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Fidelity and Game-based Technology in Management Education

Edgard B. Cornacchione Jr. *
E-mail address: edgardbc@usp.br
Universidade de São Paulo – USP
São Paulo, SP, Brazil.

* Corresponding author: Edgard B. Cornacchione Jr.
Av. Prof. Luciano Gualberto, 908, 107, FEA3, São Paulo, SP, 05508-010, Brazil.

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Abstract

This study explores educational technology and management education by analyzing fidelity in game-based management education interventions. A sample of 31 MBA students was selected to help answer the research question: To what extent do MBA students tend to recognize specific game-based academic experiences, in terms of fidelity, as relevant to their managerial performance? Two distinct game-based interventions (BG_1 and BG_2) with key differences in fidelity levels were explored: BG_1 presented higher physical and functional fidelity levels and lower psychological fidelity levels. Hypotheses were tested with data from the participants, collected shortly after their experiences, related to the overall perceived quality of game-based interventions. The findings reveal a higher overall perception of quality towards BG_1 : (a) better for testing strategies, (b) offering better business and market models, (c) based on a pace that better stimulates learning, and (d) presenting a fidelity level that better supports real world performance. This study fosters the conclusion that MBA students tend to recognize, to a large extent, that specific game-based academic experiences are relevant and meaningful to their managerial development, mostly with heightened fidelity levels of adopted artifacts. Agents must be ready and motivated to explore the new, to try and err, and to learn collaboratively in order to perform.

Key words: game-based management education; simulation fidelity; educational technology.

Introduction

Technology has been a relevant component in reshaping the traditional approach to instruction in many dimensions, and those more recently involved with education, or training, have the chance to observe the intensity of this movement. Contemporary scholars, learners and instructors may reconsider the approach to individual and collective educational objectives due to intense changes in our environment (Karoly & Panis, 2004) if, compared with five or ten years ago, or even last year, daily activities (professional, academic or personal) are developed based on substantially different conditions, with better cost-benefit.

This study focuses on alternatives for supporting management education to help learners experience a higher fidelity level by exploring business games, simulation and virtual reality instructional design elements, concerned with implications for both practitioners and academicians. Such instructional design elements tend to narrow the gap between the educational experience and the real-world business setting, increasing fidelity (Dabbagh & Bannan-Ritland, 2005) while improving the meaningfulness of the experience (Dewey, 1939), the learning process and its content (D. A. Kolb, 1984). In this study, fidelity is considered the level of realism instructional artifacts can incorporate from the real world (Alessi, 1988; Backlund *et al.*, 2009) and is linked to the meaningfulness of the learning experience (Dewey, 1939).

Due to the natural pace of evolution in such environments, practical applications of these types of instructional design elements are still far from the desired levels (Aldrich, 2004; Ghosh, 2003; Kiili, 2007; Musselwhite, 2006). Although games and simulations have been discussed in business for a long time (Newstrom, Scannell, & Nilson, 1998; Saunders, 1995; Wolfe, 1993), few extensive observational studies and even fewer experimental studies are available (if compared to traditional instructional design in management education literature). This suggests the international management education community is still assessing the process and investigating the short- and long-term consequences (investments and return) of this change.

Technology is not exclusively a big intervention of modern times. It has always been present throughout our history in particular situations, providing the required conditions and innovating to improve societal well-being in several dimensions. What can be noticed, based on the technological innovations and advancements, is the presence of a special attribute: application. In practical terms, the development of a new way of performing a particular task (*e.g.*, new technology) will only be appropriate if its potential effectiveness and efficiency outperforms existing ones. There is no rational sense in promoting change from one existing solution to a new one when it fails the cost-benefit analysis. There is no need for using a different way of performing a particular task if the overall outcomes (effectiveness) and use of resources (efficiency) are the same. Thus, some proposed technological solutions are more applicable than others, with a large number of examples: from simple house appliances to complex avionic solutions, or from food conservation elements to genetic engineering, or even from time management artifacts to telecommuting and collaboration in virtual worlds.

The use of technology as a way of improving the learning experience is not negligible and the debate is under way (Hallett, 2005). Some may consider technology devices as distractors (*e.g.*, in-class web-surfing), while others will vehemently defend such artifacts as relevant contributions to the learning experience, making it meaningful, specially by addressing different needs and conditions (*e.g.*, podcasting, on-campus TV, clickers, interactive projections, collaborative websites). As an example, a lecture hall, based on a traditional passive learning approach, may take advantage of real-time responses, providing feedback to the presenter, by using remote controllers tied to classroom performance systems (CPS), offering interactivity with the experience: both instructor and learners can profit from this.

