



Supporting Human Capital development with Serious Games: An analysis of three experiences



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ABSTRACT

Serious Games (SGs) are increasingly being used in formal educational settings and it is almost universally acknowledged that they have strong potential for bringing innovation to education and for enhancing learning, this way also contributing to the development of Human Capital. This paper proposes some reflections on the usefulness and effectiveness of SGs when used in formal learning contexts. The considerations are derived from a set of SG-based educational experiences carried out in three European countries: Italy, Spain and Romania. The paper briefly summarizes the key aspects of the three research experiences and, by referring to the main lessons learnt, it also draws some general conclusions as to the potential of SGs to support the development of Human Capital both from the cognitive and from the affective/behavioural standpoint.

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1. Introduction

Game-play is a pervasive phenomenon that is affecting a multitude of aspects in our everyday lives and social activities. The question naturally arises as to whether, and to what extent, it is also transforming education and contributing to the development of Human Capital. Following Becker (1964), in this paper we refer to Human Capital as to the knowledge and skills developed through education, training, and experience. In the context of the Knowledge Society, the two concepts of Human Capital and of lifelong learning are very close each other. According to Rose (1999a,b), in fact, the lifelong learning process contributes to promote the development of the social and human capital by offering continuous learning opportunities. In the context of lifelong learning (both as to formal and informal learning), digital games are widely regarded as effective educational tools capable of providing learners with new enhanced learning opportunities (de Freitas & Oliver, 2006; Hong, Cheng, Hwang, Lee, & Chang, 2009; Pivec, 2007; Prensky, 2005; Sandford R. & Facer K., 2006). The specific term “Serious Games” (SGs) has been coined to define those games whose primary purpose is “other than entertainment” (Michael & Chen, 2006) or, more explicitly, games which can sustain learning in its different aspects (Felicia, 2009).

Moreover, the learning potential of Serious Games has been extensively investigated in recent years. Despite some contrasting voices (Hays, 2005), their educational effectiveness in relation to

specific educational objectives has been widely recognized (de Freitas, 2006; Facer, Ulicsak, & Sandford, 2007; McFarlane, Sparrowhawk, & Heald, 2002; Milovanović, Minović, Kovačević, Minović, & Starčević, 2009; Mitchell & Savill-Smith, 2004). For example, recent studies have demonstrated the efficacy of game-based approaches over traditional learning in the health/medical field (Kato, 2010; Knight et al., 2010).

SGs have also been used extensively and effectively in job skills training, in order to sustain the development of those competences, knowledge, social and personal attributes (including creativity) that are embodied in the ability to perform labour and exercise leadership, in one word SGs have also widely been used to contribute to the development of the Human Capital. The three experiences briefly described in the following of this paper, suggest that SGs used within the whole educational process from early age to adulthood can contribute to build, incrementally and complementarily, the skills that would ultimately lead to a solid human capital development. Thus, for example, reasoning problem solving and soft skills can be fostered and enhanced through different SG-based learning activities, both using teacher and student centred approaches.

With respect to logical and strategy games as well as to those for developing decision making and cultural awareness (the types of games used in the experiences presented in this paper) the following can be said:

1. Logical and strategy games, if properly used, can contribute to improve logical reasoning and problem solving abilities together with strategic thinking.

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2. The games that train decision-making and develop communication skills are virtual training environments where the decision maker can learn through experience. According to Orasanu (1993) and Flin, O'Connor, and Crichton (2008), being alert to developing situations, being sensitive to cues and aware of implications is the first stage in the cognitive process to reach a decision. Digital games offer immediate, interactive feedback, reacting “dynamically to player’s decisions” (Salen & Zimmerman, 2004) and, according to Raybourn, Deagle, Mendinin, and Heneghan (2005, p. 3) “provide the opportunity for experiential learning [...] and] an environment for active, critical learning”
3. Developing cultural awareness is a process by which we develop sensitivity to difference, simultaneously causing reflection and awareness; cultural competence means demonstrating knowledge of the other cultures and even adopts it. Affective skills are developed, active participation and communication, both verbal and non-verbal. Cultural awareness games have proved to be a more effective educational tool compared to the traditional teaching materials. Should we look at the issue from a pedagogical viewpoint, Patrick (1992) argues that “the most common and powerful method of training is to allow the trainee to perform the task and then provide some info about the correctness of his action”. According to Raybourn (2005) games open up possibilities for simultaneous learning on multiple levels as players learn from contextual information embedded in the dynamics of the game.

