are possible: Attention, Relevance, Confidence and Satisfaction. For our taxonomy classification we have removed the Attention as this element is already inbuilt into the previous taxonomy subcategories. Creating learning Confidence, providing Satisfaction and Relevance have become the elements of the expectation and motivation subcategory. The meaning and the content of these elements are described below:

- **Creating learner confidence:** The confidence aspect of the ARCS model focuses on establishing positive expectations for achieving success among players. The confidence level of learners is often correlated with motivation and the amount of effort put into reaching a performance objective. For this reason, it's important that learning design provides students with a method for estimating their probability of success. This can be achieved in the form of a syllabus and grading policy, rubrics or a time estimate to complete tasks. Additionally, confidence is built when positive reinforcement for personal achievements is given through timely, relevant feedback. In our case, the game should be designed in a way that enables the players to believe that they can succeed and complete the game. This confidence can be achieved by using different approaches (Kebritchi & Hirumi, 2008). The players should be assured that they have a good chance of success. If they feel that they do not have a good chance of succeeding, their motivation will decrease. The confidence of the players should be supported by small rewarding steps that ensure a growth in confidence during the gaming process. Providing control is also an element that is used for building user confidence. It is important for players to feel a degree of control during their advancement and assessment. They should believe that their success is a direct result of the amount of effort they have put into the game and the control that they have in their hands.
- **Providing satisfaction:**
Learners must obtain some type of satisfaction or reward from a learning experience. This satisfaction can be from a sense of achievement, praise from a higher-up task, or mere entertainment. Feedback and reinforcement are important elements, and when learners appreciate the results, they will be motivated to learn. Satisfaction is based upon motivation, which can be intrinsic or extrinsic.
In our case, providing satisfaction during the gaming is important. The player must receive some sort of reward or reinforcement at the end of the game. The gaming must be rewarding or satisfying in some way, whether it is from a sense of achievement, praise from a higher-up task being completed, or mere entertainment. It is also important to make the player feel that the skill acquired is useful or beneficial, by providing opportunities to use the newly acquired knowledge in a real setting. Providing feedback and reinforcement is also a part that builds satisfaction. When the player appreciates the results, he/she will be more motivated to learn.
- **Relevance:**
The content of the game and the educational objectives should be relevant to the educational subject and the expected learning outcomes. Successful teaching and successful learning of a particular subject should be supported by more entertainment, but this must be fully aligned with the objectives and the skills required from the learners.

The three proposed subcategories for upgrading the Greco taxonomy should be considered a contribution to the assessment of SGs in educational processes. Assessment is important as it makes it possible to achieve optimal teaching performances and accomplish instructional activities in line with the learning theories embedded in the game's learnability elements. These concepts and the principles may be useful in the provision of quality assurance during the design and the delivery of education where

gaming constitutes an indispensable part of it. The need for an assessment framework for the business game has already been recognized by the wider educational community. However, when using an assessment framework to make predictions about which game properties will lead to the best learning outcomes, some caution should be applied. The majority of the studied serious BSGs have some of the learnability properties, as they have been inherently built in. As has already been found in the Wilson et al. study (2009), it still remains difficult to define exactly the causality of each property of the learning outcomes. The propositions made here should be used only as a rough guide in making an optimal selection by considering the elements of the complete and upgraded Greco taxonomy.

Our attempt presented for taxonomy upgrading is illustrated with empirical research that illustrates the potential applicability of the selected assessment elements. In this context we selected two business simulation games used for education in the area of project management. Their properties were evaluated based on the learnability elements described above.

4.5 Experiments and the Assessment

The selection of the games to be evaluated was based on the games' availability, and the field of application. In today's highly competitive business environment, where time, money and resources are in short supply, especially when investment projects or innovation projects are in place, companies expect successful outcomes that are based on the capacity and the efficiency of the project management. The project management is usually performed by the project manager and the project team members. A large portion of the success of any project depends on the skilled managers and engaged, committed team members who know how to lead the project, how to use the relevant tools and the available resources. A common team language and good communication processes help to avoid potential pitfalls, execute the project tasks wisely, and achieve timely and cost-effective results that are equally important in project management. For that reason, we have restricted the selection of the case study to two subjects: project management and building team leadership. The first studied case was the game called Sharkworld, which was described in the previous chapter, Chapter 3.

Virtual Leader is a game where the player needs to register and create his/her account. At the beginning the player is offered a short introduction about leadership fundamentals and a framework showing how communication affects the principles of leadership.

The data collection from the assessment process was based on an evaluation of both games, i.e. Sharkworld and Virtual Leader, by educators involved in teaching subjects dealing with the game content. Fifteen students enrolled in the third year of undergraduate study at the university level from the Department of Economics, University of Ljubljana, were asked to participate in the assessment. The evaluation followed a three-pronged approach, i.e. surveys, self-evaluation and facilitative participatory observation. The authors evaluated the Sharkworld game by playing it themselves as well as through observation and facilitating the group of educators in playing the game. The group of 15 selected students were introduced to the selected games and were allowed to play them. They received basic instructions on how to play and an explanation about the goals of the games. A group of educators with ICT knowledge, in addition to economics knowledge, observed the playing and facilitated the game playing during the study. This group also completed a survey with a series of

interviews regarding the students' experiences with Sharkworld and Virtual Leader in the education process. Based on the three subgroup categories we developed the questionnaire presented in Annex 1. The questionnaire was given to the group of players consisting of students and the observer group. The percentages of positive answers for each evaluated property collected during the survey are presented in Annex 1 as well.

4.5.1 Shark World evaluation

We started the evaluation with the first taxonomy subcategory “**Competency and cognitive abilities**”. Based on the survey from the observer group and the self-evaluation, we made the following assessments for each category element:

- **Remembering:** The game enables knowledge to be recalled. The game requires competition during the accomplishment of the tasks. The player receives useful information from the game assistant and questions from the virtual team characters in the form of emails and interviews. He/she must react by using the recalled knowledge gained from his/her computer work to complete the necessary game tasks.
- **Understanding:** This property is also present in the game. The tasks and the game content are explained to the player, and the same applies to the game's objectives. The player is offered the opportunity to use his/her personal virtual laptop, where he/she can collect and obtain additional information to understand the process of building the Sharkworld Aquarium. The player is forced by the game to reply to the virtual characters' emails with suggestions for the best solutions to overcome the obstacles. Correct answers indicate comprehension. As the satisfaction bar indicates the level of correctly taken decisions, the player is also able to accommodate decisions in order to lead the project to a satisfactory conclusion. This is also considered as evidence of comprehension.
- **Applying:** The concepts of good project leadership are well understood and are applicable. During the game, the player meets a series of challenges and problems for solving a situation where he/she needs to take several decisions in order to successfully complete the tasks. The learning objective is clearly focused on the activities that are involved in successful project management. The player constantly receives emails from the game's characters with essential information to be used for removing concrete obstacles.

The next category used in the assessment was “**Interaction and control**”.

- **Attention:** The game contains elements that keep the player's attention. Sharkworld attempts to simulate a real-life project management flow. The game continuously maintains the necessary level of engagement and self-conducted learning. The game entertains the player and holds his/her attention with elements of dramatic events and critical situations that call for acting. In our survey, almost all the participants indicated that they enjoyed playing the game. This provided us with evidence of a high level of engagement and motivation.
- **Informing learners of the objective:** This property is presented to the players at the beginning of the game. The player starts by meeting his/her personal assistant and completes the meeting with the project investor,

where he/she receives an in-depth explanation of the mission and sufficient information about the goals and the objectives of the Sharkworld game.

- **Eliciting performance:** This is a property considered to be present. The game is in the form of an FRP (fantasy role playing) type of game, where the player has an opportunity to gain and receive new skills and knowledge for understanding his/her role and the tasks as a future project manager. As the player puts himself/herself in the role of the project manager, he/she is allowed to actively participate in the learning process and to acquire the necessary knowledge. The performance of successful project management is elicited during the game.
- **Presenting stimulus:** This property is provided by the game as well. The advancement of the player through the game's steps is conditioned by the completion of certain tasks. The player is faced with different challenges and he/she must solve them in order to advance in the game, which represents a sort of stimulus. An example of the activity is the collecting of information from the e-mails of the virtual characters, which he/she receives and makes self-notes on the player's personal laptop. Making self-notes and pre-conversations with the player's project team stimulates the player to be well prepared for the conversations with his/her clients. The accomplishment of the game depends on correctly accepted stimuli.
- **Assessing performance (retrieval):** This property is present as the game provides an assessment of the player's performances. Whenever the player is having conversations with the virtual game characters, in the upper-right corner of the game's user interface, the mood bar in the form of a face icon appears. The face icon changes due to the character's mood. With this feature the game is continuously assessing the player's performance and is contributing as a stimulating element. The player must show sufficient soft skills in order to persuade the team members and increase their motivation to accomplish the task.
- **Enhancing retention and transfer (generalization):** This property is not provided as the learners are not asked to internalize new knowledge or to create new concept maps. The survey gave negative answers.
- **Feedback provision:** This property is provided as the game lets the player proceed to the next task or level after the accomplishment of certain predefined tasks, but there is still no general feedback information regarding the player's progress in the game at a particular point in the game. For example, a progress status bar in the graphical user interface (GUI) and overviews are given at the end of the game.
- **Learning guidance:** The game provides constant guidance, so this property is present. The player constantly receives notes about the objectives that need to be completed. For example, the player is provided with a "to-do list" and a "list of tasks" that need to be completed within a certain amount of time.

The third subcategory used in the assessment was the "**Expectation and motivation**". The property analysed through the elements of this category provided the following findings:

- **Creating learner confidence:** The result of our questionnaire showed that more than 80% of the participants believe that the players are able to

complete the required tasks of the game on time, which implies that learner confidence is created. The conversation with fictional characters in the game finishes with a positive reply to the player in order to encourage the player to continue and complete the next tasks. The game makes the players believe that their success is a direct result of the amount of effort that they have put into the game and the control they had in their hands during the game based on the decisions taken by the project leader – the actual game player.

- **Providing satisfaction:** This property is present in the game. By issuing elements of immediate feedback in the icon corner with an indicative color (red or green) the player receives information about the satisfaction of his project team members. He/she also receives, in the case of good advancement in the game, messages with compliments.
- **Relevance:** This property can be considered to be present. The game makes it possible to learn soft and hard skills in managing a demanding project. These properties are very important for a successful business manager.

4.5.2 Virtual Leader evaluation

The evaluation of the Virtual Leadership game started with the first subcategory, “**Competency and cognitive abilities**”. Based on the survey of the observer group and the self-evaluation we found the following:

- **Knowledge:** The game enables knowledge to be recalled. The game requires the completion of tasks and provides a tutorial introduction for obtaining the necessary knowledge to be used in task solving. The player is given sufficient instructions and information. Before the player starts playing the game he/she is presented with information about how to organize the virtual meetings. During the virtual meeting sessions, the player’s task is to lead the conversations with the virtual characters. This information and the knowledge that needs to be recalled are mainly available before the game sessions and the virtual environment really start.
- **Comprehension:** This property is partly present within the game as the creation of a series of decisions does not follow from the information obtained during the implemented scenarios and the performed actions. The results are visible much later on in the game’s practice mode, which gives information about the positively assessed players’ decisions and the information used. However, the game offers tutorials in advance, before the game starts.
- **Application:** This property can be considered to be present as the game enables the concepts to be understood and applied. The positive outcome is presented with 3D graphs and the conclusion is that the concepts presented at the beginning of the play can be, or are, understood. The judgement depends on the player’s outcome. The challenge of the game is to manage the completion of the tasks that are given to the virtual characters. To achieve the desired outcome, the player has to maintain the perfect mood atmosphere (good team communication) during the virtual meeting sessions and motivate the members to perform their tasks.

