Systèmes d'Information et Management

Volume 19
Issue 3 *Special Issue on Serious Games*

Article 2

2014

Characterizing the Serious Game and Assessing Learning Goals

Imed Boughzala
Telecom Paris Sud, France, imed.boughzala@it-sudparis.eu

Characterizing the Serious Game and Assessing Learning Goals

Imed BOUGHZALA

Telecom École de Management, Institut Mines-Telecom

ABSTRACT

Serious Games (SGs) are video or computer games designed for training or educational purposes. Thanks to the wide variety of opportunities they provide, e.g. interactivity, immersion, simulation, etc., they have become universally embraced in both academic and non-academic fields alike. However, the selection of the most suitable SG with regard to a given learning goal seems to be less well addressed in the literature. This paper tries to bridge this research gap by building a new Characterizing and Assessing Serious Games Grid (CASGG). The research was based on a design science method. The CASGG was built during a series of meetings (i.e. working group with professionals (education experts), brainstorming with students and teachers) and pilot tests with students. Subsequently, it was tested in the higher education field with 41 graduate students to assess their learning performance according to leaning goals using a specific SG. The tested SG was StarBank the Game and the learning goal was to understand the principal mechanisms of banking. The findings revealed no difference in terms of learning performance between students who have used the SG and those who have followed the theoretical course. With reference to learning satisfaction, the first category of students expressed much more enthusiasm and motivation for learning. Using the SG was for them more enjoyable and engaging. The game play succeeded in capturing their attention, challenging their curiosity and enhancing their interest in the theoretical knowledge. Moreover, owing to this research the design science approach proved most suitable for the building and application of the CASGG by demonstrating its practical feasibility and use. Regarding the context of SGs, the CASGG is actually not only an empirical elaboration of an SG assessment instrument, but also a starting point for further research in this area.

Keywords: Serious game, Assessment grid, Learning goal, Learning outcomes, Effectiveness, Performance, Satisfaction, Design science, Higher education.

RÉSUMÉ

Les jeux sérieux (i.e. Serious Game *(SG)) sont des jeux vidéo ou informatiques conçus à des fins éducatives ou de formation. Grace à la multitude d'avantages qu'ils offrent, à savoir, l'interactivité, l'immersion, la simulation, etc., ils sont devenus universellement reconnus à la fois dans le monde académique et le monde professionnel. Cependant, le choix du SG le plus approprié à un apprentissage donné, semble être insufissament traité dans la littérature. Cet article tente de combler cette lacune de recherche en proposant une nouvelle grille de caractérisation et d'évaluation des jeux sérieux (i.e.* Characterizing and Assessing Serious Games Grid *(CASGG)). La présente recherche s'est appuyée sur une méthode de type science de conception (i.e.* design science*). La CASGG a été construite au cours d'une série de réunions (groupes de travail avec des professionnels (experts de l'éducation), de* brainstorming *avec les étudiants et les enseignants) et des tests pilotes avec des étudiants. Par la suite, elle a été testée dans le domaine de l'enseignement supérieur auprès de 41 étudiants au niveau Master afin d'évaluer leur performance d'apprentissage par rapport à des buts d'apprentissage en utilisant un SG spécifique. Le SG testé était* Starbank The Game *et le but d'apprentissage était de comprendre les principaux mécanismes bancaires. Les résultats ont révélé qu'il n'y a pas de différence en termes de performance entre les élèves qui ont utilisé le SG et ceux qui ont suivi seulement le cours théorique. En référence à la satisfaction d'apprendre, la première catégorie d'étudiants a exprimé beaucoup plus d'enthousiasme et de motivation pour l'apprentissage. L'utilisation du SG était, pour eux, plus agréable et engageante. Le jeu a réussi à capturer leur attention, à challenger leur curiosité et accroître leur intérêt pour la connaissance théorique. En outre, grâce à cette recherché, l'approche science de la conception a fait preuve de son adéquation pour la construction et l'application de la CASGG en démontrant sa faisabilité et son utilisation en pratique. Dans le contexte des jeux sérieux, la CASGG est non seulement une élaboration empirique d'un instrument d'évaluation de SG, mais aussi un point de départ pour des recherches plus poussées dans ce domaine.*

Mots clés : Serious game, Jeux sérieux, Grille d'évaluation, Objectif d'apprentissage, Résultats d'apprentissage, Efficacité, Performance, Satisfaction, Science de la conception, Enseignement supérieur.

INTRODUCTION

According to the Elaboration Likelihood Model (ELM) of persuasion proposed by Petty and Cacioppo (1984), a game can be seen as a playful approach to improve the motivation and perceived ability of individuals to process information cognitively. A few years later, this untapped aspect has created a new class of games called Serious Games (SGs). SGs are used as means of meeting learning goals such as training, simulation, education, promotion, communication, etc. They are adopted in the Environments for Human Learning (EHL) by combining machine-mediated learning, simulation, use of emotions and professionalism. Thanks to their approach combining seriousness and fun, the motivation and perceived ability of individuals to process complex information or to repeat behaviors have been improved (Kebritchi et al., 2010). Indeed, companies, such as IBM, BNP Paribas, Renault, have moved to SGs for executive training in order to promote behavioral and inter-relational dimensions, not only for technical skills but also for soft skills. Several institutional studies such as Scientists (2005) and Tomorrow (2008) confirm the idea that these SGs endow players with valuable skills for their curriculum which are transferable in the business world.

In addition to considering the transformation of pedagogy, the speed of technology development, the Net generation's intensive use of high-tech, and the momentum of active learning (Prince, 2004), the use of SGs in higher education is taken on board. In the drive to be in line with new learning methods and techniques used in secondary schools, SGs meet their specific requirements. SGs are also welcome in the preparation of entering the world of business in all its aspects.

In recent years, the field of SGs has grown exponentially and has been the object of numerous research studies (Prensky, 2001a; Zyda, 2005; Alvarez, 2007; Michel et al., 2010). There has been an increasing interest in how SGs can be used to support serious objectives such as learning, training, collaborating, and teaching in formal EHLs. Several researchers have argued that SGs, including simulations and virtual worlds, have the potential to be important teaching tools because they are interactive, engaging, and immersive (Gee, 2007). Companies are attracted by these kinds of games because they are practical and well-accepted among employees, especially those of the young generation. However, according to the best of our knowledge, a very little research has been focused on their assessment (Michel et al., 2010; Boughzala et al., 2013). The assessment of their effectiveness and efficiency, according to common criteria, would allow comparing them and establishing their legitimacy with regard to other teaching or training methods. The lack of reliable, reproducible and adaptable methods for assessing SGs constitutes a research gap related to a real business need expressed by professionals and academics. Indeed, the increasing development of SGs in several sectors poses the problem of their characterization and assessment in order to facilitate their selection and adoption according to a given learning goal. Some researchers have suggested methods

Published by AIS Electronic Library (AISeL), 2014

for characterizing and assessing them, but they are offering a limited view, specific to one domain or descriptive and non-reproducible. In sum, SG assessment is a research stream that remains largely unexplored especially when targeting higher education.

This paper tries to bridge this research gap and answers "partially" the following questions of our research program:

- How to build a reproducible grid to characterize, classify and/or assess SGs?
- How to determine which SG is more suitable for a given learning goal?

The idea of building such a grid came initially with the goal of fulfilling a business need expressed by the CCMP (Centrale de Cas et Médias Pédagogiques i.e. Cases and Pedagogical Media collection publishing) of the Chamber of Commerce and Industry (CCI) of Paris. The CCMP wanted to position itself as a reference in this field by creating a quality label for SGs' editors/providers and a guarantee for future acquirers (the academic sector in particular) by guiding them to make the best choice.

To meet this business need, we have followed the design science approach in order to build a grid for characterizing and/or assessing SGs, called CASGG. This grid was built and pilot-tested with students with the assistance of professionals and teachers. This paper reports on the building process of CASGG and its applications with students at different stages and with different purposes. The paper reports also on a field application performed with 41 graduate students to assess their learning performance according to one given leaning goal using a specific SG. The tested SG was StarBank the Game and the learning goal was to understand the principal mechanisms of banking. The purpose of the research is to determine whether using this SG, in addition to the theoretical banking activities course provided to students, would enhance their learning performance and satisfaction in accordance with the learning content. To do that, we have compared two situations with two groups of students: those who have used the SG and others who have not.