When asserting the effectiveness of game-based learning, many authors focus on the nature of interaction with the game environment, citing aspects like motivation, flow and immersion (de Freitas & Neumann, 2009; Garris, Ahlers, & Driskell, 2002). Nevertheless there is also a broad consensus that SGs educational potential and actual effectiveness may vary appreciably in relation to pedagogical and methodological choices made a priori by game designers and developers (Squire, 2005) and also in relation to the choices of educators while designing and carrying out game-based interventions (Bottino & Ott, 2006).

This paper considers three different game-based learning experiences that differ in terms of country of origin (Italy, Spain and Romania), working methodology and strategy employed. The aim is to draw on these varied perspectives so to foster reflection about the effectiveness of different pedagogies and learning methodologies that can be adopted to sustain the employment of SGs in formal learning contexts so to sustain the development of different aspects of Human Capital at different stages of human life.

In all the experiences presented below, connections between the game and the real world are well established, besides, they have in common the ability to adapt to the learners and offer ground for observing their attitudes, behaviour and learning potential. The three case studies take into consideration the skills needed in handling difficult emotional situations that are built, incrementally, based on a variety of games targeting different objectives. This is what actually forms the common thread of the three experiences: the games used and the studies conducted are like a brick way, building competences in a bottom-up approach. By joining three different European-settled educational contexts in a common paper, the authors also wanted to highlight the idea that the educational process is incremental and SGs can serve the scope of building knowledge and skills starting from first training in basic “transversal” skills and ending with the development of higher order thinking skills, like decision making and cultural awareness.

The work is grounded on the considerations that have emerged in the framework of the Technical Committee on Pedagogy of the

Game and Learning Alliance (GaLA) Network of Excellence (NoE) financed by the EC under FP7.

After briefly presenting the three SGs-based experiences and their associated findings, the paper examines methodological aspects underpinning game-based learning actions in more general terms.

The study can be useful for both societal levels and scientific arenas. As technologies evolve, so will society (Morgan, 1877). This change has a clear impact on human imagination. Personal knowledge will be of utmost importance (Moravec, 2008) and students will have to be able to learn, work, play and share in almost any configuration.

Moreover, as Moravec states in Rethinking Human development in knowledge societies, individuals will build knowledge experiences, leverage their potential to produce new ideas; students can apply their ideas in various organizations and are highly motivated to collaborate as natural networkers, develop habits of mind and learn continuously, by practice. Also, in focusing on HOW to learn, not on WHAT to learn, learning becomes invisible (Meyer, 2010).

In the proposed experiences, the adoption of SGs proved that the development of Human Capital can be sustained and fostered via SG-based learning experiences; this model should be extensively adopted for building up a broadminded, advanced society able to prepare our youth and other members of our society for future challenges even in the world of work. The development of skills and habits of mind can (and therefore should) be fostered through lifelong learning also by means of innovative applications; in this light SG-based learning experiences can contribute to develop mindware; they are social, experimental and continuously evolving just like our society.

2. The Italian experience

The Italian experience was carried out in a primary school over a three-year period and involved children aged from eight to eleven. The research team comprised educational technologists, psychologists from the Local Health Authority and primary school teachers from the school where the experience took place.