The next category used in the assessment was “**Interaction and control**”.

- **Attention:** This is considered to be partly gained. Virtual Leader does not try to simulate a real-life conversation and this property influences the level of the player’s engagement and the self-conducted learning. The learning objective is mainly focused on making a learning experience in developing intuitive skills so that people can, without hesitation, understand a person’s intent in a real-life situation. However, as the game is played in a series of scenarios where the players act as decision-makers, the engagement and the attention cannot be considered as being neglected by the game.
- **Informing learners of the objective:** This property is present as at the beginning of each virtual meeting the learners receive several tasks that are required to be completed with added information about the goals of the meeting. The game provides a well-written guide that describes the theories behind the content.
- **Eliciting performance:** This property is present. The very nature of the game enables practice and responding to the challenges by acting in several scenarios as a leader. Since the game is designed as a fantasy role playing game, the player - as a main character – is elicited to actively participate in the learning process and to provide performance in completing the tasks.
- **Presenting stimulus:** This property is not provided by the game in sufficient depth. The player practices step by step. The skills to be acquired are practiced by preset communication dialogues over the course of several sessions or through one long session with virtual co-workers. The game provides opportunity to meet real-life environments to allow the users to interact with other characters. The advancement can be watched on the practice mode graph at the end of the game, but a particular presented stimulus in the step-by-step advancement is not provided.
- **Assessing performance (retrieval):** This property is partly provided as the game does not offer an assessment of the achievement based on each game step and accomplished objective.
- **Enhancing retention and transfer (generalization):** This property is not provided by the game as the learners are not asked to internalize new knowledge or to create new concept maps.
- **Feedback provision:** The game has a mode that provides an assessment of the learner’s advancement and performances feedback, which is presented as graphs. This property is considered to be present in the game.
- **Learning guidance:** The game does not contain continual guidance during the playing intended to help the player to achieve certain goals. Particular advice during each game step is not available, so it is considered that this property is not present.

The third subcategory used in the assessment was the “**expectation and motivation**”. The property analysed through the elements of this category provided the following:

- **Creating learner confidence:** This property is provided by the game as the players are supported by small steps through building scenarios that enable their confidence to grow during the advancement through the

gaming process. The game enables the learners to believe that their success is a direct result of the amount of effort they have put into the game and the control they have in their hands by taking decisions as a team leader.

- **Providing satisfaction:** This property is partly provided as the game gives the learners feedback and reinforcement. The feedback is given at the end. By viewing the results, the player appreciates them and becomes further motivated to learn. Satisfaction is known to be based upon motivation, which, in this case, can be intrinsic or extrinsic. The entertainment property is less present in this game.
- **Relevance:** This property is present in the game as the learning of leadership skills is a very important characteristic of a successful team manager and is a part of many curriculums.

4.6 The Evaluation of the Survey Results and Concluding Remarks

The exploratory research and the presented results in this chapter can contribute to the improvement of the systematic approach in building the taxonomy of BSGs as a general basic framework that incorporates all the relevant properties required to be assessed before the game is used in the education process. We have also answered the research questions regarding Hypothesis No. 3. The results have shown that learnability must be considered in any further game selection when a computer game is chosen to be used as an educational tool. This suggests that a new subcategory (learnability) that is focused on the game's learnability should be added to the BSG taxonomy.

The new subcategory was derived by exploring several theories of learning and the content of the taxonomies used in the assessment of BSGs has accomplished the learning objectives in the area of business and management education. Fourteen properties were found to be relevant in the assessment of the business game's learnability and can be used for its evaluation. The matching of the answers received from the students involved in the survey in the questions that mapped the taxonomy elements with the assessment provided by the teachers did not differ very much. It was obvious that the two games that were studied are tools that enable the students to construct, solve and analyse the decision-making process in the simulated management scenarios. The game, with its good explanatory properties and leading instructions complemented by appropriate ongoing feedback, helped the students to reason clearly and logically with the use of the available information and guidelines. The games studied and played provided practice and skills building in an environment close to the life reality. The simulation of unexpected events forced the students to think independently and to control the learning through processes that teach them how to learn independently. However, it was also found that the studied games differ in their properties. Virtual Leader has lower capabilities regarding attractiveness, providing stimulus to the player, learning guidance, enhancing retention and the transfer of knowledge compared to the same properties in the Sharkworld game. Player satisfaction was lower as well. The assessment clearly pointed out the differences in the learning properties of the studied games and that the applicability of this assessment tool is relevant and possible.

When selecting a platform game to be included in an education process, the candidate game should be carefully analysed, not only regarding technical properties and the variety of the learning environment, but also regarding its ability to create skills and knowledge, which should be considered the main focus of the game. It should include

problem-solving scenarios or tasks that enable the re-elaboration of previously acquired knowledge and content, and enable the construction of new knowledge and use of the available resources to achieve the educational objectives. Educational business games should also allow the student to learn how to identify, access, retrieve, store and organize information with the use of technology and media. Setting good cooperation links with others, even in the case of virtual characters interacting constructively, should also be part of the learnability characteristics of business games.

Many authors have worked on and explored an appropriate and suitable taxonomy to help classify and evaluate SGs in the area of business education. Greco and co-authors (Greco, Baldissin, & Nonino, 2013) believe that their exploratory taxonomy of business games represents an accurate synopsis of what is otherwise considered to be heterogeneous literature about BSGs. In their study, Greco and co-authors tried to answer the question “What are the relevant characteristics of a business game and how can they be classified?” The taxonomy they presented in their paper consists of 40 elements, and although this is a relatively large number, they stated that this is the minimum set of properties necessary for a comprehensive description of a business game. However, they also stated that their taxonomy is still limited and that additional effort is required to further categorize the business games used in learning. They also claimed that new subcategories are required to overcome the current limitations. A positive answer and recognition of the work presented in this thesis was provided by Greco and his collaborators (Greco, Baldissin, & Nonino, 2013). The contribution presented in this thesis is an attempt to implement their statements and to overcome the limitations identified in previous work. The addition of the learnability subcategory contributes to the building up of a complex but mature and usable taxonomy that will cover most of the relevant fields important in the assessment of BSGs.

The results presented, confirm that the new BSG taxonomy subcategory should be used in the process of game assessment and selection by the teachers and other involved in line with the educational objectives.

This means that the taxonomy elements allow all the considered participants to participate in a judgement of the game’s plausibility and complexity, its ability to respond to the set expectations, the achievement of the educational objectives, the clarity of the instructions, the development of the students’ creativity, and the level of expression in the interrelation between business systems and their environment.

Chapter 5

Game Design and the Incorporation of Learnability Attributes

5.1 Introduction

There are two possible mainstreams in the design of serious SGs: the use of the design model that links the game design and the learning outcomes proposed by Van Staaldunin and De Freitas (2011) and the involvement of game parameters that were part of the game taxonomy defining the game's learnability. Learnability is directly related to the level of the quality of the performance or the educational outcome (Cottrell, 2013). Both processes are complementary and are necessary during game design. The aim of this chapter is to contribute to the discussion that leads to game design advancement by providing evidence that both processes are necessary and should be considered in the design of an educational game. The area that was selected for game design is a field where not many attempts at GBL exist. This is practice and training in digital investigation and forensics in spite of the importance of the field. Digital forensics is a rapidly growing and emerging field that is considered to be part of information/computer security. The need for digital forensics experts in the labour market is expected to continue to grow over the next ten years in order for relevant institutions to respond to the ever-growing incidents of cybercrime. According to Yerby et al. (2014), a search for a game for learning digital forensics on the Web returns only two results. The first result found is an idea paper that suggests the creation of a digital forensic game (Pan, Yuan, & Schwartz, 2012). The second result for a digital forensic game points to Mark Lane's Logs: Project H.U.M.A.N. (<http://www.indiedb.com/games/mark-lanes-logs-project-human>) where the player is performing real-world investigation on a military-grade conspiracy. The game is a cinematic thriller where players solve zodiac diagrams, become involved with a drug dealer and decipher secret languages and riddles. The player is playing a role of retired CIA agent who is forced to carry out one last mission: dismantle an elusive terrorist organization, infiltrated in the American military, and the CIA. The third attempt that was found later was the DFI game by Yerby et al. (2014). This game is based on a quiz-based selection of multiple forensic tools that help the learner in the investigation. However, there is no evidence that the game was realized.

In the design of the FOREVICA game presented in this study we followed the Killi game model design (Kiili, 2005; Kiili, 2006) and the suggested framework that links the learning outcomes with the game design studied by Van Staaldunin and De Freitas (2011). The game learnability attributes that are specified in the new SG taxonomy (Blažič & Blažič, 2015) were used as building blocks of the game knowledge framework.

The FOREVICA game was created within the activities of the Cyber Academy (<http://www.d-fet.eu>), which is an association providing training in cloud infrastructure by offering cybersecurity and digital forensic courses (Cigoj & Blažič, 2015). The aim of this research was also to find out whether the identified learning attributes in the extended taxonomy can be considered and applied during game design as their usability was studied only in an evaluation process of an already developed and popular SG.

Before we move on to present the applied design approach in the implementation of the serious game FOREVICA, we will review some of the most outstanding contributions that have recently been made in relation to the problem of the learning effectiveness of SGs.

5.2 State of the Art and Related Works in the Area of Educational Game Design

The game research literature in the last ten years has emphasized the importance of applying established instructional strategies and implementing learning theories to the design of SGs that were expected to facilitate game-based learning and learning effectiveness (Dickey, 2007; Egenfeld-Nielsen, 2006; Kiili, 2005; Amory & Seagram, 2003; Bots & van Daalen, 2007; Kebritchi & Hirumi, 2008; Van Staaldunin & De Freitas, 2011). The insight into the learning process in the GBL was found to be still limited (De Freitas & Oliver, 2006) as the game entertaining property dominated over the education. As an answer to these critics a new view on the game design was proposed in an attempt to integrate the best from the classical game design, by focusing the design on learning as an immersive experience design rather than learning as curriculum design. In the literature three frameworks that produce a new design approach can be identified. They were mainly developed with the intention of providing frameworks that will help tutors in developing immersive learning experiences. The first approach is based on the inclusion of intrinsic motivation in the game. Games are designed to generate a positive effect on the players as they are most successful if the game manages to engage them, thereby intrinsically motivating them by facilitating the flow experience of the game (Gee, 2003; Salen & Zimmerman, 2004; Kiili, 2005; Schell, 2008). A game facilitates the flow experience if the challenges that the game offers are up to par with the skills of the player. However, later, based on empirical evidence, it was found that engagement cannot be simply equated with the “intrinsic motivation” of the learner (Filsecker & Kerres, 2014). The engagement provides only a multidimensional view for examining how, for whom and under what circumstances an educational game might work (Hickey, Ingram-Goble, & Jameson, 2009).

The other approach is based on the constructivist idea of a microworld (Martens, Diener, & Malo, 2008) where the games might be understood within a constructivist framework of learning. The microworlds are given domains or environments that may be explored in a non-linear way by users or learners. They describe a situation where learners do not study a particular domain but become part of the game scenario, thereby stimulating interest and motivation. In addition, they are enabled to interact with and explore complex ideas within such spaces (Rieber, 1996). Constructivism is the psychological theory that argues that humans construct knowledge and meaning from their experiences (Piaget, 1955; Bruner, Jolly, & Sylva, 1976; Vygotsky, 1978). Constructivism is not a particular pedagogy; it is a theory of describing how learning happens. Constructivist educational theory focuses on concept development and on deep

understanding, rather than on behaviours or skills, as the goals of instruction (Amory & Seagram, 2003).