The remainder of the paper is organized as follows. In section 2, we present the literature review related to SGs area: definitions, some related learning theories, and assessment. In section 3, we introduce the method adopted in this research to build the CASGG artifacts. Section 4 describes the CASGG artifacts and details their building process. In section 5, we present a field application of the CASGG in higher education and discuss its findings. In section 6, we introduce the research evaluation following the seven guidelines of Hevner et al.'s (2004) design evaluation framework. The conclusion discusses contributions, limitations and future research directions.

BACKGROUND AND RELATED WORKS

I.1. Serious games

The term "Serious Games" is an oxymoron invented by Clark Abt (1970) for

over 45 years ago. He wrote a book called "Serious Games" in which he examined war-games and simulations to train students, teachers, and managers in educational-curriculum development, school-system planning, industrial management and technological planning and forecasting (Ulicsak, 2010).

According to the Oxford English dictionary, a **serious** thing is what requires thought, concentration, or application, as opposed to what is entertaining or distracting. Furthermore, the word **game** is defined as physical or mental activity, not imposed, not targeting any utilitarian purpose, and in which you devote yourself to have fun and gratification. Thus, a game is an activity providing entertainment or amusement. Combining these two antagonist words "Serious" and "Game" one obtains a strong concept (**Serious Game**) related to a new class of games.

There are several SG definitions in the literature. SGs are a kind of *"computer games designed for training or educational purposes"* (Kebritchi et al., 2010, p.427). SGs are games *"in which education (in its various forms) is the primary goal, rather than entertainment"* (Michael and Chen, 2006, p. 17) to deliver engaging interactive media to support learning in its broadest sense. Alvarez (2007, p. 25) defines SGs as "*computer applications having as original intention to combine both serious aspects* […], *with fun aspects from video games. Such an association is achieved by providing a learning scenario corresponding, from a programming point of view, to implement a decor (sound and graphics), story and suitable rules; therefore it moves away from restricting the game to entertainment*."

The main goal is to operate the entertaining aspect of video games to facilitate the learning of serious concepts which are traditionally taught with conventional teaching or training methods. The range of usage areas of SGs is very wide such as scientific exploration, military, medicine or education. More precisely, the educational aspect of SGs is one of their greatest assets since they are promoting and opening new horizons for active learning (Prince, 2004). They have a set of potential benefits such as improved self-monitoring, problem recognition and solving, decision-making, better short- and long-term memory, and increased social skills such as collaboration, negotiation, and shared decision-making (Rieber, 1996; Mitchell and Savill-Smith, 2004; Ellis et al., 2006). Peterson and Herrington (2008) show that SGs help children to acquire skills and abilities such as: strategy, logic, psychomotor coordination, concentration, motivation, organization, memory, creativity, exploration, communication, group work, etc.

Not only secondary schools and universities are attracted by the opportunities provided by SGs, but also companies even before. Indeed, SGs are becoming very common in companies all over the world such as IBM, INTEL, BNP Paribas, Michelin, Renault, etc. They are developed for different purposes. Alvarez (2007) suggested classifying them as follow: Advergames (games for advertisement), Edugames (educational games), Exergames (games providing exercises), Data-

games (games based on data banks), Military games, Green games (games focusing on ecology), Newsgames (informative games), Edumarket games (games combining educational or informational messages with marketing), etc. In this research, we are much focusing on the Edugames.

I.2. Learning theories and serious games

To understand the factors of effective learning and study learning specificities, several theories and models were developed. Indeed, the researcher can refer to them to explain the factors that enable or inhibit the effectiveness and efficiency of learning and adoption of learning technology. One could cite, among others, the experiential learning theory (Kolb, 1984), social cognitive theory (Bandura 1986), self-determination theory (Deci and Ryan, 1985; Ryan and Deci 2000), flow theory (Koufaris, 2002), learning style models (e.g. Felder and Silverman, 1996), technology adoption models (Davis, 1989; Venkatesh et al., 2003), expectation-confirmation theory (Bhattacherjee, 2001), etc.

In order to identify common criteria that could be useful to characterize and evaluate SGs, we investigated some of these above theories and models and tried to understand the principal factors for an effective learning.

Indeed, according to the flow theory, people participate in activities because of their rewarding outcomes. Enjoyment is one of the potential outcomes. Flow is described as a state of intense pleasure that comes from doing something enjoyable (Agarwal and Karahanna, 2000; Csikszentmihalyi, 1990). Typically, people participate in these playful activities because of the pleasure they derive from it, and not for the external rewards that result from them. Csikszentmihalyi (1975) originally described six elements of the flow experience. These elements are merging of action and awareness, centering of attention, loss of ego, control of action and environment, demands for action and clear feedback, and autotelic nature of flow. Individuals that experience flow while participating in an activity are more likely to experience satisfaction with the activity (Choi et al., 2007), and they are more likely to repeat the same activity (Koufaris, 2002).

Otherwise, with regard to the self-determination theory, individuals experience an intrinsic motivation to do something only when they find the activity inherently enjoyable (funny), interesting, or attractive for some reason – which could be called also hedonic (vs. utilitarian) motivation in the consumer behavior literature (Hirschman and Holbrook 1982). Besides, extrinsic motivation means that individuals are performing the activity because this will yield to rewards or benefits. Three relevant needs of the learner are studied in this theory (Ryan and Deci 2000): competence evolving (learner needs to feel improvement); relatedness (learners need to interact, to be connected to, and experience caring for others); autonomy (is the universal need to be relevant for the project and act in a harmony with one's integrated self). According to this theory, if these needs are satisfied, people

will be motivated and evolve optimally.

Moreover, the social cognitive theory is based on the assumption that people learn by imitating and using their individual cognitive capabilities. They can learn when seeing others behaving in a certain way. People can expand their knowledge and apprehend new skills. According to Bandura (1986), three aspects are highlighted in this theory: the development of people's cognitive social and behavioral competences; the cultivation of people beliefs in their capabilities, so they will use their talents effectively; and the enhancement of people's motivation through goal systems.

In the SGs literature, from one side according to Prensky (2001b) and Gee (2007), the pleasure and richness of experiences in the game will increase the learner interest in the topic. Thus, SGs sublimate learning by making a learner interested in a subject that may not interest him/her from the beginning. More generally, literature distinguishes interest in a topic into two categories: topic based interest and situational interest (Flowerday et al., 2004). Topic based interest (or topical interest) is one that is developed over a long period of time. It is content based and stable (Schiefele, 1999). Topical interest is developed through personal experiences and emotions that give it a cognitive/affective quality that individuals carry with them wherever they go (Alexander and Jetton, 2000; Schiefele, 1999; Tobias, 1994). In contrast, situational interest is more transient in nature. It is short-lived, context dependent, and environmentally activated (Krapp et al., 1992; Schraw and Lehman, 2001). This type of interest is based mostly on the novelty of the topic, curiosity, and the salience of the informational content (Wade, 1992). Situational interest may be a good way to "catch" the attention while topical interest may serve to hold the attention over a long period of time (Hidi and Baird, 1986; Flowerday et al., 2004; Mitchell, 1993).

From another side, according to Rooney (2007) one of SG' challenges is to find the right synergy between pedagogy and learner (user) engagement. Indeed, strongly favoring pedagogy at the expense of engagement risks to make learner lose the interest in the game. Conversely favoring engagement at the expense of pedagogy risks to make SG lose their original utility. General engagement can be broadly classified into two categories: emotional engagement and cognitive engagement (Kintsch, 1980). Emotional engagement occurs when the information that is provided evokes a strong affective response in the reader (Schraw and Lehman, 2001). These emotions may be positive like elation, or negative like disgust or anger. Emotional engagement can be stimulated by addressing important life themes like death, livelihood, and personal struggles. Cognitive engagement occurs when individuals engage in events that are outside their deep emotional range. They are ordinary events that may capture their attention because of the contents or novelty of the text (Wade, 1992).