The main focus of the experience was to explore the potential that digital games offer to support young students’ reasoning and problem solving abilities. The project also sought to shed light on the cognitive abilities involved in the use of a selection of digital mind games and to identify the design and interface characteristics making games more or less fruitful for the targeted educational purposes.

Throughout the three years of the project, a group of around 40 children belonging to two classes of the same age level used digital mind games in computer sessions carried out during normal school hours. The student group was followed from the third grade (age 8–9) up to the fifth grade (age 10–11); it remained largely stable over that period, with only a few arrivals and withdrawals per year.

The adopted games (freeware, shareware and open source products) were mind games, namely games that require enactment of thinking and reasoning skills in a deep manner. All were mini-games (Prensky, 2001), that is “games that take less than an hour to complete”, as the experience called for game play to be completed within single class sessions; games of other types can require a substantial and prolonged time investment (Becker, 2007).

2.1. Methodology and pedagogical approach adopted

The students were divided into groups of 5 or 6, with each group taking it in turns to attend a computer session of

approximately 1 h per week in the school computer lab; each child had a computer at his/her disposal.

Different games were used by the same child for more than one session and at different difficulty levels. This multi-trial and multi-level approach made it possible to involve students in a game cycle with recurring judgment-behaviour-feedback loops, leading to better acquisition of target skills (Garris et al., 2002) (see Fig. 1 and 2).

During the work, members of the research team followed each student individually, observing and intervening when necessary. Curricular teachers were deeply involved, cooperating with the research team to: (1) conduct the learning actions, (2) assess the learning outcomes, and (3) guarantee the sustainability of the learning intervention. In this sense, we can say that the adopted pedagogical approach was strongly teacher-based.

2.2. General findings

During the experience, researchers gathered quantitative data on students' individual performance (score obtained, errors committed, etc.) and recorded each subject's perceived behaviour and general attitude while carrying out the learning tasks (attention, motivation, boredom, etc.). Data analysis (Franco, Mañas, Cangas, & Gallego, 2011) revealed a general improvement in reasoning and problem solving abilities among the students participating in the experience with respect to a control group (Bottino, Ferlino, Ott, & Tavella, 2007). A substantial correlation also emerged between the students' possession of the reasoning skills needed to play mind games and their overall school performance. This finding supports the idea that a set of specific reasoning abilities exists which has a role in both curricular and gaming activities (Bottino, Ott, & Tavella 2012). In addition, findings revealed that the vast majority of students were basically very attentive and engaged in game-based learning tasks; this held true irrespective of school achievement level, although low achievers were more reliant on teachers' help to complete some activities.

These findings appear to confirm the view gained from similar experiences that early interventions in the field of reasoning abilities carried out by means of engaging game-based activities can positively affect students' school achievement.

3. The Spanish experience

The Spanish experience focused on the design and preparation of a SG derived from an initial face-to-face learning activity destined for adults studying business management as a part of their postgraduate executive education. Initially called the eFinance Game, it was later retitled MetaVals.

Essentially, participants in ESADE's business courses need to build their finance knowledge in order to advance in their professional careers. In parallel, ESADE's programs address some key transversal competencies in the school's different courses to improve general abilities, such as communication skills, leadership and decision-making. As part of these activities, learners have the

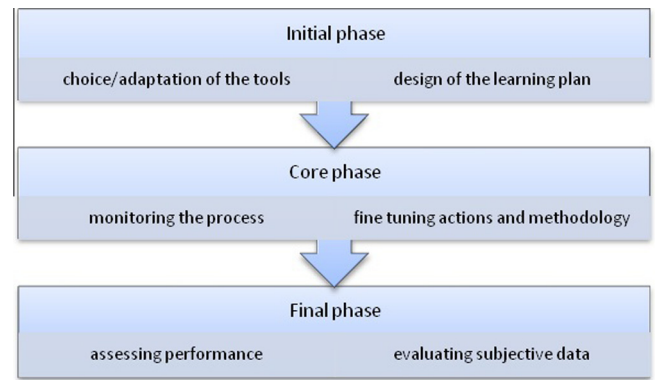


Fig. 2. Phases of game-based learning processes requiring specific attention.

opportunity to play the MetaVals (Padrós, Romero, & Usart, 2011; Romero, Usart, & Almirall, 2011).