The third approach is known as the game object model (GOM). The GOM attempts to create a dialectic between pedagogical dimensions and game elements (Amory & Seagram, 2003). It consists of a number of complex interrelated objects used to describe SGs that could be simplified into three major spaces: challenges, narrative and conversation. It is applicable for game design but also for studying the game from the instructive perspective. The approach was criticized by Killi (2005), who thought the GOM was too superficial and neglected the game play and the flow theory. However, this approach is still considered to be a model that enables game structuring discussions. Another approach known as Killi's model is used in the design and study of SGs and gaming in general (Kiili, 2005). In that model the game is designed with the aim of being usable and providing clear goals and appropriate feedback to the player in order to facilitate the flow experience. The model links the experimental learning for facilitating the game flow experience of the learner but lacks a comprehensive educational approach built into the game design.

Good integration based on several proposed frameworks was provided by De Freitas and Oliver (2006) and De Freitas and Liarokapis (2011). The four-dimensional framework presented by them arose from their work with tutors and learners seeking to understand more about how games are selected and used (De Freitas & Javris, 2008). The authors' previous research found that very often tutors did not know which games to use in which contexts and what were the most effective game deployments for their students. The framework proposal postulated four dimensions that are incurred in learning processes and need to be considered for game selection. The framework has been used as a design tool for the development of three SGs to present their usability. The four elements considered in the design were: the learner specifics, representation (e.g. fidelity), pedagogy and the context. The main contribution of this model is the 25 game elements that may contribute to the learning (Van Staaldunin & De Freitas, 2011), combined with an organizing structure for learning, which was provided by Anderson and Krathwohl (2001). However, the authors claim that the usage of the suggested game elements in a game is tied to the game type and game subject. Games should use only a selection of the suggested game elements as even good games are not required to use the complete set. The elements were validated as a conceptual basis for serious game design, but it was recognized that this conceptual work needed to be pushed into the area of practical applications.

We presented in Chapter 3 the important elements that reflect the relationships between the learning outcomes and the game's attributes. They were identified as learnability attributes and were introduced as a specific branch in the serious game taxonomy previously developed by Greco and co-workers (Blažič & Blažič, 2015).

It was specified that the proposed learning attributes should not only be used in game assessment but should also be applied and integrated when the game is designed. The complete new taxonomy branch was defined by integrating the concepts of the learning theories that belong to three categories: the ability to achieve learning outcomes by enabling the building of competency (which can be learnt in the game), the ability to provide learner control and interaction (based on the employment of experimental/self-guided learning in the game) and the ability to motivate the learner (engagement). These three categories are presented below:

- **Building competency and cognitive** abilities (enabling low- and high-road knowledge transfer in an experimental environment (learning theory: transfer of learning),

- **Interaction and control** (enhancing the ability to learn independently, through one's own thinking (theory of active learning),
- **Expectations and motivation** (enhanced motivation, performance and anxiety reduction (learning theory based on metacognition)).

The detailed serious game taxonomy was presented in Chapter 3 and here we recall the learnability attribute that is presented in Figure 4.3. in section 4.3.2. How these attributes were integrated within the game scenario's game design and later implemented is illustrated by the FOREVICA game.

5.3 A Serious Game for Digital Forensic: FOREVICA

The design of FOREVICA was based on the Killi experimental gaming model (Kiili, 2005). The model was later updated by the author and is presented in Figure 5.1

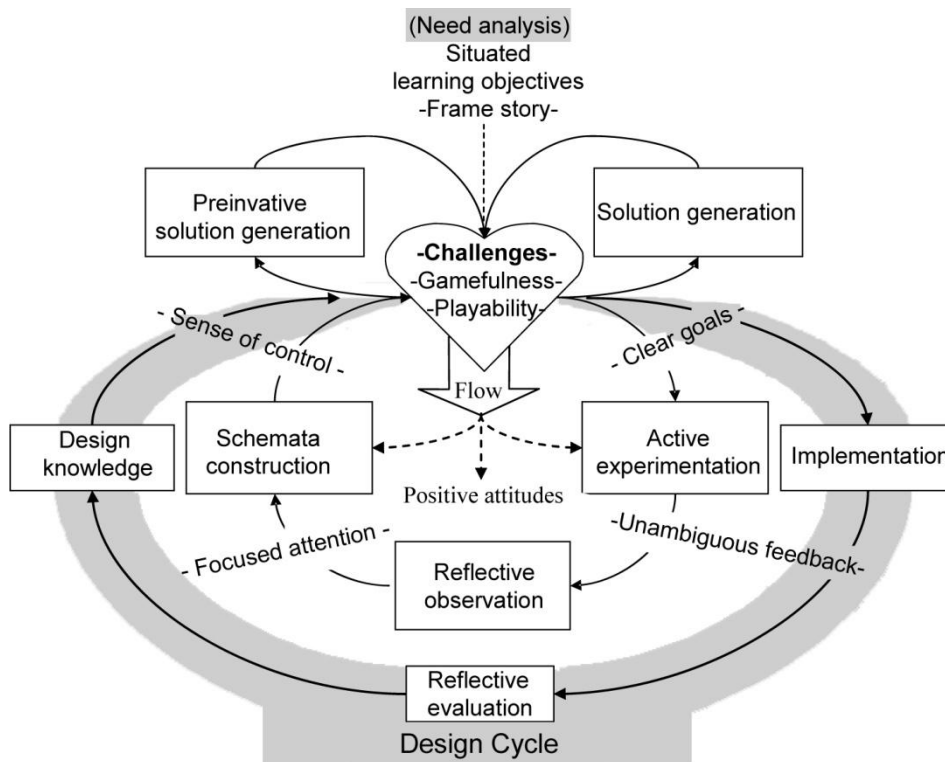


Figure 5.1: The Killi game design model (Kiili, 2005).

This gaming model is intended to be used for educational design and study. It consists of a gaming cycle and a design cycle. The gaming cycle provides a description of the gaming process and the learning process in the game. The efforts of the designers are focused toward enhancing the most important factors that influence the gaming experience with the learning. The model suggests several flow antecedents that should be considered during educational game design. They are challenges matched to the skill level of a player, clear goals, unambiguous feedback, a sense of control, playability, gamefulness, focused attention and a frame story. The frame story of FOREVICA is designed around a digital forensic investigation carried out by an investigator in a virtual environment that simulates the real location of a committed cybercrime, a police station and a forensic

laboratory. The objective of the game design was to provide education and training for students taking a digital forensics course in a higher level educational institution. The trainee plays the role of a young police detective, known as Agent Smith, who works in the police squad at the central police station. The story of the game begins when the FBI notices a lot of recent Internet activity related to the dispatching of child pornography among local Internet users and websites. Media and TV news report on the appearance of child pornography dispatched by an actor known by the name Hacker. His identity is not known. However, IT specialists from the FBI investigation team with cooperation from the central police station squad investigate the source of this activity and the hijacked web servers used for dispatching.

The game begins with an introduction with an animated video scene presenting the Hacker at his work. The Hacker is typing on the computer keyboard and is uploading illegal content. The game proceeds to a new scene, but before that the new text window appear where the player can read about the instructions of the game and all information about what is considered abuse and crime in the act of child pornography dispatching and what steps the player is going to learn during the game. Then the game continues with a new scene, with Agent Smith arriving at the central police station where he is invited to a meeting with the FBI investigation team. The next scene takes a place in the virtual meeting room where agent Smiths (the player) is sitting together with the FBI investigation team to discuss the latest events that occurred regarding the dispatching the child pornography. Then the FBI investigation team reports that they have managed to identify the website and the IP address of the FTP server used by the Hacker for dispatching the illegal content. They have also managed to trace the home address of the Hacker. They then acknowledge Agent Smith with their decision to prepare a surprise visit to the Hacker's private home and take the action to seize the relevant digital equipment and evidence. Agent Smith is asked if he is prepared to perform the following task: provide a court order based on a police request for an investigation, visit the Hacker's home, inspect the house, capture the digital equipment (he has to decide which one), bring the equipment to the police forensic laboratory, inspect the equipment, use the analytical forensic tool, collect digital evidence in line with the specified forensic procedures and in line with the court rules in cases of prosecution and prepare a written report in line with a standardized report template. Some scenes providing an illustration of the FOREVICA 3D environment are presented in Figure 5.2, Figure 5.3, Figure 5.4 and Figure 5.5.



Figure 5.2: Screenshot of Hacker's home, where Agent Smith must collect the digital evidence.

Agent Smith can decline the task and then the game is finished with no success, or he accepts the task and the game continues. The game is organized in a flow of 12 steps accompanied by 11 learning lessons, each one containing a task or question for Agent Smith (the flow of the game is presented in Annex 2 at the end of the thesis). In each step the player is asked to answer the question in the window, solve a puzzle pick the right order of dialogues or perform a task. This is always a control point for making a decision. If the player is not able to answer or solve the task he is offered an opportunity to learn – a learning lesson window appears and the game, after a correct answer or task solution, is provided. Each correct answer or solved task brings points/scores but they are higher if the learning lesson is not consulted. The points are collected and are presented with the debriefing at the end of the game. If the trainee picks a wrong answer, they are sent back to the previous step of the game. At the very beginning, the game opens with Learning Lesson 1, which introduces the basic digital forensic principles and the objectives of the game, e.g. providing information about what will be learnt. An important aspect of the game is the experimental setting. To obtain the relevant digital evidence, Agent Smith must invoke the forensic analytical tool and perform several tasks on the captured equipment as he is asked to provide digital evidence about the committed cybercrime. The game enables reading and consulting of the analytical tool manual and the instruction of the commands to be performed by the tool. A snapshot of the tool results is presented in Figure 5.5.

The final step of the game is the investigation report prepared by Agent Smith, which is based on the collected digital evidence. The game ends with a scene with Agent Smith presenting the report and the approval by the FBI investigation team. Debriefing follows with the score achieved by Agent Smith.

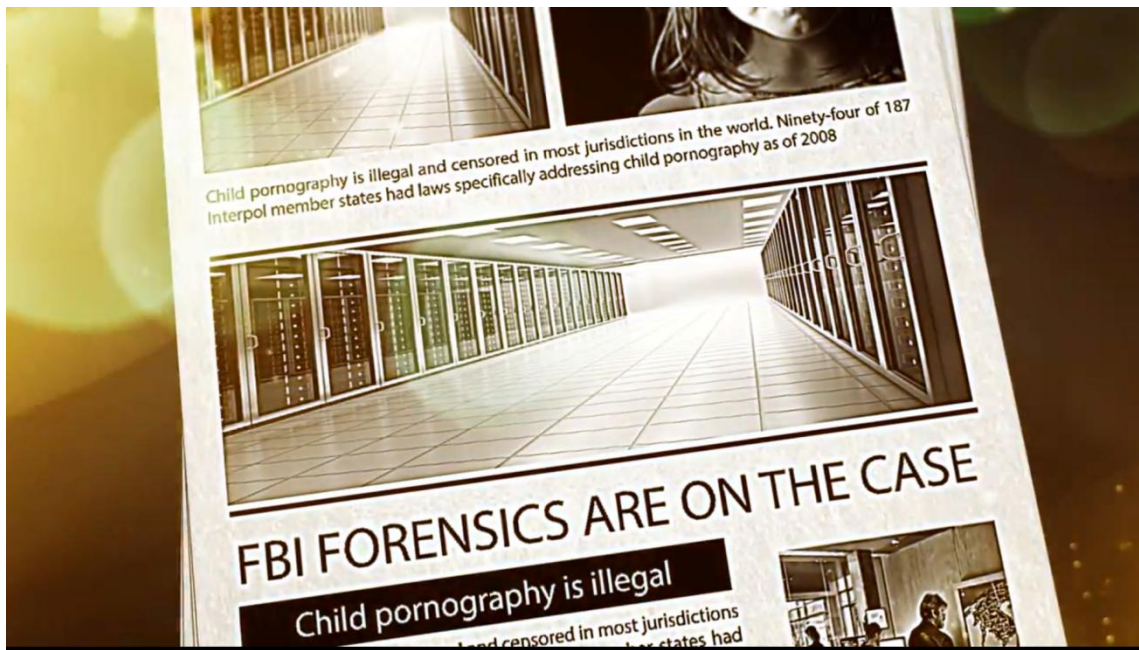


Figure 5.3: Screenshot of game introduction video – the newspaper headlines about cyber-attacks.