Depending on the field of study or particular topic, alternative educational means may be employed, affecting the overall teaching and learning process. As a consequence, agents involved in

this process (*e.g.*, institution, instructors, learners) must be aware of the alternatives, as well as willing to explore the new. It is reasonable to assume that we fear the unknown or even familiar things in unfamiliar ways (Hergenhahn & Olson, 2001). Fear is a primal behavior of human beings. People tend to react differently to these types of situations, and this is also true of educational matters. Working together, operating collectively or acting as a group, they all represent initiatives that usually offer better conditions to overcome such affective barriers. Not only can working as a group be beneficial in terms of overcoming technological barriers, but this idea is, indeed, deeply connected to the learning process. Shapiro and Levine (1999) explore the idea that by acting as a group (*e.g.*, learning communities), agents of the educational process can overcome the obstacles of a particular learning situation in a more valuable way: “students, together with their peers and teachers, can build more meaningful connections to each other and what they are learning” (p. 16). Thus, the essence here is that, with agents playing together and with help from technology, the learning process may become more interesting and effective.

Purpose and Goal

This study focuses on the use of technology to improve the teaching and learning process, based on individual differences and needs, the presence of a collaborative environment and the motivation of both institution and instructors to select and employ alternative means to support the learning experience, when such means provide an overall better cost-benefit solution, in terms of both tangible and intangible outcomes, as well as monetary and non-monetary conditions. In particular, the selected alternative means analyzed here includes high fidelity educational technology: games, simulations and virtual reality. Although the elements of the learning process explored in this discussion are general, the analysis is more connected to graduate management education, especially MBA programs.

The purpose of this study is to update the discussion by gathering evidence while exploring the influence of educational technology on management education, observing socioeconomic and cultural evolution, as well as the changes in technology. This study is designed in such a way as to provide supporting arguments for this key issue. The goal here is to gather evidence linked to the main concept that educational technology, particularly business games and simulations, can provide students with meaningful learning experiences associated with their managerial development, based on heightened fidelity levels.

Literature Review

The observable intense change in society, along with new forms of relations and connections among individuals, is also, unmistakably, present in the business world. In fact, businesses can be seen as people operating in teams in order to achieve a better combination of resources and opportunities with the aim of delivering the appropriate level of services and goods at the quality level expected by a particular consumer market. Companies, universities, instructors, executives, learners and professionals should all share similar concerns when it comes to education, based on the perspective of business and assuming time as a constraint: the boundary between school and company responsibility as providing appropriate resources to improve the learning of the learner/worker. This may be gauged by the level of application of the set of knowledge, skills and attitudes the learner/worker brings to the **real world**. Knowing is important, having the skills is also important, but choosing to apply a solution in a particular situation (often ill-structured real-world problems) is what makes all the difference.

Cognitive Flexibility Theory (CFT) is useful when discussing this particular aspect of learning in complex and ill-structured domains, but even more when supporting the use of interactive

technology for this purpose. Spiro and Jehng (1990, p. 165) state that “by cognitive flexibility, we mean the ability to spontaneously restructure one's knowledge, in many ways, in adaptive response to radically changing situational demands”, stressing the relevance of dynamic context. They continue by stating: “this is a function of both the way knowledge is represented (*e.g.*, along multiple rather single conceptual dimensions) and the processes that operate on those mental representations (*e.g.*, processes of schema assembly rather than intact schema retrieval)” (Spiro & Jehng, 1990, pp. 165-166). As observed, CFT focuses on dynamic situations by addressing mental representations, or schema assembly, that would benefit the learner when applying knowledge, skills and attitudes towards a specific situation. This is of high value in business contexts where parameters may be varying (in number and content) throughout instances of similar business decisions, increasing the pressure on the manager. Naturally, business simulations and games tend to benefit from this approach.

Some of the best business schools (Lavelle, 2006) are paying a great deal of attention to action. According to this perspective, it is not only a question of having the knowledge, skills and attitude but, mainly, a question of identifying and tackling a particular business problem under certain circumstances and acting. Again, knowing and having the skills but not choosing to use them is a big concern, especially in business education. Thus, the balance between extent and intensity of theoretical and practical training at schools has been revisited. Both the cognitive and affective sides of education must be integrated to increase the potential of applying it under certain circumstances. Consequently, transfer of learning is even more present in today's recovering corporate America, principally if the number of mergers and acquisitions involving similar, but occasionally different, industries, cultures, and markets is considered. These major changes impact society in general and business and education (consumers and providers) when considering good citizens and a well-prepared workforce.