Thanks to their interactivity and pedagogy, SGs provide a "learning by doing" experience to players rather than listening or reading, as a way to apprehend new skills. To achieve such

serious goals, SGs need to be engaging and following a pedagogy (Ulicsak, 2010) targeting a set of learning goals. The experiential learning theory (Kolb, 1984) explains the learning by doing experience and the role of learning goals in the serious gaming. This theory is studying the cycle of learning by doing experience. Kolb (1984) has proposed four main steps in this kind of learning, respectively:

- **Concrete experience:** it starts with doing something in which the individual, team or organization are assigned a task. According to this author, the key of learning is the active involvement in the experience. We cannot learn by the simple act of reading or watching.
- **Reflective observation:** at this step, one takes time-out from the experience of doing something and steps back in the aim to review what has been done.
- **Abstract conceptualization:** the learners capitalize what they have learnt by comparing their new state of knowledge with their starting point.
- **Active experimentation:** once the learner integrates the new knowledge and puts it into practice in the appropriate context.

With regard to the assessment of SGs as a learning technology, one can refer, as suggested by Michel et al. (2010), to the Kirkpatrick's (1994) four-level evaluation model. This model proposes to assess the contribution of a learning device or training program according to four levels:

- **Level 1: Reaction** (i.e. learning satisfaction) – How well did the learners like the learning process?
- **Level 2: Learning** (i.e. learning performance or knowledge acquisition) – What did they learn? (The extent to which the learners gain knowledge and skills)
- **Level 3: Behavior** (i.e. individual capabilities) - What changes in job performance resulted from the learning process? (Capability to perform the newly learned skills while on the job/ situation)
- **Level 4: Results** (i.e. organizational outcomes) - What are the tangible results (for the organization) of the learning process in terms of reduced cost, improved quality, increased production, efficiency, etc?

Moving from level 2 to level 3 was called the **knowing-doing gap** (Pfeffer and Sutton, 2000). Later, another level related to the Return on Investment (ROI) was suggested to be added to this model by Philips (2003).

I.3. Serious Games assessment

Before proposing a new grid for characterizing and assessing SGs, a literature review on the SGs' assessment was done. Two main grids for assessing SGs have been identified. The first one is G/P/S proposed by Djaouti and Jessel (2011). This grid allows assessing "approximately" the gameplay of SGs with gain comparing to SGs without gain. Moreover, it allows characterizing the serious goal of the SG (passing a serious message, training, advertisement, etc) and to define the

targeted sector by the game (military, health, public, etc). Thus, this grid gives a classification scheme that could not be considered as an assessment tool. Likewise, only three aspects have been taken into account namely the gameplay, goal and targeted sector. Indeed, this grid did not provide any qualitative information about the easiness of use, appropriateness or effectiveness of an SG. Finally, the number of evaluated criteria related to these aspects is restrictive (only six criteria).

Second, Peterson (2008) has proposed a grid allowing the assessment of several aspects of SGs for young children such as curiosity exploitation, mastery of the game, challenge, social, pedagogy, technology, etc. This grid is the most complete one we found in the literature. Nevertheless, it refers to SGs targeting the children sector only. Therewith, the value scale used by this grid is binary (Boolean). Indeed, every aspect of an SG is divided into several criteria that the game could fulfill or not. Besides, this grid does not provide qualitative aspects which are necessary to achieve a complete assessment of an SG.

This grid is dedicated to educational SGs only; it does not focus on other sectors. This grid does not determine any description of technological aspects (e.g. accessories, display device, programming, etc.). No information is provided on the game execution. Additionally, the grid does not focus on learners/users' appreciation/perception which could be useful for new users of the game. Finally, this grid has a high number of assessment criteria (44).

Name	G/P/S Grid	Peterson Grid	CASGG
Reference	Djaouti et al. (2011)	Peterson, (2008)	Current paper
Grid goal	Classification	Assessment	Characterization, classification and Assessment
Nomber of criteria	6	44	Library
Value scale	Graduated and binary	Binary	Graduated
Evaluated aspects	Objective	Objective	Objective and subjective (qualitative)
Sector	Any sector	Education	Any sector
Audience targeted by the SG	– Public – Professionals – Students	– Children – Children with special needs	– Public – Professionals (public and private corporation) – Professional in higher education – Students (initial and executive education)

Table 1 : Comparison between assessment grids

Published by AIS Electronic Library (AISeL), 2014

This suggests once again the interest in investigating our research gap, namely the building of a grid for characterizing/classifying/assessing an SG with regard to a learning goal whatever the sector. This grid should be reusable and as precise as possible to cover all useful aspects for a complete assessment. This grid should take into account different criteria omitted by the previous grids and especially to allow qualitative evaluation using a graduated measurement scale.

RESEARCH METHOD

The present research is a Design Science research. If the behavioral science seeks to explain and predict phenomena that are related to organization's business needs through the development and justification of theories (i.e. applicable knowledge), the design science tries to meet the identified business needs through the building and evaluation of artifacts (Hevner et l., 2004).

March and Smith (1995) identify two processes and four design artifacts produced by the design science research. Processes are building and evaluation; and the four artifacts are the constructs, model, method and instantiation. First, we build the grid (i.e. CASGG) and then, we evaluate it. This evaluation will generate a lot of feedback and will provide information on the match of the built grid (set of artifacts) to the requirements of the business need. The evaluation of the CASGG artifacts presented in the next sections is conducted with students from a business school (ref. below as BS) and an engineering school (ref. below as ES) hosted on the same campus in France. Furthermore, this research is validated later according to the seven guidelines of Hevner et al.'s (2004, p.86) design evaluation framework.

The four artifacts related to the CASGG are represented as follows:

1. The **CASGG structure** (constructs) that describes the SG characteristics (areas of concerns or sections (cards)) and their related items (criteria);
2. The **CASGG questionnaire** (model) that includes questions, levels of rating and mathematical equations for analysis;
3. The **CASGG application process** (method) that (a) defines the steps and provides guidance on how to run the CASGG questionnaire in the field, and (b) supports the development of recommendations;
4. The **CASGG tool** (instantiation) which is a customized MS Excel application that represents the implementation of the above artifacts, and enables the execution of a concrete assessment by allowing the collection and analysis of the questionnaire data (quantitative/qualitative). It provides different presentations of results (e.g. forms, statistics, individual and collective spider diagrams, and comparison curves) and subsequent reports.

The building and application of the CASGG can be summarized as follows. Firstly, based on the literature, we have identified the main previous re-

search in the area of SGs, learning theories and assessment methods. Secondly, to maximize the proposed grid's relevance and practical applicability, different profiles (professionals, students and teachers) were involved from the early stages in the building of CASGG artifacts and applications (see section 4.3). Third, the grid was field-tested with students to validate the artifacts (see section 5). Further field studies should be continued to enhance the quality of the CASGG artifacts, still under validation. For the moment, the CASGG tool is at the refinement stage. It should be in the next future further enhanced to better analyze quantitative data and generate reports.

THE CASGG

II.1. Description and structure

The CASGG aims to holistically characterize and/or assess a given SG. This grid supports from one side the characterization and classification of SGs, and from another side, the development of recommendations in the form of an action plan to optimize and streamline its usage for a specific learning goal regarding particular conditions. Its applicability is not limited to a particular sector even if the initial business need was expressed for higher education. The grid can be used for different learning settings and sectors.

The last version of the CASGG is divided into three sections. A first section, called the **identity card,** which gives a brief identification of the SG. A second section, called the **descriptive card,** contains the set of criteria allowing the characterization of the SG. Finally, a third section called the **assessment card**, provides more "subjective" details through a set of qualitative criteria of the SG according to each one's perception (some related to the SG itself and others to its usage).

For each section (card), a number of items (criteria) were defined (see Table 2). For the identity card, items were entered by the user in a textual or numerical format. For the descriptive card, items are multi-valuated lists. For the assessment card, each item is evaluated on a 4-level scale, with =4' representing the best and =1' the worst. The overall rating is evaluated on a 10-level scale, with =10' being the highest and =1' the lowest.