Figure 5.4: Screenshot of Agent Smith's Office.

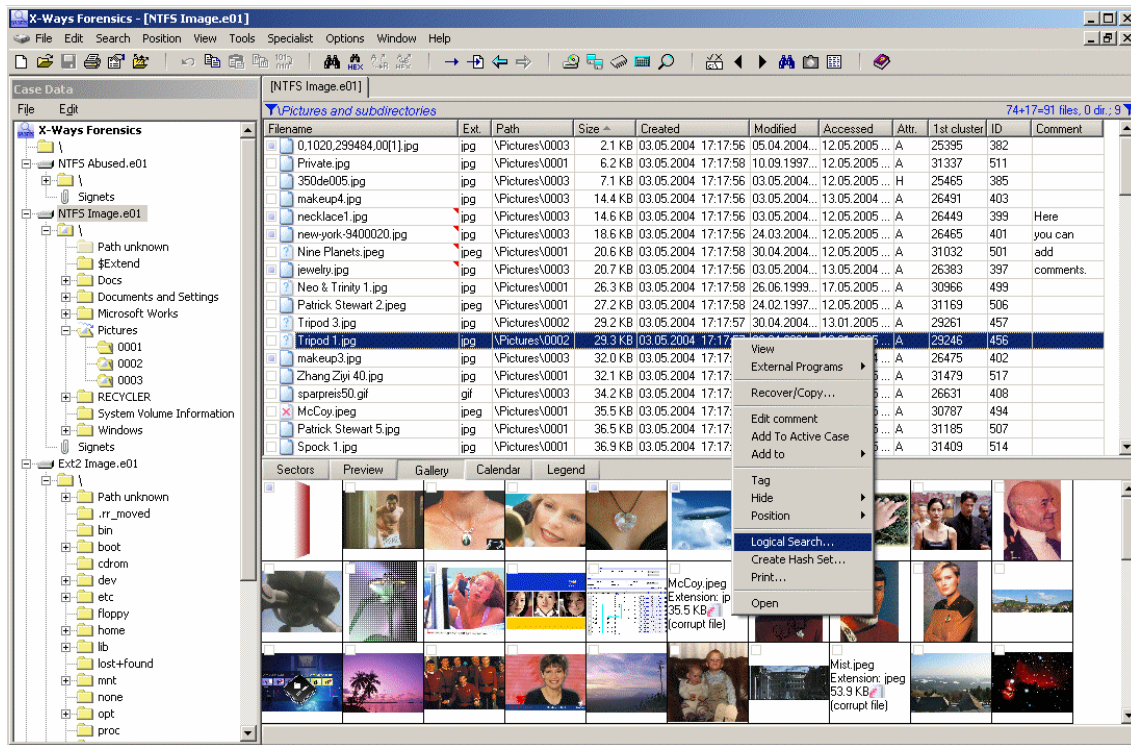


Figure 5.5: Snapshot of the X-Ways digital forensic tool and its results.

5.4 FOREVICA Design and In-Building of Properties that Reflect the Learnability Attributes

Special care during the FOREVICA game design was attributed to the incorporation of the learning attributes presented in Figure 4.3. They were considered in developing and designing the game. Other basic guidelines from the Killi model that are associated with the game flow were followed as they ensured that the game challenges matched the skill level of a player. Other requirements were followed as well. The goals were set up by defining clearly the game's learning objectives, the feedback provided was clear and unambiguous, a sense of control for the player enabling decisions was incorporated and the game playability and gamefulness were designed with the use of good animation techniques and the tasks involved. The frame story was designed to meet the educational needs and training of a digital forensic course.

The next important part of the Killi model addresses the design of the knowledge to be passed to the learner. This is the most important content in an educational game. In FOREVICA the knowledge and the skills to be acquired are supported through the learning lessons presented to the learner and they are available in each step of the game. The game flow was designed in a way that enables active experimentation through tasks related to investigation cases and use of the forensic tool. The player is always informed about the educational objectives at the beginning of the game. The knowledge content of the game is divided up between 11 learning lessons that are named according to the player demand (the lessons and the content are presented at the end of the thesis in Annex 2 (Game flow and learning lessons)). These lessons address the major steps in any digital investigation starting with the correct legal procedure, continuing with a lesson that introduces the carriers of digital information and the related equipment, then the processes of capturing, collecting and preserving digital information are presented

followed by the method that enables digital carrier recovery in the case of data deletion, then an introduction to the digital forensic tool is provided with a lesson that describes the use of the tool (e.g. for disk recovery) and how to examine the data, how to do the search for digital evidence, how to make an analysis of the data found and how to prepare an investigation report. In addition, a scene when Agent Smith discusses the investigation report with the police squad team provides the option for reflective observation and evaluation of the performed task.

In the text above (Section 5.2) we have pointed out that the learnability attributes will be carefully implemented during the game design. FOREVICA was designed to enable the player to acquire knowledge about digital forensic procedures and investigation methods and to make a player to be capable of carrying out an investigation, where main objective was the to identify and collect of digital evidence that is admissible in court in the case of prosecution. The designed game flow incorporates several decision control points (steps) with respective challenges and required actions that contribute to the game's playability and the motivation of the learner. On the other hand, the designed knowledge enables several learnability attributes to become part of the game. To illustrate how they act we describe most of them. The presence is evaluated in the next chapter.

5.5 The FOREVICA Game Assessment

The experimental evaluation of the FOREVICA game was conducted with the same approach used for the evaluation of the Sharkworld and Virtual Leader games (see chapter 4). This time only a few (3) students from the Postgraduate Jožef Stefan School (www.mps.si) enrolled in the ICT postgraduate programme with basic knowledge of information security took part in the evaluation. The evaluation followed a three-pronged approach, i.e. surveys, self-evaluation and facilitative participatory observation. The authors evaluated the FOREVICA game by playing it themselves as well as through observation of the survey participants and the participating educator of the Digital Forensics course while playing the game. All participants received basic instructions but the objectives of the game this time were provided by the game itself. Two other educators with information security knowledge observed the playing and facilitated the game playing during the study. This group also completed a survey with a series of interviews regarding the students' experiences with FOREVICA. The same questionnaire as that presented in Annex 1 that used positive answers for each evaluated property collected during the survey is presented in Table A.2.

However, the presence of the learnability attributes and the application of the design rules explained in Chapter 2 were evaluated by the information security educator. The following was found:

5.6 Game Design Rules and FOREVICA Game

The rules that should be followed in the game design according to Tang, Hanneghan and El Rhalibi (2009) should be defined as meaningful learning activities that promote the formation of new concepts and the development of cognitive skills. The 11 learning lessons of FOREVICA clearly introduce the new concepts and develop new skills. This is especially true for Learning Lessons 6 and 7, which enable the acquisition of skills in using the digital forensic tool X-Ways. In addition, rules that govern the game play must be coupled with measurable learning objectives that are assessable via the game

interactivity. Interactivity is present in the whole flow of the FOREVICA game as the player's interaction with the game is enabled in each step of the game. Distinct challenges that place demands on the learner to solve a variety of problems cognitively and that require hand-eye coordination and use of the forensic tool are also part of the FOREVICA game (Blažič, Cigoj, & Blažič, 2016).

The other parameters requested in the game design by the same authors are the culture details that depend on the subject matter and the designed learning objective as an ideal educational game should exhibit belief and norms from some real-world scenarios to facilitate knowledge transfer from the game world to the reality. This culture characteristic of FOREVICA is obvious as the game is built from real-world scenarios and uses the forensic tools that are used in everyday forensic investigation practice. In addition, the story and the narratives used to set the FOREVICA scene are created from case scenarios that could actually happen in the real world.

The third design requirement is related to play, which in the context of computer games has always been perceived as an activity of enjoyment or recreation instead of having a serious or practical purpose. In contrast to computer games, play in the context of educational games is defined as meaningful learning activities that promote the formation of new concepts and the development of cognitive skills. Play is a part of the FOREVICA game as the learner plays the role of Agent Smith and is engaged in several activities that enable building of the context and the development of cognitive skills.

Based on this finding it can be concluded that all required properties in game design were followed in the FOREVICA game design. The next assessment of FOREVICA is related to the presence of the learnability attributes that were defined in Chapter 4.

5.7 FOREVICA Game and Presence of the Learnability Attributes

To provide the presence of the learnability attributes, we used the properties that were comprehensively explained in Chapter 4, where we explained the learning theories to be used for assessment. With the help of Figure 13 we enabled the next assessment. Starting with the first group:

Competency and cognitive abilities

These elements enable the game capacity to build learner comprehension and the ability of the acquired knowledge to be used in concrete applications when decision-making is required. Here we include the following:

Remembering

Acquiring and applying basic and applicable knowledge in FOREVICA is enabled through completion of the allocated tasks in each of the ten game steps. The learner has to overview the learning lessons that are provided in the game. At this point the learner must remember the information and then apply the knowledge by answering practical questions or by performing a particular task. To illustrate successful completion of a task, a player needs to identify any kind of evidence from the seized computer disk (e.g. IP addresses) that was deleted and recovered (lesson No. 5). In lesson 6. the work with the forensic tool X-Ways is introduced. Each learner is presented with a new investigation case. This facility is enabled by the underlying tool Eduforce, which generates new crime instances for each new run of the game (Cigoj & Jerman B, 2015). Lesson 8 teaches how

to find and obtain evidence and Learning Lesson 9 teaches how to prepare the investigation report.

Understanding

The other category of learnability attributes is related to the understanding attribute, which relates to the creation of a series of decisions or selections. If the learner understands the learning lessons, they can make their first decision in step 3 where the learner has to decide what kind of equipment should be seized and how the seized equipment should be marked. The learner is offered a choice, but if the decision is wrong the learner is told to read Lesson 3. A similar test of comprehension can be found in step 4 where the learner is asked to select the appropriate hypothesis for a particular crime act. If the answer is wrong the learner is sent back to Learning Lesson 4. Similar approaches are used in steps 5 and 7.

Applying

This element addresses the capacity of the player to perform some actions. Step 5 of FOREVICA instructs the learner to solve a task where he needs to prepare and use a new forensic tool. He must use the right command to launch the X-Ways console. In step 6 he is asked to generate a legal copy of the recovered disk.

Interaction and control

The second group of learnability attributes is known as Interaction and Control. These elements follow from the theory of active learning and can be embedded within the game play. The learners become more engaged in the learning process when they are required to interact with it.