On top of this, we may reflect on the remarkable change across generations, mainly in terms of technological gaps (Beck & Wade, 2004; Hitch & Duncan, 2005). People are different in exposure to information and selective use of means of accessing information. The decision making process is also being influenced by the information and communication technology (ICT) evolution. The current generation is different from those of the past, and it is highly likely that it will be different from those to come. As mentioned above, businesses are made up of people, and so are schools.

Ultimately, it is natural that things and artifacts evolve, and it is no different in education. When the first microcomputers reached classrooms and laboratories in business schools, a challenge was ignited: How were instructors and learners going to take advantage of computers? The answer was not generalized. In some cases, immediate use was made, in other cases several years were required, and in others, it just did not happen. It is part of human nature, as already mentioned (*e.g.*, risk, fear, surprise, exposure). However, back then, the percentage of students with access to microcomputers (both from their homes and jobs) was very different when compared to today. The diffusion of innovations (*i.e.*, technology) is deeply connected to time and personal traits (Rogers, 2003).

The current presence of technology in learners' daily lives is a key factor when discussing the future of business education. Business education institutions and instructors cannot afford to neglect the way executives perform in business (*e.g.*, automatically dealing with corporate technology, virtual collaboration, electronic decision making systems, overcoming geographic barriers – time and space concepts), where the cadence of business naturally demands the support of technology. Therefore, instructional designers are expected to incorporate similar solutions in order to at least minimize the gap in the transfer of learning (output), and match new styles and characteristics to the new generation of learners (input).

The Need for Technology in Business Education

The discussion on learner needs can be broad. If we think about distinct learner characteristics (e.g., age, gender, field of study, experience level) and other elements, we will find several dimensions influencing the aforementioned concept of learner needs. However, it is relevant to ponder the potential of the educational technology in this matter. For instance, the three neural networks (recognition, affective, strategic) as discussed by Rose and Meyer (2002), can be better addressed with the support of technology. It seems that when comparing the more traditional educational environment with the ones relying more heavily on technology, the possibilities of meeting the needs of learners, with the support of technology, are even higher.

When thinking about learning needs and learner uniqueness (mainly based on the three major learning neural networks: recognition, strategic and affective) it is almost essential to consider that the one-size-fits-all traditional educational approach is not an answer. According to Rose and Meyer (2002, p. 41) “flexibility in media is the key to providing instruction that reaches more students, more effectively”. This is something that we can expect when embedding technology into the educational environment, making it more capable of dealing with several alternative electronic formats and with telecommunications as well. Beyond flexibility, according to Allen, Otto and Hoffman (2004, p. 216), we can also observe “advantages of ... media technology ... against possible loss in representational fidelity,” which may improve the overall learning experience adding increasing its meaningfulness.

Tied to this concept of flexibility empowered by technology, another relevant aspect is support for both direct and indirect learning. Schwartz, Martin and Nasir (2005, p. 24) explain the difference between first- and second-hand theories: “first-hand theories focus on direct experience, and second-hand theories focus on descriptions of experience (*i.e.*, communicated knowledge)”. Addressing a particular aspect of first-hand theories, the authors highlight: “no amount of reading is sufficient to learn to drive a car” (p. 24). They also mention that “an incalculable amount of people’s knowledge comes second-hand from books, and understanding how this happens is important... we doubt that second-hand theories are sufficient for prescribing instruction” (p. 25). Applications of both first- and second-hand theories are more likely to occur relying on technology rather than traditional chalk-and-talk.

Similarly, Johansson and Gardenfors (2005) discuss aspects of behaviorism, cognitivism, sociocultural and situated cognition, and constructivism, based on Dewey’s learning by doing approach and the paradigm of information and communication technology (ICT). Regarding the methodological framework (pedagogy), it is reasonable to consider that none of the approaches (*e.g.*, behaviorism, cognitivism) offer the ideal solution. According to Schwartz *et al.* (2005) focusing on an integrative approach is a good way of dealing with methodological isolationism (cognitive mechanism and outcomes of learning), as well as focusing on an instrumental approach (*i.e.*, future learning). Technology in business education should be aligned with this experiential approach, supported by many theories. Duffy and Jonassen (1992), expanding on constructivism and consequent multiple world views and meanings, stress implications for technology of instruction as a robust enabler of conditions required by (and part of) the new educational environment, aligned with current learner needs.