The following table gives a synthetic view of the CASGG:

For the assessment card, to support the respondents, the levels of each item are described briefly with examples wherever possible. When a respondent cannot answer, no score is recorded.

In essence, the CASGG is structured as a library of criteria. Sometimes, not all criteria are always relevant. So, the evaluators can decide which item fits better with a particular context. They can also decide to expand the set of items. Also, for some contexts certain criteria may be more important than other. In such situations, it is possible to assign different weights to the criteria.

II.2. The CASGG application process

The retained CASGG process, after pilot testing, defines five main stages

Published by AIS Electronic Library (AISeL), 2014

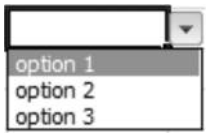
Identity card (entered by the user)	**Example**
Name: Owner: Web link: Cost: Editor: Edition date: …	***StarBank the Game*** BNP Paribas http://starbankthegame.bnpparibas.com NA KTM Advance 2009
Descriptive card (chosen by the user among multi valuated lists: option 1…option N, N=5 or 6)	
Languages: Age: Expertise Field: Pedagogical purpose: Pedagogical model: Requested level of expertise: Game mode: Personalization: Number of simultaneous players: Number of scenarios: Accessories: Device: Assessment mode: Graphical display: …	French and English 17-25 / 25-35 / 35-60 Banking Learning Strategy builder None Individual None One - Many (online) More than 5 None PC/Mac/Tablet Scoring calculation during the game execution 2D and 3D
Assessment card (chosen by the user among 4-level scale)	*According to the perception of one user for example* 
Easiness of set up and configuration: Interface ergonomics: Graphics richness: Complexity: Animation: Cognitive load: Appropriateness with the learning goal: Experience richness: Usage satisfaction: …	4-Very easy 3-User-friendly 3-Good 2-Simple 2-Basic 2-Average 4-Very good 3-Rich 3-Satisfied
Overall rating: (from 10 to 1)	**7**

Table 2 : CASGG: Grid for Characterizing and Assessing Serious Games

to perform the analysis: the characterization, classification and/or assessment. It is not mandatory to complete all the process in each application:

1. **Scoping:** at this stage, the purpose of the analysis is delineated according to the learning context and strategy. The boundaries of the analysis are precisely defined before starting. CASGG could be used for a) characterizing and classifying SGs, b) assessing an SG according to one learning goal, or c) both.
2. **Testing:** at this stage, the game must be thoroughly tested by one or more testers at least once. For the purpose of characterization, the test should be preferably done by an experienced person in the SG field. For the purpose of assessment, several cases arise depending on the aim of the analysis. The test can be done by the teacher before proposing the game to students in their learning process (by him/herself and/or pilot students), or can be used to evaluate learning outcomes (performance, satisfaction) of students after using the SG.
3. **Data collection and analysis:** at this stage, the CASGG tool is used first to perform the collection of data provided online by the testers, and second to quantitatively analyze this data. This analysis is performed in several ways depending on the purpose: classification of SGs, learners'/users' feedback, need fitness matching with one learning goal, learning outcomes assessment, etc. At the end of this stage, the results of the analysis are presented through a report with different presentations (e.g. forms, statistics, individual and team spider diagrams, and comparison curves).
4. **Training:** at this stage, the teacher should test an SG through training as a self-contained learning means, based on the feedback of the initial testers. It is thus operated to determine the use conditions and protocols, scenarios and learning assessment method.
5. **Packaging:** at this last stage, the training curriculum is validated after several tests in real-life conditions. The time has come, therefore, to write a user guide and recommendations (i.e. best practices) for the SG. This could be presented as a teaching case.

II.3. The building of CASGG

The CASGG was built during a series of meetings (i.e. expert working group, brainstorming with students and teachers) and pilot tests with students. The process of building includes several steps and involves different participants. It was performed from December 2010 to November 2012 (2 years).

II.3.1. Expert working group

A working group was formed by the CCMP in December 2010 to meet periodically in order to address the business need mentioned above with the grid building. This group included

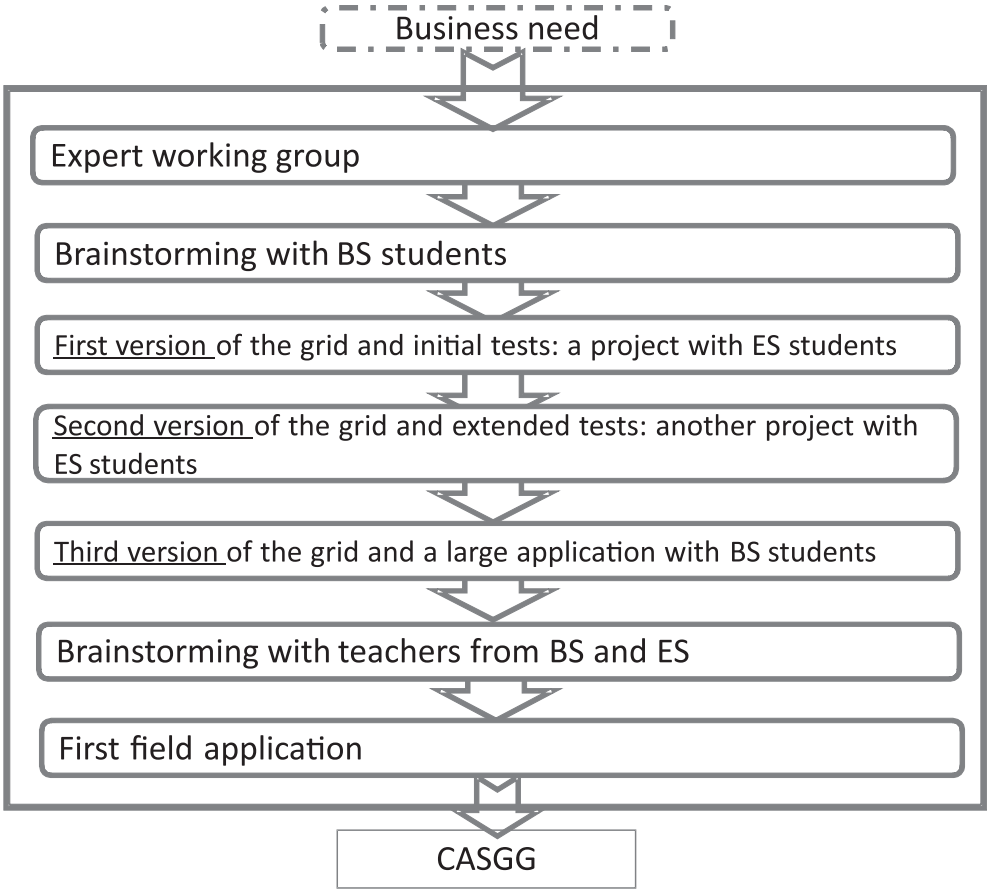


Figure 1 : CASGG building process.

eight persons: four persons from academia, three professionals and the CCMP Managing Director. The principle of the grid (the product) and the protocol of use (the process) have been discussed from the first meetings. Subsequently, participants came up with the idea to draw on quality maturity models, such as the Capability Maturity Model (CMM) (Paulk et al., 1993), to build the grid with a list of criteria. The process of labeling an SG was initially defined to include three main steps: (1) the test of the SG by at least two experts, (2) the application of the grid by the same expert for identifying, characterizing and assessing the SG, and (3) the test of the SG by a teacher in real-life conditions within a classroom (tests with a group of students).

II.3.2. Brainstorming with business students

In order to start thinking about the grid and its structure, a directed brainstorming session, for a period of

120 minutes, has been conducted in March 2011 with 25 graduate management students (their average age was 21, 52% were Male, and very familiar with video games) enrolled in the course of "Facilitation techniques for brainstorming and creativity" in BS. The question asked during the brainstorming was: what should be the characteristics of characterizing and assessing SGs Grid?