The game should allow the learner to take control of the flow and sequence of the learning activities as this makes the game more interactive and engaging. To recall the attributes that have been selected from Chapter 4, we list the following:

- Gaining attention
- Informing learners of the objective (expectancy)
- Eliciting performance (practice and responding)
- Presenting stimulus
- Assessing performance (retrieval)
- Enhancing retention and transfer (generalization)
- Providing feedback
- Learning guidance

The FOREVICA design was designed to provide interaction and control in several circumstances. In particular:

- **Gaining attention** is ensured by continuous interaction of the learners that happens by solving tasks or answering questions in several instances during the game flow. The player is, for example, asked in step 1 about his/her readiness to perform the investigation task and to provide digital evidence about the crime committed by the suspect, which includes a visit to the suspect's home. Before he/she is asked, an exhaustive explanation of the investigation procedure is presented to the player. Similar interactions happen in step 2 and step 3 and the other steps that lead to the conclusion of the game.
- **Informing the learners** about the objective (expectancy) of the game is the property provided in step 1 where the objectives of the game are

briefly but clearly presented as well as the skills that are expected to be obtained from the training.

- **Eliciting performance** (practice and responding): This property is ensured by the practical training that starts in step 4 where the learner gets information on how to implement the forensic procedure and solve the concrete task. In step 5 he/she is introduced to the experimental part of the investigation, (i.e. isc recovery). In step 7 the learner is expected to continue with the experimental work and in the case of disk inspection identify data that provide proof that a criminal act was committed. The level of the game's difficulty is gradually increased by proceeding from step 5 to step 7 (more different cases) and by the last challenge in steps 8 and 9.
- **Stimulus** within FOREVICA is provided through awards in the form of scores for each of the correctly provided answers or solved tasks that lead the player to a successful end of the game where the scores are collected and provided as feedback. The game enhances the learner's performance as when is to the player only three attempts allowed for provision of correct answers. The score become smaller with every next attempt of the player to provide correct answer.
- **Assessing performance (retrieval)**: The effectiveness of the game and achieved learning outcomes is assessed at the end through feedback of the collected scores and a brief report by the player.
- **Enhancing retention and transfer (generalization)** is an important learning property as the developed expertise must be generalized to new knowledge. This property of the FOREVICA game is realized in step 9 where the learner is asked to provide a forensic report in line with the standard investigation procedures. The methods used to help learners to generalize the new knowledge in Learning Lesson 9 include several examples from different cases and crime acts. The awarding of scores here is done by the game but later they can be corrected by the educator.
- **Providing feedback**: FOREVICA provides feedback in step 10 of the game. Feedback is given based on the decision taken by the players and the performance of the tasks. Successful completion of the game is necessary.
- **Learning guidance**: FOREVICA provides guidance to the learner during the game playing by offering ten learning lessons and a practical manual on how to use the forensic tool ensuring self-learning and active involvement.

Expectations and motivation

As mentioned in Chapter 4, this subcategory is aimed at ensuring better motivational appeal of the instructional materials in the game, as the learning is most effective when the learners are engaged throughout the entire learning process. The next three properties that ensure that expectations and motivation can be present throughout the FOREVICA game flow are:

- **Creation of learner confidence**
- **Provision of satisfaction**
- **Relevance**

FOREVICA implements most of these properties:

- **Creating learner confidence.** FOREVICA implements both methods for achieving player confidence; the players advance step by step receiving positive scores and have the feeling that the control is in their hands. The players make the decisions about how many times will they repeat the learning lessons in order to upgrade their knowledge.
- **Providing satisfaction** contributes to the creation of player confidence. FOREVICA provides satisfaction by announcing in each step the score obtained (the award) and reports on the game play progress in the form of a progress bar presented with the percentage score.
- **Relevance:** FOREVICA addresses the learning and training of learners that take the Digital Forensics course and need this expertise in the environment where they work. The educational content of the game is aligned with well-known textbook in that area – including Eoghan Casey’s *Handbook of Digital Forensics and Investigation* (Casey, 2009).

5.8 Concluding Remarks

The answers received from the involved students and the educators’ observation have confirmed that the suggested approach in the design of serious games for education was correct. All relevant properties that lead to the achievement of the educational and learning objectives in a difficult subject like digital forensics can be incorporated during the game design. The careful analysis of the game properties that have led to the evaluation results show that the FOREVICA game is an educational tool enabling learners to learn how to construct, solve and analyse a demanding decision-making process that is based on an exhaustive data analysis and appropriate technical skills. The game, with its good explanatory properties and leading instructions complemented by appropriate ongoing feedback, enables learners to reason clearly and logically with the use of the available information and guidelines collected within the learning lessons. The content of the learning lessons is offered incrementally and is invoked by the learner and the advancement in the process of skill acquisition. The FOREVICA game provides practice and skills building in an environment very close to the life reality. The simulation of unexpected events during the investigation process forces the learner to think independently and to control the learning through processes that teach how to learn independently. The relevant game rules design and the Killi game design model applied provide all the necessary game characteristics regarding the technical capabilities and the entertainment property of the FOREVICA game.

It is accepted by educators that in the selection process of a game design an education process has to be properly included. The game to be chosen for development should be carefully analysed, not only regarding technical properties and the variety of the learning environment, but also regarding its ability to create skills and knowledge, which is considered to be the main focus of the use of SGs. This implies that the game includes problem-solving scenarios or tasks that enable the re-elaboration of previously acquired knowledge and content, the construction of new knowledge and use of the available resources to achieve the educational objectives. The work presented in this chapter has shown that the presence of these properties can be incorporated during the game design by following the learnability properties specified in the BSG taxonomy branch denoted as

Game Learnability, which confirms Hypothesis No. 3 of the dissertation. Furthermore, the work presented in this chapter and the content of Annex 2 clearly confirms that the learnability properties of an educational game are universal and applicable to the business and engineering domains of educational games (Biagi & Loi, 2013).

Chapter 6

Conclusions

6.1 Introduction

Serious computer games have been demonstrated to provoke active learner involvement through exploration, experimentation, competition and cooperation. They have been seen as a good opportunity to support learning because of their ability to increase visualizations and challenge student creativity (Riedel & Hauge, 2011). Academia has studied video games and their use in learning in the last two decades. However, the area is still treated as a novel field of research with a focus on learning capabilities in both universities and lifelong learning programmes (Aleckson, 2009). The literature review and the exploratory research presented in the thesis have also shown that the use of gaming is not a new phenomenon as many reports from the past have pointed out that serious games (SGs) are a good and successful learning tool used by many educators. The evolutionary context of ICT and its application in the educational process has shown that the problem of good categorization of SGs is still present and needs further research and exploration. The importance of SGs for learning was clearly confirmed by the well-known biannual PISA study that showed that the relationship between the domain-specific PISA (<https://www.oecd.org/pisa/>) test scores and the measure of the intensity of a student's gaming activity is the only ICT indicator that is positively correlated in the majority of studied European countries for mathematics, science and the language of instruction.

The importance of SG categorization and the need for learnability assessment approaches has become a challenging research task. Two European consortia from EU FP7, e.g. the Network of excellence GALA (<http://www.seriousgamesinstitute.co.uk/applied-research/GALA.aspx>), the project Imagine1 (<http://www.projectimagine.eu/>) and Engage learning2 (<https://ec.europa.eu/digital-agenda/en/news/engage-platform>) have also pointed to the problem of the need for this to be approached widely by the research community.

The presented current state of the art in the field shows that SGs and their categorization as well as the design models that consider game learnability are still in the early phase of development. The research work and the results presented in this dissertation can be considered contributions that provide some solutions to the problem to be solved. The research questions that were answered through the presented research work in the thesis can be summarized as “What are the relevant characteristics of an SG and how can they be classified?” and “What are the parameters to be used in the design and in the assessment of the effectiveness of an SG that will ensure game learnability and achievement of the educational outcomes?” The answers to these questions are elaborated

through the elaboration of the hypotheses and the results that have confirmed their correctness. In particular:

6.2 Confirmation of the Hypotheses

H1 – Current serious games taxonomies used in the assessment and classification of the games do not consider sufficiently the learnability parameters required in the process of game selection by the educators.

The assessment of the learning outcomes is usually performed with the use of procedures based on known taxonomies for good practice (Imrie, 2008). According to the work of Imrie, an indication of a good taxonomic approach to the assessment enables the accountability and quality assurance of the applied educational curriculum or the used educational tool to be ensured. The last published taxonomy that encompassed most of the already known taxonomies of serious games known as Greco's taxonomy according to their authors (Greco, Baldissin, & Nonino, 2013) represents an accurate synopsis of what is otherwise considered to be heterogeneous literature about SG. However, deep analysis of the suggested taxonomy parameters has resulted in the fact that the learning aspects and the educational values of the games are present only to a very small extent. Evaluation of the game's properties focused on teaching, learning and the achievements of educational goals was not possible with either this new taxonomy or with some others as these important elements were missing. For that reason, a new sub-tree was developed as an upgrading of Greco's taxonomy that introduces the missing learning properties. Chapter 4 of the thesis and the published paper describing the proposed upgrading in the highly referenced Journal of Educational Computing Research (Blažič & Blažič, 2015) confirms the correctness of Hypothesis No. 1. The communication with the main author (Prof. Marco Greco from the University of Cassino, FR) and co-workers has also approved the correctness of the proposed upgrading.

H2 – The learning theories have not been properly considered in the building process of serious games design.

The detailed analysis of the published models for game design has shown that important learning elements already identified in the work of Wilson et al. (2009) and Van Staaldin (2011) who studied the relationship between the learning outcomes and the game's attributes are missing. Other authors, e.g. Van Staaldin (2011) and Wilson (2009), have also identified that the elements that contribute to successful learning, e.g. the motivational aspects and the student engagement in the learning identified by Malone and Lepper (1987) and Moser and Moreno-Ger (Moreno-Ger, Burgos, Martínez-Ortiz, Sierra, & Fernández-Manjón, 2008; Moser, 2000) are not considered in the game design process. This confirmed the finding that the approaches taken in the building processes of serious games focus mainly on the amusement and entertainment part in addition to the modelling of the virtual reality and that there is a need for learnability theories to be studied again along with how learning processes are considered in game design and assessment. Based on these findings and the three learning theories ("transfer of learning", the "metacognition" or "the personalized theory of learning" and the "constructivism" or the "theory of active learning") were studied and 14 learning parameters were defined as elements that govern the learning process. These elements

were then shaped as the three branches that build the new added taxonomy subcategory. These branches are: “competency and cognitive abilities”, “interaction and control” and “expectancy”. Achievement of the learning outcomes is more probable if these learnability attributes are present in the game. This leads to the conclusion that, if the instructional objectives and game attributes have an increased rate of overlapping, the SG will be more effective, and that consideration of the learning theories, which is missing in the current approaches, should be included in the building process of SG design. These confirm H2. The paper (Blažič & Blažič, 2015) also provides confirmation of Hypothesis No. 2.

H3 – The learnability parameters of serious games need to be considered in the process of game selection and in the course of game development.