3.1. Methodology and pedagogical approach adopted

The participants were enrolled postgraduate Executive Education (ExEd) general management course in the master's programme entitled *Master Corporativo en Dirección y Gestión de Empresas* (MCDGE). During the MetaVals game activity the participants were divided in 9 dyads ($n = 18$ students) with an average age of 37.12 years ($sd = 2.56$).

The experience highlighted the critical role of the teacher in supervising the transition from the original face-to-face activity and in ensuring that the resulting digital game would be educationally effective for all participants. To this end, an iterative design process was implemented with several stages; the aim of this approach was to scaffold adoption of the innovation in the classroom and also to support student performance during gameplay.

3.2. General findings

MetaVals includes individual and collaborative phases in which players classify the items appearing on the screen as assets or liabilities in the balance sheet. The added value of the collaborative activity is the interdependency created within the teammates playing together and the capturing of the level of certainty during individual and collective decision making. In the MetaVals game, the level of certainty is captured when learners classify their answers by placing a mark expressing the associated level of certainty. Kiili (2010) considers the representation of a certainty as a game design pattern that "can be used to point out the certainty of knowledge. Certainty is based on the beliefs of the character and it is not determined based on facts". The impact of the certainty level on outcomes during the MetaVals game has been analyzed to ascertain its influence in collaborative game performance.

The MetaVals game has been designed to allow the participants' to declare their level of certainty. Next to each item of the individual and collaborative phases of the MetaVals game, the



Fig. 1. Aspects of school experiments.

participants are invited to declare their level of certainty using a 10-points scale from 0 (total uncertainty in the decision made) to 10 (total certainty in the decision made).

During the reported experience, quantitative data were collected on each student's individual performance and on collective performance in the MetaVals game. The results show better performances in the context of collaborative decision making when the participants use the level of certainty feature of the MetaVals game (Usart, Romero, & Almirall, 2011). In addition to the learning performance in the MetaVals game, the participants were invited to answer the Spanish version of the Technology Acceptance Model (TAM) designed by Davis (1989). The TAM survey consists of 14 items or statements, each one has to be graded in a 7 point Likert scale and participants could fill it after the MetaVals gaming experience in order to measure the level of perceived ease of use and usability of the game. The TAM results shows a high score in the perceived ease-to-use ($m = 5.76$; $sd = 0.77$) and the perceived usefulness ($m = 5.22$; $sd = 0.78$) of the participants' experience of using the game MetaVals.

4. The Romanian experience

The Romanian experience involved adult learners in the defence field, specifically officers and enlisted military personnel destined to participate in military operations in Afghanistan. It was carried out using a Cultural Awareness SG integrated into a Learning Management System (LMS) for pre-deployment training on cultural concepts and for fostering affective skills. The experience was carried over a period of three years by the Advanced Distributed Learning Department at the Romanian Defence University and involved 100 students. A learner-centred approach was applied to address the development of cognitive and affective skills. The goals of this experience were to better grasp aspects of the instructor's role in orchestrating adult training and to investigate how games can be used to reinforce special skills prior to in-theatre deployment of personnel. A further aim was understanding how to maximize the learning potential of embedding games in an LMS; although not yet SCORM compliant, the game is integrated in the ILIAS LMS platform and so instructors can track learning progress and evaluate knowledge acquisition. In terms of content, the game provides operational cultural knowledge and language familiarity as players work through specific vignettes that support content retention.