To conduct the brainstorming, a Delphi approach was used, enriched with *thinkLets*[1]-based facilitation process contribution (Briggs et al., 2003). We had the opportunity to use a Group Support System (GSS) and a well-structured facilitation process to conduct the session. The brainstorming process consisted of several activities where participants were asked to contribute during a 120 minutes period. First, participants were asked to anonymously generate ideas around the theme "Characterizing and assessing SGs through an assessment grid". Second, participants were requested to reduce, clarify and organize collectively the generated ideas into unique statements around the subject. The goal was to converge on similar ideas, remove non-related ones, and reword those that were insufficiently clear. Third, the facilitator presented and explained to the group the selected statements. Thereafter, participants were asked to rate individually and anonymously the relevance of each statement on a 5-point Likert-type scale, with =5' representing a very relevant statement and =1' a least relevant statement. Finally, voting scores were presented (statement by statement) to all participants in a ranking format to stimulate a discussion of the results, to allow the reformulation of statements when necessary, to clarify ratings' standard deviations (SDs) and to build a collective consensus.

The final results of this brainstorming consisted of seven ideas that received the best consensus with highest means and smallest SDs. According to the participants, important goals to build such grid are as follows:

1. The grid should be as comprehensive as possible to provide maximum analytical elements.
2. The grid should be divided into themes, incorporating several criteria.
3. The grid should be intuitive and easy to use.
4. The themes of the grid should provide adequate support in characterizing the game.
5. The criteria should provide a deep understanding of the game features.
6. The measurement scales of different criteria should be graduated.
7. The process involved in using the grid should be targeted in terms of learning goal.

[1] ThinkLets are codified best facilitation practices that create predictable, repeatable patterns of collaboration among people working toward a goal. They are used to streamline collaboration during brainstorming sessions, rapid decision-making, strategic objectives evaluation, team building, and creativity (Vreede et al., 2009).

II.3.3. First version of the grid and initial tests: a project with engineering students

Following the results of the brainstorming session, two undergraduate students of ES have been assigned to work on the building of the first version of the grid (from April to July 2011), and supervised by one researcher.

The building of the grid has been preceded by a literature review related to SG and learning theories and assessment models. Subsequently, they produced the early version of the grid.

This grid was thus tested with four games (chosen at their convenience) by these two students (*Being the Big Boss, Stop Disasters Game, America's army, and Take Back Illinois*). Afterwards, it was presented to the expert working group in order to be validated after considering the initial modifications (unclear or redundant criteria, criteria order, subjective criteria, etc). In October 2011, the grid was presented to the engineering students during the course "Collaboration technologies" for getting volunteers for its application. Six students accepted to test each one a game at their convenience and provide their feedback. The six games tested were *Star Bank the Game, Power of Research, Ma Cyber Auto-Entreprise, Reveal by l'Oréal, Stop Disasters Game, and CitéJob Recrut*.

This step resulted in the building of the first validated but not finalized version of the CASGG (at this stage called C-CE-SG).

II.3.4. Second version of the grid and extended tests: another project with engineering students

After that, four undergraduate students from ES have been assigned to work on the building of the second version of the grid (from February to June 2012), and supervised by the same researcher. Thus, this grid has been amended several times. Several criteria have been removed and the grid has been deeply reorganized. This reorganization had two main goals: making the grid more logically structured and creating three different sections for more readability (identity, description/characterization and assessment). Along the reorganization, five criteria have been removed. They were redundant and added misunderstanding to the grid (i.e. themes vs. application fields; interactivity vs. interactive tools and game mode; test levels vs. evaluation mode and number of scenarios). Furthermore, the second version of the CASGG (still called C-CE-SG) was presented to the expert working group in order to validate the last changes for starting extended tests with business students (from BS).

II.3.5. Third version of the grid and a wide application with business students

Students enrolled in the course of "Virtual Worlds and Serious Games" in BS were invited to participate in a wide application of the second version of the CASGG (still called C-CE-SG). This application followed the three first stages of the CASGG process (§ 4.2). It was performed between

April and May 2012. As presented to students, the objectives of this application were to check:

- if the grid was suitable to characterize, classify and assess an SG easily,
- if there were some improvements to the grid.
- If the SGs was suitable to be used at a business school as a new alternative for learning.

24 undergraduate management students accepted to participate to this application. All of them were familiar with video games and had already tested at least one SG before. These students were asked to test a given game for a few days. A rich set of games were proposed to them by the researcher in which they could choose at their convenience. Then, the CASGG questionnaire was sent, through an electronic online form to the students for fulfillment. The data collection and analysis was done thanks to the initial version of the CASGG tool. A few open ended questions were added for getting participants' feedback.

The grid was applied for 24 SGs available on the marketplace such as *Darfur is dying, Global Challenge, Staying Alive, Action police, StarBank the Game, Energyville, Alcootel, Moonshield, Trading 212 demo, Peace corps, Cesim, Renault Academy, Innov8, Energuy, City Rain, Ace Manager the Second Set, Learning Beans, History of Biology*, *Surgeonsim, Football manager, Born to be alive, City one, et Mission Anti-trust*.

The grid application showed relevant and useful information for deep understanding of the tested games characteristics and qualities. In addition to characterize each SG, it helped to classify games in terms of expertise field, type, sector, purpose, etc., and other proprieties related more to the judgment/perception of each person: ease of use, perceived usefulness, interface ergonomics, complexity, etc. Some of these SGs were tested by more than one student. The comparison of responses (especially the assessment section) is very interesting.

Some diagrams to present the findings of the grid application are provided here above. These findings show that the SGs tested by students cover various fields, 14% for education and 22% for management. 48% of these SGs are edutainment games. 44% of the purposes of these SGs are for learning. 39% of them have a Strategy-builder as pedagogical model.

In terms of feedback related to the use of the grid and its improvement, some interesting assertions were provided by students, such as:

- The grid provides very rich information.
- The use of the grid requires going further in understanding the features of the game.
- Interface ergonomics have an important impact on the user attitude towards the game usage, but this as other criteria can be weighted according to the learning goals.
- The possibility of interaction with other players / components of the game environment is important.
- Several terms (i.e. criteria names, measurement scales) remain un-

clear, such as cognitive load and remote use.

- Allowing the respondent to check more than one choice for some criteria (e.g. age, game type…).
- The scoring system should be reviewed for some criteria.
- Some criteria should include open choices.
- Some criteria seem too technical, are not always clear, and/or simply where information cannot be found (e.g. scalability, programming language, development platform, architecture, etc).

To the question if the tested SGs are suitable to be reused at a business school (and in higher education in general) as a new alternative for learning, students have made several statements. Some SGs, i.e. those issued from the education, management, human resources (HR) and entrepreneurship fields were judged as suitable for training in a business school curriculum under various conditions such as a clear learning goal, accurate experiment script, well defined learning scenario and pedagogy, and good learning assessment method (i.e. related to learning outcomes). Students stated that SGs in general could be a complement but not a substitute to traditional learning means/methods. After this application, the grid was once again updated.

II.3.6. Brainstorming with teachers (from BS and ES)

In order to debrief on the previous application and validate the new version of the grid, a free (Post-it based) brainstorming session has been conducted in July 2012 with 13 teachers (their average age was 42 years [min 33 – max 62], 70% French, 54% were Female, and having a pedagogical experience of more than 3 years and very informed about SGs) from different areas (Management, HR, MIS, Sociology, Finance, Marketing, Computer Science, Telecoms, Languages, etc) at BS and ES. The purpose of the brainstorming was to discuss this question: under what conditions should the grid be used to assess learning outcomes using an SG toward a learning goal?

The final result of this brainstorming is an ordered list of important tasks to consider before assessing learning outcomes of learners according to a learning goal when using an SG:

1. Explaining to learners how to use the SG with an SG presentation before starting the experiment;
2. Defining precisely what the learning goal is and what type of learning outcomes to assess: satisfaction, attention, knowledge acquisition, etc;
3. Reviewing the grid in accordance with the context: e.g. criteria choice and questions rewording;
4. Weighting the criteria according to their importance in the learning context and requirements;
5. Specifying the experiment procedure and the assessment method;
6. Organizing a collective debriefing after the use of the SG;
7. Collecting assessment data (using assessment card section) immediately after the test;

8. In addition to the grid use, providing an independent assignment for assessing knowledge acquisition (learning performance) in the framework of a specific learning to confirm learning outcomes (i.e. hard skills).