The combination of three learning theories defining the learning processes was used for the development of the upgraded taxonomy with the learnability attributes. To prove the applicability of the learning parameters in the assessment of ready games and in game design two experiments were performed within the research presented in the thesis. The first experiment was carried out through the assessment of two popular games in the area of management: Virtual Leadership and Sharkworld. All 14 learnability parameters were applied and the presence of the attributes defining learnability was studied. The results obtained from the assessment were afterwards confirmed through an empirical study based on a survey carried out with students and educators in the area of ICT and economics. The second experiment was carried out through the design of a game for training and education in the field of Digital Forensics – FOREVICA. The game was designed by applying the Killi design model for serious games. In all the design steps of the game the parameters defining learnability incorporated game properties enabling learning and were inbuilt in the game flow. The assessment of the FOREVICA game’s learnability was performed with the same method as the method applied for the assessment of the Virtual Leader and Sharkworld games, by applying the parameter assessment evaluation model with a survey. The obtained assessment results from the property study and from the empirically obtained results have proved that the learning parameters can be successfully applied during serious game design and development by following the game flow and the learning theory findings. Consideration and incorporation of the 14 learning parameters during the game design ensure that the learnability properties of a serious game can be present to the desired extent in order for the instructional objectives to be achieved. Games designed based on these recommendations can be used successfully as an educational tool in the education or training process. This confirms Hypothesis No. 3

6.3 Summary of the Main Contributions

The confirmation of the three hypotheses enables the main contributions of the performed work in the field of SG assessment and design to be summarized.

6.3.1 Critical state of the art

As a first contribution we consider the in-depth analysis of the technical parameters of SGs and the defined purpose of education represented in Chapter 3. The results of the

analysis were used for the development of a classification tool for SBGs. This contribution was published in several papers with different insights and points of view regarding this research problem (Blažič, Ribeiro, Fernandes, Pereira, & Arh, 2012; Blažič & Novak, 2015; Blažič & Arh, 2013). Following Chapter 3, Chapter 4 completes the insight and the critical analysis of the state of the art in the field of serious game categorization, design and assessment provided in Chapter 3. The analysis identifies clearly the deficiency of the current BSG taxonomies and the missing elements. The findings in both chapters clearly point out the main directions of research that is expected to solve the identified problems in order to enable educational game developers and educational communities to come closer together with the desire for mutual understanding and the production of efficient educational games in the modern education processes accompanied by training based on real scenarios. Correct vocabularies and taxonomies being widely shared by the stakeholders in the field will enable faster and more efficient serious game production for many fields of education for the benefit of learners and educators.

6.3.2 The suggested upgrade of the existing taxonomy and the learnability parameters

The second important contribution of the thesis is the identification of the missing parameters in the recently published and what was considered to be mature taxonomy that was built on previous attempts to categorize serious game attributes. Upgrading was provided as a new taxonomy tree containing 14 new parameters defining the learnability game attributes. The new parameters were defined based on the study of the three known learning theories (“transfer of learning”, the “metacognition” or “the personalized theory of learning” and the “constructivism” or the “theory of active learning”) that define and explain how learning processes happen. The new taxonomy sub-tree was designed with the intention of it being applied as a tool for the assessment of the game’s learnability. In Chapter 4 it is shown that the suggested assessment elements enable the pedagogical features embedded in the game to be evaluated by educators for judging the game in view of its educational objectives. This means that the capability of the upgraded taxonomy allows the game’s expected plausibility and learning complexity to be judged by the considered participants in the educational process. The developed parameters enable the clarity of the instructions, the development of the students’ creativity and the level of expression in the interrelation between the systems being taught and their environment to be evaluated without any bias. The correctness of this learnability assessment model was confirmed with surveys conducted with students and educators. This result was published in the journal paper (Blažič & Blažič, 2015).

6.3.3 One of the first attempts at learning parameters to be used in game design

The third contribution is based on the first attempt to use the learning parameters in serious game design. With the development of the FOREVICA game presented in Chapter 5 it was shown that an innovative approach to game design can be provided to overcome the difficulties associated with digital forensic teaching, which is considered a very difficult engineering subject, through a successful combination of visualization technologies, animation, the application of game flow design models and the incorporation of learning properties. The game FOREVICA was designed and developed

by application of the Killi design model (Kiili, 2006) for serious games, but with novelty that consisted of the incorporation of learnability properties in all implemented design steps. The steps were implemented taking into consideration the parameters defining the learnability and through a process of in-building them during the game implementation. The confirmation of the correctness of the design method was provided based on the same approach as that used in the evaluation of the cases described in the second contribution of this thesis. The positive results obtained ensure that the learnability properties of serious games can be successfully introduced in game design.

6.4 Concluding Remarks and Future Works

In conclusion, based on the presented results we may claim that educational game developers and educational communities should come closer together in order for vocabularies and taxonomies to be widely shared and developers to be better informed about effective game-based learning experiences and study results (De Freitas & Oliver, 2006) when they plan a new game design. The recent study results obtained in the PISA project impose an additional need for a deeper understanding of the game's influence on the creation of knowledge in educational processes and for building successful problem-solving skills enabling the removal of the existing trends about which of the game's properties most contribute to the adoption of the strategic thinking, fantasy, interaction and creativity of the learners. At this point, it should be mentioned that this was indicated by Wilson et al. (2009) and that a further interpretative framework that links the game's properties and the learning outcomes still remains a scientific challenge to be further developed. The thesis has shown as well that there is no need to differentiate between the design of management- and engineering-oriented games when learnability is in question.

6.4.1 Future work

The value of SGs in education is undeniable (Nieto-Gullien & Carbonell-Aleson, 2012) and the potential benefits of using SGs as ideal companions to classroom instruction are unquestionable (Chen & Michael, 2005; Corti, 2006; Pan, Yuan, & Schwartz, 2012). However, there is still no clear consensus on the game attributes supporting learning effectiveness or the presence of the learnability parameters on achieving the learning outcomes through game playing among game developers and game evaluators (Nieto-Gullien & Carbonell-Aleson, 2012; De Freitas & Liarokapis, *Serious games: a new paradigm for education?*, 2011). Here, two streams can be recognized: the design model that links the game design and the learning outcomes proposed by Van Staaldin and Freitas (2011), and the incorporation of the game parameters that are used for assessment of game learnability. Learnability is directly related to the level of the quality of the performance or the educational outcome (Cottrell, 2013). Both processes should be considered as complementary and necessary during game development. In that context the assessment of the learners' performance should be understood as a domain of interaction between the students and the educational tool being used (Wawer, Milosz, Muryjas, & Rzemieniak, 2010) as the level and the quality of the performance are usually demonstrated by the correct student decision-making when playing a game. This indicates the quality of the learning tool as the required learnability properties are present and are built in during the game development. The interaction of these two streams in game development is still not sufficiently researched in order for a common game design model to be provided that will enable both sides of the problem: game

design and game assessment of the educational properties. The development of such a model it should be subject of future research work in the field of the development of SGs and assessment.

Appendix A

Questionnaire from Chapters 3 and 5

A.1 The Questionnaire from Chapter 3 and 5

Competency and cognitive abilities

1. Do you find that you can recall the knowledge obtained by playing the game?
2. Have you been able to take decisions the game asks for based on the earlier information provided by the game?
3. Did you find yourself capable of solving problems presented to you during the game?

Interaction and motivation

1. Did you find that the game was able to retain your attention during most of the gaming?
2. Did the game provide information about the educational objectives (what kind of knowledge or skill you will be able to obtain)?
3. Did you find that the game stimulated you to continue and finish the game successfully?

Learning guidance

1. Did you find that the game guided you sufficiently during the gaming process? Did you receive a sufficient number of cues enabling you to accomplish the game tasks?
2. Did you find that the game enabled active participation of the player, e.g. by making your own selection to proceed with the gaming process?
3. Did the game provide a view about your performance during the gaming process?
4. Did the game provide feedback of your achieved results at the end?

5. Did you have the feeling that you will be able to generalize the knowledge and the skills acquired during the game playing, e.g. to use the acquired knowledge in another case?

Expectation

1. Did you feel confident that you were capable of successfully finishing the game?
Or were you scared that you would not finish the game?
2. Were you satisfied with the achieved results at the end of the game? Do you find that you have learnt and acquired new skills?
3. Do you feel that the game is relevant for your education?

A.2 Responses from Chapter 4

Table A.1: Responses from Chapter 4.

Table A.1		Sharkworld	Virtual Leader
Property		Percentage of positive answers (%)	
Competency and control	Knowledge	83	89
	Comprehension	92	12
	Application	79	72
	Attention	100	41
Interaction and control	Informing learners of the objective	85	72
	Eliciting performance	73	55
	Stimulus	82	24
	Assessing performance	76	32
	Enhancing retention and transfer	14	13
	Feedback	34	65
	Learning guidance	92	16
Expectation	Learner confidence	86	74
	Satisfaction	83	45
	Relevance	77	81

A.3 Responses from Chapter 5

Table A.2: Responses from Chapter 5.

		Property	FOREVICA game Percentage of positive answers (%)
Competency and control		Knowledge	93
		Comprehension	90
		Application	88
		Attention	82
Interaction and control		Informing learners of the objective	90
		Eliciting performance	77
		Stimulus	65
		Assessing performance	84
		Enhancing retention and transfer	72
		Feedback	100
		Learning guidance	71
		Learner confidence	67
Expectation		Satisfaction	81
		Relevance	91

A.4 The Game Flow: FOREVICA Game Scenario and Learning Lessons

The game flow consists of the challenges and actions the game offers players and the sequence of the game is the progression of activities that the game consists of. The challenges and actions have been carefully designed and implemented to achieve the aims of the game.

The game is designed to enable the learning and training of a trainee or student to be capable of collecting and recovering digital evidence through the use of adequate digital forensic tools. The game is designed as a stand-alone game (you must install the game on your PC and then the game is ready to be played), with point and click options and based on an FRP (fantasy role playing) genre. The player takes the role of a young detective, Agent Smith, who has just started to work at the central police station as a digital forensic agent. Agent Smith is a beginner and has no experience. He/She has the chance to improve himself/herself and receives an offer to work for the FBI (Federal Bureau of Investigation). The game has a point system that allows the player to replay the single scenario multiple times while trying to solve a particular task or quiz and trying to earn a higher score/points. The points total is presented at the end of the game when the player creates the final report on recovering digital evidence. The game is applicable for teaching and training the use of digital forensic tools. At the beginning the game guides the player through a simple narrative scenario, where the player is introduced with a text explaining briefly the basic information relevant to understanding the game flow and the objectives. The game objectives can be summarized as follows:

A.4.1 The intro of the game

The game starts with animation no. 1 showing the Hacker working on a computer in his bedroom. On his computer it can be seen how he accesses the hijacked server and dispatches the illegal content – in our case, child pornography. Animation no. 1 finishes and animation no. 2 starts. Animation no. 2 shows the publishing newspaper with headline news, where it is reported that the Hacker is on the move and how he becomes successful in dispatching illegal content on the Internet. The police are helpless and the digital forensic team have no trace to help with finding and arresting the Hacker. The second animation finishes and the screen with the instructions for the game appears where it is explained to the player that he/she is going to learn the basic digital forensic investigation procedures and the basic use of a digital forensic tool for collecting and archiving relevant digital evidence. In particular:

- Fundamental computer forensic concepts and procedures.
- Use of digital forensic tools to discover, collect and preserve digital evidence.
- Uncovering and analysing digital evidence.
- Detecting and identifying evidence of acts of cyber crime.
- Documenting digital evidence to be used in court.

Introduction text: *“Welcome to the game. As you can see there has been an act of cybercrime. The server has been attacked. The Hacker has uploaded child pornography on multiple servers around the world and published illegal content on public forums. Child pornography is illegal and censored in most jurisdictions in the world. Ninety-four out of 187 Interpol member states have had laws specifically addressing child pornography since 2008. You are a young digital forensic investigator named Smith. You must follow*

instructions within the game and try to get all the evidence, so you can do the forensic investigation later on and prove who is the real Hacker. You are going to learn how to use the forensic tools to retrieve erased data from the seized storage devices and find the evidence that proves the Hacker is responsible for the attacks. During the game play you will earn points by taking the right actions and choosing correct answers. To help you with the tasks, you will be provided with various lessons.”