4.1. Methodology and pedagogical approach adopted

The game is designed as a self-paced learning module within a global course and follows an introductory theoretical phase. It can be seen as an application phase that enhances retention, and is combined with assessment of the knowledge already gained on cultural awareness. Upon enrolling in the course, participants are aware of the goals they want to attain and therefore appreciate an educational program that is organized, has clearly defined elements and embeds real-life elements.

Students take this game as experiential learning as well as free practice stages within a pre-deployment training for various tasks unfolded in Afghanistan in-theatre operations. Being a case of ubiquitous learning, students have the freedom to choose when to use it. Time limits have been imposed yet as mandatory-base course completion rule. Being more of a third person approach type of game, the Afghanistan cultural awareness game encourages inquiry-based techniques, collaboration and cooperation, as well as reinforces interpersonal skills by exposure to a culturally-embedded type of social interaction.

Being part of a self-paced course, trainees can choose their own deadlines. Integration in the LMS allows instructors to track progress and evaluate knowledge acquisition. Of the 100 students who completed the course by connecting to the LMS from camp, about 10 downloaded it as a self-paced package.

Game design was informed by learning principles derived from Knowles (1980). Adults learn in an autonomous and self-directed manner. Self-judgment and self-reaction (Zimmerman, 1990) allow them to reflect on their progress and adjust their actions appropriately to maximize performance. This aspect was integrated in the game design by permitting players to choose from various situations with different conflict metrics. They assumed responsibility for their own choices and their actions were correlated to instant gratification; the conflict state indicator offered a sense of reality, heightening immersion. Path branching based on multiple-choice situations was another way of supporting transfer. For example "misconduct" leads to life-threatening consequences.

4.2. General findings

In the Romanian experience, insight into pedagogical aspects was derived from Knowles' vision, while from the technological viewpoint LMS integration suggested ways of later breaking down the game into smaller scenarios processed as individual SCORM packages for greater interoperability with the LMS.

Although the game is oriented towards self-driven and self-regulated learning, interaction with tutors is fundamental. The tutors set the main educational objectives in accordance with learners'

Table 1

The Italian experience at a glance.

Characteristics	Italian experience
Learning objective	Fostering reasoning abilities
Target population	40 Primary school students
Tools adopted	Mind games
Experience setting	School
Experience duration	Three years
Pedagogical approach adopted	Teacher-based

Table 2

The Spanish experience at a glance.

Characteristics	Spanish experience
Learning objective	Improving collaborative decision-making and finance knowledge
Target population	18 Learners in executive business courses
Tools adopted	MetaVals Serious Game
Experience setting	Business school
Experience duration	One year
Pedagogical approach adopted	Student-based

Table 3

The Romanian experience at a glance.

Characteristics	Romanian experience
Learning objective	Develop cultural awareness and improve affective skills
Target population	100 military and civilian adult learners to be deployed in Afghanistan for various tasks
Tools adopted	Cultural awareness game, LMS
Experience setting	Public military university
Experience duration	Three years
Pedagogical approach adopted	Self-regulated learning

Table 4

Overview of the three reported experiences.

	Italy	Spain	Romania
Conducted by...	ITD–CNR: public research body	ESADE: private university in management and law	Carol I NDU: state university in defense and govt.
Educational objectives	Enhance reasoning skills	Improve collaboration, decision making and finance knowledge	Develop cultural awareness & improve affective skills
Target population	Primary school students	Adult learners	Adult learners in the defense field
Educational approach	Teacher-driven	Collaborative	Self-regulated learning

interests (mission in theatres) and guide them by providing additional study material as well as assisting them before and during the game.

Tutors can monitor players' individual progress as they work their way through self-selected sequences of situations presenting escalated/decreased states of conflict, with the possibility to access additional support information. On this basis, tutors tailor post-game activities in case signals of high conflict emerge, and provide additional input where required. A second assessment is then performed to verify improvement.

Another finding of the Romanian experience was that even though the game was designed for single-player mode, collaborative activities can be created by means of forums and survival case scenarios overseen by tutors.