At the end of this brainstorming, it was suggested to rename the grid. The retained name of the fourth and current version was called CASGG for Characterizing and Assessing Serious Games Grid.

THE FIELD APPLICATION OF CASGG

III.1. The process

Students enrolled in the course of "Virtual Worlds and Serious Games" in BS and others enrolled in the course of "Collaboration technologies" in ES, were invited to participate to a wide application of the CASGG. The field application was performed with business students in October 2012, and with engineering students in November 2012. The tested SG was *StarBank the Game* developed by KTM Advance for the bank group BNP Paribas.

The field application followed the CASGG process:

III.1.1. Scoping

The learning goal was to understand the principal mechanisms of banking. In other words to learn the three core activities of the bank group: retail banking, asset management and fund investment management. The purpose was to see if using this SG, in addition to the theoretical banking activities course (6 hours by a banking specialist), would enhance learning outcomes (performance, satisfaction) of students. The learning performance was compared in two cases: students who have used the SG and others who have not. In order to motivate them, students who volunteered to participate in the SG testing received an extra credit.

III.1.2. Testing

The following table summarizes the characteristics of students participating in this experiment:

Table 4 presents the assessment card used in this experiment and all the criteria' definitions.

Each participant, concerned by the use of the SG, has received the same overview description of the SG: principals, rules, features and scenarios. A three page French-written document was distributed two days before the SG testing to all the participants during the theoretical banking activities course. The testing experiment was conducted in three hours-long session. The process treatment was applied to each of the two groups as follows:

– **Participants using the SG**: for these students, the session started with the receipt of an email from the teacher explaining the purpose of the SG testing, the process of the session, the SG login and some usage's guidance. Then, when ready, participants were asked to log in and start using the SG according to teacher's instructions (in the classroom, in the labs or through the campus Wi-Fi). Three

	Business School (BS)	**Engineering School (ES)**	
Total of participants	52	29	
Nationality	39 French by birth	17 French by birth	
Participants who have used the SG	27	14	**41**
Participants who have not used the SG	25	15	**40**
Grade level	Master degree in management	Master degree in computer science	
Youngest participant in Age	21	21	
Oldest participant in Age	25	24	
Average age of participants	23	22	
Male participants			
With SG	12	9	
Without SG	11	12	
Female participants			
With SG	15	5	
Without	14	3	
Video Games experience	good	very good	
Experience with the bank group	none	none	

Table 3 : Participants' demographic data

hours later, each participant was asked to complete the assignment – online multi-choice questions (NB: the internal score calculated through the game execution was not considered here for the assessment). When finished, each participant had to fill in the CASGG assessment card. At the end, participants were asked to meet in the classroom with the teacher for an open discussion (40 minutes period) as a collective debriefing and rating on a 10-point Likert-type scale (with =10' being the highest and =1' the lowest) three dimensions related to the course: interest in the topic (To what extent have you been interested by the topic?), attention capture (To what extent did the SG captured your attention?) and learning satisfaction (To what extent are you satisfied with this learning experience?). Moreover, a research assistant audio recorded and made field notes about oral statements during the meeting.

– **Participants without using the SG**: these students were asked to

Criteria	Definition
Interface ergonomics	The extent to which the player finds the SG interface user friendly.
Complexity	The extent to which the SG logic is difficult to get.
Playfulness/Flow	The extent to which the player enjoys using the SG.
Cognitive load	The extent to which the SG requires concentration effort.
Animation	The extent to which the player appreciates the rhythm variation and man-machine interaction in the SG.
Assistance	The extent to which the player feels assisted through the SG use.
Appropriateness with the learning goal	The extent to which the SG use allows achieving the desired learning goal.
Usage satisfaction	The extent to which the player is satisfied with its usage experience of the SG and content.
Overall rating	The extent to which the SG pleases globally to the user.

Table 4 : Used assessment card (third section of the CASGG questionnaire)

complete the assignment – online multi-choice questions in the classroom. When finished, each participant was asked to rate the three above dimensions.

III.1.3. Data collection and analysis

Data collection was made right after the experiment through electronic online forms, to the students for fulfillment. The data collection and analysis were done thanks to the CASGG tool. A few open ended questions were added for getting participants' feedback on their engagement and motivation to play, curiosity and increased interest in the banking topic through gaming.

Table 5 presents the results of the data analysis related to the eight criteria of the assessment card, for all students who have used the SG (41 in total) in terms of Mean and SDs.

With regard to the three dimensions related to the course, table 6 presents the results of all the students who have used the SG (41 in total) and who have not (40 in total), in terms of Mean and Standard Deviation (SD).

The Cronbach's alpha (α) for all these questions is higher than 0.7, indicating certain homogeneity in the

Criteria	Mean	SD
Interface ergonomics	1.95	0.84
Complexity	3.65	0.50
Playfulness/Flow	3.45	0.65
Cognitive load	2.95	1.22
Animation	1.86	0.67
Assistance	2.56	1.00
Appropriateness with the learning goal	3.12	0.32
Usage satisfaction	2.87	0.92
Overall rating	**7.28**	**1.91**

Table 5 : Results of all students with the SG

	Mean (With SG)	SD (With SG)	Mean (Without SG)	SD (Without SG)
Interest in the topic	3.45	1.12	2.55	1.78
Attention capture	3.05	0.76	2.66	1.33
Learning satisfaction	3.34	0.42	2.82	0.54

Table 6 : The three dimensions related to the course

participants' responses relative to the understanding of these statements. In terms of learning performance (knowledge acquisition), table 7 presents the average scores related to the assignment for all the students.

	Average score	Average score for male	Average score for female
Business students (with SG)	87.3	89.1	85.5
Business students (without SG)	86.5	85.4	87.6
Engineering students (with SG)	91.8	92.6	91
Engineering students (without SG)	92.1	92.3	91.9

Table 7 : Average scores (score out of 100)

III.1.4. Training

At this stage, the teacher has tested the *StarBank the Game* through training as a self-contained learning instrument/device based on the feedback of initial users (engineering students §4.3.3 and business students §4.3.5). This feedback was useful to decide on the choice of this SG according to its characteristics and the satisfaction of users with the best overall score among all tested SGs up to now.

The feedback from the first group (Business students) was also very useful to the experiment procedure. Participants made some statements on the time reserved for the testing. An extra time was suggested by most of participants. Moreover, the feedback from the second group (engineering students) was no less useful, but different. The most two important suggestions were: first, to add in the learning performance evaluation, the score of users at each stage and the average timespan required to move from one level to another; second, the assignment had to be exactly related to the SG content.

III.1.5. Packaging

This stage was not executed since this was just an experiment and not related to the CASGG application. The two schools are not supposed to teach banking knowledge for a specific bank group. Having said that, this SG is used for training new bank group employees and not students.

III.2. Findings

Through the data analysis, findings showed that there is no difference in terms of learning performance between students who have used the SG and those who have followed the theoretical course only (in terms of average scores, see Table 7). Surprisingly, the scores of engineering profile students were slightly higher even if they had less management skills. Scores for males in both groups were slightly higher than those of females, except for females from BS who did not use the SG. This could be of interest, but further investigations should be done before arriving at any conclusions.

In some cases, using the internal score of the game is not a reliable way to assess the learning performance since some students effectively had a good score with the game but a rather poor score for the assignment. Further analysis of this correlation (internal score vs. knowledge acquisition) should be carried out in future experiments.

If we try to interpret findings related to some criteria of the assessment card, we notice that for the students who have used the SG, the interface ergonomics of the SG is poor but according to students themselves, offset by the richness of game scenarios and content. The SG is judged complex and needs higher concentration. Unsurprisingly, they found the animation and assistance to be very basic. One participant commented: *"having the theoretical course before using the game was interesting in order to have a foundation in the banking field."* One can ask if having the course before or after the game has a different effect on the findings. In view of the fact that the aim is to replace the theoretical

knowledge with the game, a good balance is to be found in the packaging stage (§ 4.2) but this depends on the complexity of the topic.