Figure A.1: Screenshot of the Hacker hijacking the server.

A.4.2 The game starts

The game starts when Agent Smith enters the central police station. At the reception desk there is a policewoman. Agent Smith starts a dialogue with the policewoman. In the dialogue, Lesson 1 begins. The text in the lessons presented are derived from the well-known handbook in that area – the Eoghan Casey’s Handbook of Digital Forensics and Investigation (Casey, 2009). The text in italic represents excerpt from the book.

The policewoman explains to Agent Smith the basics of cybercrime and digital forensics:

Lesson 1: Introduction to cybercrime and digital forensics

Cybercrime commonly refers to a broad range of different criminal activities where computers and information systems are involved either as a primary tool or as a primary target. Cybercrime comprises traditional offences (e.g. fraud, forgery and identity theft), content-related offences (e.g. online distribution of child pornography or incitement to racial hatred) and offences unique to computers and information systems (e.g. attacks against information systems, denial of service and malware). The forensic science for investigating cybercrime is called digital forensics.

Digital forensics is the process of “gathering/collecting and analysing data in a manner as free from distortion or bias as possible to reconstruct data and determine what has

happened in the past in a system. The method of collecting and storing data without any bias data is prescribed by digital forensic procedures that as a final result provide legally accepted evidence for court in the case of crime prosecution. Strictly speaking, forensic science is the application of science to law and is ultimately tested by use in court

The Task 1: Quiz Questions:

- a) What is digital forensics?
 - 1. *The application of science to law and it is ultimately tested by use in court*
 - 2. *It's an application that enables advanced programming*
 - 3. *Securely erasing digital data from computer systems*
- b) What is digital evidence?
 - 1. *It is defined as information in binary form that may be relayed to the court*
 - 2. *It is a set of tools for helping digital forensic investigators*
 - 3. *It is hardware such as routers, servers, backup storage devices and printers*
- c) What must digital forensic investigators do?
 - 1. *Follow an appropriate forensic procedure to ensure that data is handled in a manner as free from distortion or bias as possible*
 - 2. *Train police officers about computer security systems*
 - 3. *Prevent hackers from destroying the computer and its data before it is seized*

After the player has read the text he/she must take the quiz and give the correct answers. Agent Smith can take the quiz multiple times. But if he/she answers correctly in the first step, he/she will gain 9 points; if he/she fails and takes the re-quiz, he/she can gain only 6 points; with the next re-quiz, he/she will gain 3, and then 0. When the quiz is finished (choosing all three right answers) he/she can proceed to the office where he/she meets the FBI agent. They start the conversation, in which the FBI agent gives him/her the next quiz question. Agent Smith must give the best answer to gain the highest points. If he/she chooses the best answers he/she will gain the highest points. When the conversation is over, Agent Smith is invited to proceed to the meeting room, where the case of the Hacker is presented. In the meeting room, the FBI personnel and the police detectives are gathered. Animation no. 3 is shown: the TV breaking news reports that the FBI team has successfully tracked the Hacker's IP address and the police have him successfully arrested and brought to the central police station for interrogation. Animation no. 3 finishes. Agent Smith now has the opportunity to take the first investigation case. The FBI agent comes to Agent Smith and has a dialogue with him/her. The FBI agent gives Agent Smith the next question in a pop-up window:

Question: "To perform the task:

- a. You first have to know how to confiscate legally the cybercrime actor's equipment such as disks, computers, USB keys and other relevant items.
- b. Then you have to use the tools and other equipment in the digital forensic laboratory and perform a forensic procedure to discover, collect and archive evidence of the performed cybercrime act.
- c. And finally you have to prepare a report.

Do you accept the task?"

The player answers yes. If he/she answers no, he/she loses the investigation case and doesn't get the offer to work in the FBI. The game closes, and the player must start from the beginning.

The FBI agent explains to Agent Smith the next task, which is going to the Hacker's home address and finding the digital evidence. But first, young Agent Smith must give the FBI agent a small report about what digital evidence is and its meaning. After Agent Smith gives the complete report, he/she can go to the Hacker's house and search the "crime scene". The lesson window appears to the player.



Figure A.2: Screenshot of meeting room where Agent Smiths accepts the cybercrime case.

Lesson 2: Digital evidence and equipment that carry relevant data

Digital evidence is generally an abstraction of some digital object or event. When a person instructs a computer to perform a task such as sending an email or uploading a file, the resulting activities generate data remnants that give a view of what has happened. The specific role that a computer plays in a crime also determines how it can be used as evidence. When a computer contains only a few pieces of digital evidence, investigators might not be authorized to collect the entire computer. However, when a computer is the key piece of evidence in an investigation and contains a large amount of digital evidence, it is often necessary to collect the entire computer and its contents. Additionally, when a computer plays a significant role in a crime, it is easier to obtain a warrant to search and seize the entire computer.

Digital evidence can be duplicated exactly and a copy can be examined as if it were the original. It is common practice when dealing with digital evidence to examine a copy, thereby avoiding the risk of altering or the original evidence. With the right tools, it is very easy to determine whether digital evidence has been modified or tampered with by comparing it with an original copy. Digital evidence is difficult to destroy. Even when a file is "deleted" or a hard drive is reformatted, digital evidence can be recovered. When criminals attempt to destroy digital evidence, copies and associated remnants can remain in places that they were not aware of.

Task 2: The player must choose the right text to and put into the chapter in order and fill up the report.

Right text	Wrong text
<i>The specific role that a computer plays in a crime also determines how it can be used as evidence. When a computer contains only a few pieces of digital evidence, investigators might not be authorized to collect the entire computer. However, when a computer is the key piece of evidence in an investigation and contains a large amount of digital evidence, it is often necessary to collect the entire computer and its contents.</i>	<i>The entire computer must be seized and not just its hard drives, because the other hardware equipment also qualifies as digital evidence. We must not forget to collect any of the power and data cables so that we can examine the computer at the forensics laboratory.</i>
<i>Digital evidence is difficult to destroy. Even when a file is “deleted” or a hard drive is reformatted, digital evidence can be recovered. When criminals attempt to destroy digital evidence, copies and associated remnants can remain in places that they were not aware of.</i>	<i>When the hacker deletes the infringing files, digital data can almost never be recovered, even with the best and most advanced forensic tools available. A hacker can get away without charges and can obtain back his own data with his hacking tools.</i>
<i>In a child pornography investigation the criminal act on the cyber ecosystem involves digital evidence stored in various media such as RAM, hard drives, compact disks, floppy disks, logs, tapes, USB drives, cellphones and PDAs and it is the investigator/agent’s duty to select the relevant. The equipment for digital storage locations that are the typical focus of e-discovery are grouped in five groups: There are several locations for e-discovery of data that need to be preserved.</i>	<i>In a child pornography investigation of a criminal act on the cyber ecosystem the digital evidence is usually only stored on the computer itself; other data sources cannot be used as evidence. The hackers usually use fast computers for encrypting and preserving their data securely. The investigators/agents have to interrogate the hacker and prepare a report on the hacker’s criminal acts that can be used in the court. Investigators can seize the following:</i>
• Workstation environment, including old, current, and home desktops and laptops • Personal Digital Assistants (PDAs), such as the BlackBerry® and Treo® • Removable media, such as CDs, DVDs, removable USB hard drives and USB “thumb” drives • Server environment, including file, e-mail, instant messaging, database, application and VOIP servers	• Hacker’s fingerprints • Hacker’s voice for voice recognition • Hardware equipment such as a mouse, keyboard, monitor and speakers • Hacker’s passport
<i>Backup environment, including archival and disaster recovery backups</i>	

Agent Smith can take this task only once. When he/she fills in the report, he/she delivers it to the FBI agent and task 2 is finished. Now Agent Smith takes a car and drives to the Hacker’s home address. He/She enters the house and starts exploring.

He/She has to explore the house and find six items hiding in different rooms: a USB key, hard drive, laptop, CD-ROM, digital tablet, mobile phone and PC. When he/she completes the task and collects all six items Agent Smith has to put all items in the box and collect the right sticker – the next learning lesson starts:

Lesson 3: Digital evidence form

There are many challenges involved in identifying and collecting data, including the sheer number and variety within the five groups of digital storage devices that exist in the crime actor system. Comprehensive, diligent investigation and analysis enable identification of all relevant for collection and preservation. The most valuable are the backup disks and available removable media.

The preservation step of the data on the found equipment is where actual digital forensics begins. It is generally the first stage in the process that employs commonly used tools of a particular type. The output of this step is a set of duplicate copies of all sources of digital data. This output provides investigators with two categories of exhibits. First, the original material is catalogued and stored in a proper environmentally controlled location, in an unmodified state, and a document about that signed. Second, an exact duplicate of the original material is created that will be scrutinized as the investigation continues.

SAMPLE OF THE DIGITAL EVIDENCE FORM :

Investigator's Name and Association: Eoghan Casey Knowledge Solutions

Location of Computer/Media (full address) Corporation X, Building 6, Redmond, CA

Task 3: Agent Smith has to choose the right sticker report to put it on the box of collected items

EVIDENTIARY SYSTEM A

Computer/Processor: Sony Vaio/Celeron

Name and Address of System Owner: Corporation X, Main Office Redmond, CA 510-555-3465

Case No.: 2003040601 Date: April 4, 2003

Name of Suspect(s)/Type of Case: John Doe/Information Theft

Make and Model: PCG-R5050TLK (PCG-1362)

It is an offence to gain unauthorized access to a computer, its software or data. Do you have authorization to undertake this backup/examination?

Serial No.: 325-67545 Photographic Exhibit No.: 2003040601-3 CMOS

Date and Time: 04/06/2003, 14:30

Actual Date and Time: 04/06/2003, 14:32

EVIDENTIARY SYSTEM B

PC Computer: keyboard, mouse, monitor, speakers

Date: April 4, 2015

Name of Suspect(s)/Type of Case: John Smith/Bank Robbery

Make and Model: PCG-R5050TLK (PCG-1362)

Serial No.: 1201-92140 Quad Core Processor 12497192-4 PowerVR GPU

Actual Date and Time: 04/06/2003, 14:32

Modem Model No.: Courier 56K Modem 3453c

EVIDENTIARY SYSTEM C

Computer/Processor: ZX Spectrum 64

Name and Address of System Owner: John Smith, Main Office Redmond, CA

Fingerprint No.: 19283981 Date: April 4, 2003

Name of Suspect(s)/Type of Case: John Doe/Information Theft

Make and Model: PCG-R5050TLK (PCG-1362)

The evidence was found in the kitchen, toilet and living room. The scene was sealed, the items have been transported to the police station.

Passport No.: S12983196 Person Age: 28

Date of Birth: 12/06/1993

The player must take the test only once. After choosing the right sticker, the box with items is sealed, and the next animation appears with Agent Smith driving back to the central police station. If player chooses the wrong sticker, he/she loses points. When Agent Smith arrives at the central police station, he/she enters his/her office – the digital forensic laboratory. He/She opens the box and places the seized items on the desk in order to examine them. On the table he/she picks up a paper, before he/she starts to use computer. On the paper is the next lesson where he/she learns about digital forensic analysis.



Figure A.3: Screenshot of Agent Smith's computer lab and the box of seized equipment.

Lesson 4: Digital forensic analysis

Digital forensic analysis plays a direct role in identifying and apprehending offenders, helping investigators establish linkages between people and their online activities. The dynamic and distributed nature of networks makes it difficult to find and collect all relevant digital evidence. Data can be spread over a group of adjacent buildings, several cities, states or even countries but they are always in some storage media.