All in all, the Romanian experience highlighted the importance of the tutor in guiding the SG-based learning experience even though tailored for self-regulated learning. Besides, SG-based learning scenarios enhance better knowledge transfer for both cognitive and metacognitive skills, via experiential learning.

5. Conclusive remarks

All the three reported experiences were aimed at exploiting the educational potential of SGs and at verifying their impact on learning. As summarized in Table 1, they actually differed greatly in nature since they: (1) were carried out in different educational contexts by institutions with different missions; (2) had different educational objectives; (3) addressed different target populations; (4) adopted different pedagogical approaches; and, of course, (5) employed different gaming environments.

Despite such significant intrinsic differences, the results obtained show that all three experiences offer interesting stimuli for re-thinking today's education in the light of the Knowledge Society's new requirements and constraints. But if we look at them globally, what overall gist do we get? What are the main lessons to be learnt? What acts as the glue that holds all three together?

If we take the viewpoint of the overall learning process, and subdivide it into three main phases (initial – design of learning actions; core – enactment of the educational experience; final – assessment of results) we see that all three experiences provide some general indications (see Tables 2–4).

The first is precise and thorough design and planning of SG-based activities, including selection of appropriate tools. The Italian experience revealed the importance of carefully planning the activity sequence with respect to chosen tools, and the need for prior definition of the role and tasks of teachers. The Spanish experience emphasized the need to put in place appropriate scaffolding to support adoption of games-based innovation in the classroom. The Romanian experience highlighted the importance of selected activities and careful consideration of the stages in training at which games are adopted.

The second phase regards accurate monitoring of learning processes together with fine tuning whenever necessary. Monitoring of student performance in the Italian experience led to on-going adaption of game levels and difficulty in response to personal constraints. In the Spanish experience monitoring was essential for

gaining understanding of collaborative dynamics in game play. The Romanian experience differed with regard to this phase as game play was self-regulated. Consequently, monitoring was part of learners' self-observation, self-judgment and self-reaction; nonetheless LMS embedding allowed tutors to monitor progress and knowledge acquisition.

The third phase involves assuming different perspectives, where appropriate, to evaluate learning outcomes from SG-based activities (Busquets & Gómez, 2011). The Italian experience considered both objective and subjective data related to performance and attitude/behavior. The Spanish experience entailed analysis of student performance both individually and collectively, so as to investigate the nature of the collaborative dimension. Similarly, the Romanian experience allowed for both cognitive and affective skills to be evaluated by means of different approaches.

Irrespective of the variables in the three presented experiences, they all connect significantly in the sense that they all build both on cognitive and affective skills, seen as intangible assets of human capital. By paying attention to building a win-win mentality via using SG in learning we stressed importance of student-tailored activities so as to evidence the SGs development of knowledge, collaboration, creativity and leadership, social responsibility and failure-free attitude (Carida & Vaggelis, 2012). By displaying the proven possibility of using Serious Games to train and educate at all levels (from K-12 to higher education and even Post-Graduate levels) the authors of this paper intend to highlight the impact Serious Games can have in the education sector. This should also be regarded as a major component of well-being, given the fact that any investment in education is actually an investment in Human Capital, whose results can later be seen in a country's economic development. Additionally, by sharing and over-lapping experiences from a three different yet similar European experiments, the authors of this paper utterly commit themselves to further developing and improving a knowledge network to support the Knowledge-based society we are currently living in, by more joint collaborative activities of the kind (Bakry & Al-Ghamdi, 2011). Our collaboration – one of the Human Capital assets–comes as a smooth continuation to the collaboration we build in our students along with the desire to learn better and know more, to think more creatively and thus lead a better world.

As part of their continuing joint collaboration in the area of games-based learning and Serious Games, the authors intend to build on this foundation and to carry out a meta-analysis of the above results as a means for fine tuning on further activities in the field.

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