In terms of learning satisfaction, participants who have used the SG have expressed much more motivation, enthusiasm for – and interest in learning than the others. It was not only enjoyable but comprehensibly relevant. They expressed their interest in experiencing other SG topics *"This experience took me out of routine learning methods and encourage me to get involved in the matter. I will definitively volunteer for further tests."*

According to participants, the game enhanced their attention (with regard to the flow experience and novelty of the situation), challenged their curiosity (of how they can improve their knowledge through playing – competence evolving, §2.2), and created greater interest in the theoretical knowledge related to banking and gaming (i.e. both topical and situational interests, §2.2). In fact, being immersed in the game scenario is a key factor in sustaining attention and enhancing their engagement (cognitive rather than emotional, §2.2), and motivation (intrinsic rather than extrinsic, §2.2) *"Fortunately we allowed to play the game first otherwise the theoretical course would not have interested me as much."*

This field application has also put forward another need studied in the self-determination theory, namely, the autonomy sought by the new generation (the do-it-yourself (DIY) feeling, learning by doing) *"This is the first time that I feel autonomous "utilement", as we say, in a challenged learning situation"*; *"This provides the student with a sense of empowerment"* and *"Apart from the fact that we were in experimental conditions (fixed time period), this learning mode could provide more flexibility to each of us where the learning goals are clear."*

RESEARCH EVALUATION

In this paper, we have followed the seven guidelines for design science evaluation as proposed by Hevner et al. (2004). These guidelines help to check to what extent the CASGG gives an effective and efficient response to the business needs. Indeed, this means that this grid, as a set of artifacts, acts not only on a technical level, as it serves as a means to characterize/classify/assess SGs basing on their features and qualities, but also it explores the complex subject-object relationship when considering the SG in its micro and macro-social environment (real-life conditions of use).

In order to produce new artifacts [CASGG structure, questionnaire, process, and tool] to be added as applicable knowledge to the knowledge base [see IS research framework in Hevner et al. (2004, p.80)], we developed a purposeful instrument and application **(guideline 1: Design as an artifact)** showing step by step how to use the grid and solve a specific problem related to the overall assessment of an SG. This managerial instrument meets a business need clearly expressed by professionals (educationalists, business managers, and the CCMP) and society in general (through the evolution of educational system and

means), namely: the difficulty to choose the most appropriate SG that suits with a specific learning goal **(Guideline 2: Problem Relevance)**.

The CASGG not only allows better detecting the (internal) characteristics of SG, but also evaluating their impact on user learning performance and satisfaction. 41 graduate students participated in a field application of the grid to assess its relevance and utility. Besides, an active contribution of a working group of learning experts (through an expert focus group) has been established to validate the CASGG **(Guideline 3: Design Evaluation)**.

Our literature review showed that the SGs' assessment seems to be not well studied in the existing research. Mostly two grids were developed before, but they are either very simplistic to rigorously meet the business need (a characterization / classification more than assessment), or very complicated to apply. Moreover, the involved experts have clearly highlighted the business need to create an easy to use and rigorous assessment instrument **(Guideline 4: Research Contributions)**.

Several work sessions with three different participants (business and engineering students, teachers and experts) have been conducted, thus a first version of the grid has been built. Afterwards, three versions have been proposed to improve the quality of the grid **(Guideline 5: Research Rigor)**.

In order to build the grid, we have used a combination of methods and researches including a literature review, a working group of experts, and lab and field studies **(Guideline 6: Design as a Search Process)**.

Finally, our results are and will be published in two stages **(Guideline 7: Communication of Research)**: First, the CASGG (with the application process) and training experimentation will be presented through publications to other researchers who, we hope, will consolidate and extend the grid and application, and to experts who could apply the method and provide feedback and recommendations for its future enhancement. The CCMP will communicate on it in the field, which will accelerate its diffusion and legitimacy. Second, after a further and deep study of the grid and its application in various contexts with SGs, researchers could reuse it as a background to improve it and/or develop new instruments.

CONCLUSION

In this paper, we report on the building process and a field application of a new assessment instrument for SGs. It was developed in an inductive design science perspective to meet a real business need as expressed by the CCMP through the requirements of businesses and higher education institutions.

Our contribution is both theoretical and practical as we propose a grid, an application process, a supporting tool, and an empirical application. The results should be of interest to academic researchers and learning practitioners interested in the use of SGs in their educational programs. The research contributes to SGs literature, theory

and practice through the building of CASGG artifacts that provide evidence of proof of value and proof of use in the field.

Nevertheless, there are limitations related to this work in order to complete the design science evaluation framework. Firstly, our empirical evidence is based on only a single field application with students. Future applications should be done by other teachers and professional trainers. The CASGG process has not been completed since only four of the five stages have been executed (as mentioned above, the fifth stage does not apply to CASGG), and the correlation between internal game score and knowledge acquisition remains an issue. Further field studies have to be executed to expand the evaluation of CASGG artifacts and to further enhance its current version (e.g. CASGG tool features, criteria weighting, etc). Particular care will have to be taken to ensure that CASGG can determine conditions of the training provided with SG and offer recommendations to educationalists. Secondly, with regard to the second research question (addressed in this paper is not answered yet), the CASGG cannot currently be used to determine which SG is more suitable for a given learning goal. However, it provides a first step and many insights into this direction.

In this sense, future research efforts will include several perspectives. With reference to Kolb's (1984) cycle of learning by doing experience (§2.2), we have tackled only the two first steps (Concrete experience with the game execution and Reflective observation with the collective debriefing). Abstract observation and Active experimentation should be explored later with other applications through longitudinal studies. Regarding Kirkpatrick's (1994) four-level evaluation model, we have investigated in this application only the two first levels (learning satisfaction and learning performance). Level 3 (individual capabilities), level 4 (organizational outcomes) and the proposed added level (ROI) should be explored later as well. This means that CASGG should be applied in business contexts to assess knowledge transferability (from learning to behavior - knowing-doing gap and further from game situation to real situation) and organizational impacts and outcomes. The type of knowledge (skills) should be important here. Other factors should be also considered such as age, gender, and culture.

Furthermore, another interesting perspective related to SG adoption and its continuance use (beyond the first impression and discovery effect related to the novelty of the situation) could be considered in this research area. Indeed, learning is influenced by individual attributes, which interact in the learning process with an instructional activity in a specific learning environment. Learning Styles (LSs) have been considered as a key attributes in learning and the research community has some findings about their influence. LSs denote the set of preferences that students have for perceiving, assimilating, and interpreting or processing incoming information (Kolb 1984; Felder and Silverman 1988). Collinson (2000) describes LS as a combination of cognitive, affective, and physiological factors. In their Index of Learning

Styles (ILS), Felder and Silverman (1996) have identified four dimensions: active-reflexive, sensitive-intuitive, visual-verbal and sequential-global. With regard to SGs, one important question could be asked: to which extent the adoption of SGs is influenced by everyone's LS? Findings would demonstrate if LS influence will be good predictor for SG adoption and effective use.

ACKNOWLEDGMENTS

The author would like to thank the *Centrale de Cas et Médias Pédagogiques* (CCMP) for supporting this research and all professionals, students and teachers for their involvement in the building and evaluation of the CASGG; and at the same time, Gregory Rosenstock for his valuable feedback.

RÉFÉRENCES

Abt, C. (1970). *Serious Games*, New York: The Viking Press.

Agarwal, R. and Karahanna, E. (2000). Time flies when you're having fun: Cognitive absorption and beliefs about information technology usage, *MIS Quarterly*, 24, 4, 665-694.

Alexander, P. A., Jetton, T. (2000). "Learning from text: A multidimensional and developmental perspective." In: Kamil, M. L. Mosenthal, P. B., Pearson, P. D., Barr, R. (eds.), Handbook of reading research, Vol. 3, pp. 285-310. Mahwah, NJ: Erlbaum.

Alvarrez J. (2007). *Du jeu vidéo au Serious Game : Approches culturelle, pragmatique et formelle*, Thèse de doctorat, Université de Toulouse.

Bandura, A. (1986). Social Foundations of Thought and Action: A Social Cognitive Theory, NJ: Prentice-Hall: Englewood Cliffs.

Bhattacherjee, A. (2001). Understanding Information Systems Continuance: an Expectation-Confirmation Model. *MIS Quarterly*, 25(3), 351–370.