Attributing network activities to a particular individual can be challenging. For instance, logs showing that a particular Internet account was used to commit a crime do not prove that the owner of that account was responsible since someone else could have used the individual's account. When dealing with a specific computer and a known suspect, some investigative and forensic steps may be required to place the person at the keyboard and confirm that the activities on the computer were most likely those of the suspect. Catching the hacker on his/her own computer at home could be one of these.

The top-level steps used for examination and evidence collection are: preparation, data collection, data analysis, presentation of findings and incident closure. As a proof of concept, the steps consist of surveying, extracting and examining the evidence.

Task 4: The player must choose the right digital forensic analysis steps; only four steps are right steps

- Gathering information and making observations. This focuses on certain items and a preliminary review of system configuration and usage. This phase need not be limited to digital evidence, and can be augmented by interviews, witness statements and other materials or intelligence.
- Getting a lot of coffee, sitting for a long time and working on recovering the digital evidence.
- Focusing on the explanation of the observations. This step is often influenced by the knowledge and experience of a forensic practitioner.
- Reading the newspaper and articles about the Hacker's hobby and reading the Hacker's blog. It is important to create the Hacker's profile and draw conclusions about what is he thinking and the way he is thinking.
- Developing a hypothesis, examining the seized equipment and evaluating the hypothesis. Various predictions flow naturally from any hypothesis (if the hypothesis is true, then the investigator will expect to find fact X in the evidence), and it is his job as a forensic agent to determine whether such expectations are borne out by the evidence.
- Watching YouTube and tutorial videos for breaking into the government server and stealing secret information.
- Drawing conclusions and communicating findings. Once a likely explanation of events relating to a crime has been established, forensic practitioners must convey their results to decision markers

After Agent Smith has chosen the four right steps, he/she gains 8 points (each step is 2 points), and he/she is now allowed to switch on the computer and attach the found items for recovering deleted data. But when he/she goes to recover the deleted data, Agent Smith must get the information about captured data preservation. There are several locations for e-discovery of data that need to be preserved: the workstation environment, including old, current and home desktops and laptops, Personal Digital Assistants (PDAs), such as the BlackBerry® and Treo®, removable media, such as CDs, DVDs, removable USB hard drives and USB "thumb" drives, and the server environment, including files, e-mail, instant messaging, database, application and VOIP servers, as well as the backup environment, including archival and disaster recovery backups. All these six items that Agent Smith has captured at the Hacker's home must be preserved according to the legal rules. The next lesson appears on his/her computer screen in the form of instructions.

Lesson 5: Preservation and collection

The forensic investigator of the electronic data preservation and collection in formal discovery initiates and maintains a chain of custody and control of the electronic data that need to be preserved. A well-documented chain of custody process allows the data to be submitted as evidence in a court or other legal or administrative proceeding. The preserving procedure is as follows:

- *Upload all the user files extracted from the preserved data into an electronic discovery database and perform the data filtering in the database.*
- *Use forensic software or other processing tools such as X-Ways Forensic to filter the data and transform it into a reviewable format.*
- *Use a hybrid approach where the extracted data is first reduced through filtering with forensic software or other processing tools and then uploaded into an electronic discovery database for review and/or further filtering.*

Forensic examiners should understand how data are uploaded, stored and examined later. The originally captured data should stay as they are and should be protected in order to be used in the court.

The player will choose from the desk which tools Agent Smith is going to use, such as a laptop, external hard drive, USB keys, mobile phone or digital tablet. The player will have to handle the correct tools, in our case an external hard drive, and attach it to his/her laptop. Agent Smith will determine which file types are most likely to be relevant; whether processing will include attempts to identify and recover deleted files; how to handle compressed or encrypted files; what level of forensic review, if any, will be accomplished for high priority and/or to identify and recover deleted files; how to handle compressed or encrypted files; what level of forensic review, if any, will be accomplished for high priority and/or lower priority custodians; whether attempts will be made to identify and recover fragments of deleted files from unallocated space; whether personal data will be excluded from uploading into the review environment; and more.

When Agent Smith logs in to the computer a screen with the following text will appear:

Lesson 6: Forensic tools

There are many forensic tools that can be used for recovering digital data from electronic devices. In this game X-Ways Forensic is going to be used. X-Ways Forensic is a hexadecimal file, disk and RAM editor and other software for data recovery, computer forensics, IT security, browser log file analysis and secure data erasure. It is an advanced work environment for computer forensic examiners and our flagship product. Runs under Windows XP/2003/Vista/2008/7/8/8.1/2012*, 32 Bit/64 Bit, standard/PE/FE.

Task 6: The player must click on the right button and proceed.

Question: “Are you ready to proceed to find out more about X-Ways Forensic?” “Yes”, “No, I don’t want to know anything more”.

When the player hits the “No” button, the game turns him/her back again to the Hacker’s house to repeat Lesson 3. If he/she hits “Yes”, he/she enters the computer screen. On the screen appears the tutorial and a manual of X-Ways Forensic software.

Lesson 7: Introduction to how to make a legal copy of a seized hard drive. Instruction on how to call up the file with the found deleted hard drive.

When a few deleted files or folders are critical to a specific case, forensic analysts should examine them closely after the recovery and seek corroborating evidence from other areas of the computer system. Forensic tools usually capture the full contents of memory from various devices and attempt to reconstruct the data structures containing files, processes, call logs, connecting logs, images and other information. Given the variety of data structures, mistakes may be made when parsing physical memory dumps and attempting to recover deleted items. Documentation relating to this recovery process, such as an inventory of the recovered files and a description of how they were salvaged, should be saved and maintained to enable other experts to assess what was recovered if necessary. Given the variations between tools and the potential for error, it is advisable to compare the results from one tool using another. Such a comparison can be made by comparing the inventories of undeleted files from both tools for any differences.

TIPS: Compressed files are not password protected or corrupted, they can be uncompressed with relative ease. If the forensic tool does not support a particular kind of compression, then files can be exported, encompress them using a specialized utility for that purpose, and add the uncompressed files back to the case. For example, Outlook e-mail is stored on disk using a simple form of encoding. Therefore, when searching for deleted e-mail associated with a particular address, forensic analysts select the appropriate decoding mechanism. X-Ways Forensic provides this in a “code page” called “Outlook encryption” to search for such encoded e-mail addresses and text. MIME encoding adds an additional layer of encoding to e-mail attachments. An alternative approach to searching for e-mail messages is to use a tool that understands the specific file format and makes it accessible for keyword searching.

Lesson 8: Finding evidence

In this lesson the player will use X-Ways Forensic tools to recover and back up the data from an external hard drive. He/She will be directed to the Cloud Computing Training Environment – a virtual cloud-based platform that enables sharing of courses. The part where he/she will be assessed if the correct procedure is performed. If any actions are inappropriate, the error message will be displayed and the player will have to repeat the actions until the correct one is performed.

When the all data and information gathering is finished, the player will have to click on pieces of evidence, to mark which of them are relevant to the investigation and which are not, and later include them in the final report.

Lesson 9: Hypothesis/Conclusion following the examination***The Time***

The operating system was Microsoft Windows XP, Service Pack 3 (installed as SP2), December 22, 2008 at 10:10 p m. Both the Registered Owner and Registered Organization Fields contained “-”, and at the time of the forensic analysis, the assigned computer name “TEST13”. The system was configured for “Central Europe Standard

Time” which is one hour in advance of GMT. The active time bias at the time of acquisition was: +4:00 from GMT. The primary user account was “Roman”, with a Logon Count of 22 and a Last Logon of May 23, 2009. This user account was not protected by a password. Utilizing AccessData’s Password Recovery Toolkit with associated Registry.

The File

“Files (SAM/System) from the subject computer as input file log, the administrator account password was determined to be L1b3r4t0r. User’s Folders of Potential Interest Photographs of naked children taken on February 14, 2015 were found on the suspect’s system. In addition, on February 15, 2015 at 2:45 pm, the folder C:\Documents and Settings\Roman\My Documents\Garmin was created as shown in data log file

The document named Funds.ods (content of the files) was created on May 23, 2009 in the My Documents folder and requires further analysis (to be continued...).”

The player will have to go through the following text, to get ready for making the final report

Lesson 10: Conclusion provision

Forensic practitioners are regularly presented with questions that require relatively straightforward analysis of the evidence followed by confirmation of the hypothesis and conclusion. For instance, in order to determine whether incriminating files were downloaded from the Internet or copied onto the system from removable media, a forensic analyst might test the download speed of the subject system versus transfer rates of files copied from a CD, DVD or removable mass storage device. Running controlled tests with a specific set of files using a similar or exactly the same computer and network set-up may show that files were copied from a DVD in 60 seconds, from a USB device in 30 seconds and downloaded via the Internet in 0 seconds. Based on a series of such tests combined with other evidence on the system, a forensic analyst should prepare an opinion and conclusion that the incriminating files were downloaded or uploaded onto the system from the Internet and further dispatched. Look at the following examples and possible mistakes in preparing conclusions.

Lesson 11: Possible mistakes

In a child abuse case, an expert hired by the defence to examine the defendant’s computer concluded that it had been used to access the Internet during the first six hours after it was seized by the police. The expert’s report indicated that there was substantial evidence of the defendant’s computer being altered while it was in police custody, including access to Hotmail login pages and a possible child pornography site. It transpired that the defence expert had not taken the difference in time zones into account when converting the date-time stamps in the Internet Explorer index.dat files.

In another case involving time zone complications, the suspect flew from London, and accessed remote hosts on the Internet from the laptop he brought with him before he and his associate were apprehended. The suspect challenged some of the data; having conducted his own review of the data set, he believed it indicated that he was framed by the undercover agents for some of the activity on the system when in fact he simply had

failed to take into account the time zone difference. Once presented with the findings of an independent forensic analysis performed as a result of his complaint, he immediately recognized his fundamental mistake

Lesson 12: The final report

The last task the player has to do is to write a final report. He/She will use an included template and evidence that he/she recovered successfully. The player will indicate when he/she will complete the final report by clicking on “submit report to FBI agent”. The full paper report will be displayed to the player to review once more and they will have the option to go back to revise or confirm that the report and investigation have been completed.

At the end of the game, Agent Smith comes to the meeting room, where he/she presents his/her results and delivers the report to the FBI investigation team. The FBI investigation team asks Agent Smiths if the forensic report is ready to be delivered. If the player hits “No”, the game moves one step back, where a player can adjust or edit his/her final report. If the player hits “Yes”, the FBI agents will receive the player’s report. If the player has completed the investigation report correctly, the following video is presented in which the FBI agents thank Agent Smith and give him/her a chance to be promoted to a higher office and to start working for the FBI. The next video will be presented in which the Hacker goes to gaol, because he/she has been fully charged with adequate and legally presented evidence. If the player has missed items or preserved data in the final report, or the report is not completed accurately, the FBI agents will explain that the case was not put together well enough to use against the Hacker for the following reasons. And the animation will be shown of how the Hacker is freed and is released and walks to freedom.

Lesson 13: what we have learnt

We have learnt how to gather, legally collect and save, and examine digital evidence and provide conclusions about the acts that have been performed by the offender. Digital evidence helps in answering many questions in an investigation ranging from the whereabouts of a victim at a given time to the state of mind of the offender. Therefore, evidence on computers and networks should be included whenever feasible in crime reconstructions. At the same time, care must be taken when interpreting the abstracted behavioral evidence that is stored on computers and associated equipment. People use technology in creative ways that can complicate the forensic analysis process, particularly when attempts are made to conceal digital evidence.

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Publications Related to the Thesis

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Biography

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