Boughzala I., Bououd I., Michel H. (2013). Characterization and Evaluation of Serious Games: A perspective of their use in higher education, *Proceedings of the 46th Hawaii International Conference on System Sciences (HICSS 46)*, IEEE Computer Society, January 7-10, 2013, Maui, USA.

Briggs, R. O., Vreede, G. J., de, Nunamaker, Jr., J. F. (2003). Collaboration Engineering with ThinkLets to Pursue Sustained Success with Group Support Systems. *Journal of Management Information Systems*, 19, 31-64.

Choi, D. H., Kim, J. and Kim, S. H. (2007). ERP training with a Web-based electronic learning system: The flow theory perspective, *International Journal of Human-Computer Studies*, 65, 223-243.

Collinson, E. 2000. "A Survey of Elementary Students' Learning Style Preferences and Academic Success," *Contemporary Education* (71:4), p. 42.

Csikszentmihalyi, M. (1975). Play and intrinsic rewards, Journal of Humanistic Psychology, 15, 3, 41-63.

Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience*, Harper & Row, Publishers, New York.

Davis, F., (1989), Perceived usefulness, perceived ease of use and user acceptance of information technology, MIS Quarterly, Vol. 13, N° 3, September, pp. 318-340.

Deci, E. L., Ryan, R. M. (1985). The general causality orientations scale: Self-determi-

nation in personality. *Journal of Research in Personality*, 19, 109–134.

Djaouti, D. J. A., Jessel J. P. (2011). Classifying Serious Games: The G/P/S Model, Patrick Felicia (ed), "*Handbook of Research on Improving Learning and Motivation through Educational Games: Multidisciplinary Approaches*", IGI Global.

Ellis, H., Heppel, S., Kirriemuir, J., Krotoski, A., McFarlane, A. (2006). "Unlimited Learning: Computer and Video Games in the Learning Landscape." Accessed March, 2014, from http://www.org.id.tue.nl/IFIP-TC14/documents/ELSPA-report-2006.pdf

Felder R. M., Silverman, L. K. and Solomon, B. A. (1996). "Index of learning styles (ILS)," Available on line: http://www.ncsu.edu/felder-public/ILSpage.html.

Felder, R., and Silverman, L. 1988. "Learning styles and teaching styles in engineering education," *Engineering Education* (78:7), pp. 674–681.

Flowerday, T., Schraw, G., Stevens, J. (2004). The role of choice and interest in reader engagement. Journal of Experimental Education, 72, 93–114.

Gee, J. P. (2007). "Are video games good for learning?" *Curriculum Leadership* 5(1).

Hevner, A., March, S., Park, J., and Ram, S (2004). "Design Science in Information Systems Research." *MIS Quarterly* 28(1): 75-105.

Hidi, S., Baird, W. (1986). Interestingness-A neglected variable in discourse processing. *Cognitive Science*, 10, 179-194.

Holbrook, M. B., & Hirschman, E. C. (1982). The experiential aspects of consumption: consumer fantasies, feelings, and fun. *Journal of consumer research*, 132–140.

Kebritchi, M., Hirumi, A. & Bai, H., (2010). "The effects of modern mathematics computer games on mathematics achievement and class motivation", *Computers & education* 55(2): 427-443.

Kintsch,W. (1980). Learning from text, levels of comprehension: Why anyone would read a story anyway. *Poetics*, 9, 87–89.

Kirkpatrick, D.L. (1994). *Evaluating Training Programs: The Four Levels*. San Francisco, CA: Berrett-Koehler

Kolb, D. (1984). *Experiential Learning: experience as the source of learning and development*, NJ: Prentice Hall: Englewood Cliffs.

Koufaris, M. (2002). Applying the technology acceptance model and flow theory to online consumer behavior, Information Systems Research, 13, 2, 205-223.

Krapp, A., Hidi, S. Renninger K. A. (1992). Interest, learning, and development. In: Renninger, K. A., Hidi, S., Krapp, A. (eds.), *The role of interest in learning and development*, pp. 3- 25, Hillsdale, NJ: Erlbaum.

March, S. T. and Smith, G. (1995). Design and Natural Science Research on Information Technology, *DecisionSupport Systems* (15:4), December 1995, pp. 251-266.

Michel H., Kreziak D., Héraud J-M., (2010). Evaluation de la performance des Serious Games, pour l'apprentissage : Analyse du transfert de comportement des éleveurs virtuels de Vacheland, *Système d'Information Management* 14(4).

Mitchell, A., Savill-Smith, C. (2004). "The Use of Computer and Video Games for Learning: A Review of the Literature." Accessed March, 2014, from http://dera.ioe.ac.uk/5270/1/041529.pdf

Mitchell, T. R. (1982). Motivation: New directions for theory. *Academy of Management Review*, 7, 80–88.

Paulk, M., Curtis, B., Chrissis, M. and Weber, C. (1993, February). Capability maturity model for software, Version 1.1. Technical Report CMU/SEI-93-TR-024 ESC-TR-93-177.

Peterson, R.I. V., J. Herrington (2008). Standards for educational, edutainment, and developmentally beneficial computer games. *World Conference on Educational Multimedia*. Vienna, Austria.

Petty R. E., Cacioppo, J. T., (1984). "The Elaboration Likelihood Model Of Persuasion." *Advances in Consumer Research* 11.

Pfeffer, J., Sutton, R. (2000). *The knowing-doing gap*, Boston, MA: Harvard Business School Press.

Philips J. (2003). Return *on Investment in Training and Performance Improvement Programs*, 2nd Edition, Jack J. Philips, Butterworth-Heinemann, Burlington, MA.

Prensky M. (2001a). *Digital game-based learning*. New York:McGraw-Hill.

Prensky, M. (2001b). Digital Natives, Digital Immigrants Part 1. On the Horizon on the Horizon, 9, 5, 1–6.

Prince, M. (2004). Does Active Learning Work? A Review of the Research, *Journal of Engineering Education*, 93(3): 223–231.

Rieber, L.P. 1996. "Seriously Considering Play: Designing Interactive Learning Environments Based on the Blending of Microworlds, Simulations, and Games*," Educational Technology Research & Development* (44:2), pp. 43-58.

Rooney, P. (2007). Students @ play: serious games for learning in higher education, International Technology, Education and Development.

Ryan, R.M., Deci E.L. (2000). Self-Determination Theory and the Facilitation of Intrinsic Motivation, Social Development, and Well-Being. *American Psychologist*, 55, 1, 68-78.

Schiefele, U. (1999). Interest and learning from text. *Scientific Studies Reading*, 3, 257–280.

Schraw, G., Lehman, S. (2001). Situational interest: A review of the literature and directions for future research. *Educational Psychology Review*, 13, 23–53.

Scientists, F. o. A. (2005). Harnessing the Power of Video Games for Learning, Proceedings of the Summit on Educational Games.

Tobias, S. (1994). Interest, prior knowledge, and learning. *Review of Educational Research*, 64, 37-54.

Tomorrow P. (2008). "Speak Up 2007 for Students, Teachers, Parents & School Leaders Selected National Findings".

Ulicsak, M. (2010). "Games in Education: Serious Games." Accessed March, 2014, from http://media.futurelab.org.uk//resources/documents/lit_reviews/Serious-Games_Review.pdf

Venkatesh, V., Morris, M.G., Davis, G.B., Davis, F.D., (2003). User Acceptance of Information Technology: Toward a unified view, *Management Information Systems (MIS) Quarterly*, Vol. 27, N° 3, pp. 425-478.

Vreede, G. J. de, Briggs, R., Massey, A., (2009). Collaboration Engineering: Foundations and Opportunities", Journal of the AIS, vol. 10, no. 3, p. 121-137.

Wade, S. E. (1992). How interest affects learning from text. In: Renninger, A., Hidi, S., Krapp, A. (eds.), *The role of interest in learning and development*, pp. 255-277, Hillsdale, NJ: Erlbaum.

Zyda M. (2005). "From Visual Simulation to Virtual Reality to Games". *Computer* Vol.38, N° 9, pp 25-32.