In order to achieve successful and meaningful learning experiences, with technology-based instructional designs, there is one variable that will always be present, demanding attention throughout the entire learning cycle: fidelity. This variable brings together at least two main concepts discussed here and connected to Dewey’s (1939) position on social and environmental meaning present in the educational experience: transfer of learning and experiential learning (A. Y. Kolb & Kolb, 2009; Gardner & Korth, 1997). The level of fidelity embedded in a particular learning experience will set the tone for the transfer of learning, based on the quality of the learners’ experience. Information and communication technology (ICT) can leverage the quality of learning experience by introducing a different set of resources to equip both instructors and learners to better achieve their goals within

business education. Seels, Fullerton, Berry and Horn (2004), by analyzing media (*i.e.*, TV and movies) and concerned with ways of improving the meaningfulness of a particular learning experience in management education, present and discuss functional characteristics of learning technologies, stressing realism or fidelity as a relevant aspect to be considered when tying technology to learning.

Games, Simulations and Virtual Reality in Business Education

The dynamic business environment is rich in interactions, time constraints, pressures, competition, people issues, emotions, indirect intentions and unaligned goals; in other words, a world much less precise and linear than what a medieval textbook-chalk-and-talk approach can ignite in students' minds. It is also true that with an ever-increasing dependency on business software the decision-making process is becoming more electronic every day (e.g., collective and computer-based). Research was conducted by Faria and Wellington (2005) to gather evidence from "outcomes reported over the past 40 years from the ongoing PIMS (Profit Impact of Marketing Strategies) project as now administered by the Strategic Planning Institute" (p. 259), involving the General Electric Company and Harvard Business School. Based on reports from 717 business game companies (PIMS), and acknowledging the presence (games results) of appropriate strategies and real-world connections, the authors present positive evidence of business games as a relevant and meaningful teaching tool.

As can be observed from these examples, some areas will benefit more from a particular technology than others, but in general terms technological solutions may interfere (positively) with the learning process (if appropriately considered), due to the natural presence of technology in society, where professionals will actively become involved with the procedures that they have learned in their educational process. Again, it is a matter of narrowing the gap towards a better condition for transfer of learning. In addition, a combination of technologies may also provide intense beneficial outcomes, such as the reported case of gaming and simulation techniques with online instruction (Rude-Parkins, Miller, Ferguson, & Bauer, 2005). Boehle (2005), while analyzing the use of simulations in eLearning, presents some key points discussed by experts as ways of promoting an appropriate experience: (a) selecting the right simulation for the right need; (b) rethinking the evaluation method; (c) deciding what the goals are upfront (being specific); (d) looking for the right mix of collaboration and feedback; (e) simulating the real world, but not too closely; and (f) involving senior management. Judging by these comments, it is clear that technology may provide a good or bad learning experience, depending on the way it is planned and incorporated into the curriculum.

Another concern is presented by Kline (2004, p. 141) when considering that enthusiasts of the information and communication technology approach to education may be ignoring risks and associated costs while putting "the future of both schooling and children's leisure into the hands of the various global corporations and organizations that can afford to design and distribute interactive entertainment worldwide". This is a particularly important concern if corporations with clear and fair distinct interests may bypass or replace the traditional freedom of discussion and speech in education (*e.g.*, postsecondary education). But, let us assume here that the flexibility of selection and decision on what to use still remains in the agents' hands (*e.g.*, educational institutions, learners and instructors).

The case for simulations is openly made by Aldrich (2004, p. 7), based on organizations that care the most about training (due to the major fact that in case of an error, people would die): airlines training pilots and the military training soldiers. He stresses simulations as the learning method selected for such cases, because "people learn by doing" (p. 9). Classifying simulations into four genres, Aldrich (2005) mentions that they are all valid and relevant in terms of educational perspective. The genres are: (a) interactive spreadsheet, (b) virtual labs and virtual products, (c) branching story and (d) game-based models. Ranging from linear to dynamic and from instructor-supported to stand-alone, a wide variety of educational simulations is presented by Aldrich (2005): game-based, branching stories, virtual labs, adventure games, traditional role plays (including mock congress), workflow modeling and predictive simulations, airline flight simulators, war games,

technology assisted role play, interactive spreadsheets, virtual products, simulation computer games, real-time strategy games, multi-player games and first-person shooters. Thus, depending on the purpose of the educational model, a specific approach would be more appropriate.

When interpreting the successful connection of such technologies with education, Herz (2002, p. 34) explores the idea that this is a natural fact: games are appealing in educational terms because there is an “innate human desire to compete and collaborate”. This brings another perspective to the discussion: it is not only a matter of using appropriate technology that will be available to learners when performing in real-world conditions, but also a natural condition of human-beings that can be explored to achieve better results. It is interesting to stress that competition is not an answer to all problems, and that is why collaboration is very relevant in the game context. The combination of these two elements tends to lead to a better approach of games and simulations to education and corporate needs.

Michael and Chen (2006, p. 145) recorded that “corporations have a wide variety of training needs and have shown an increased interest in using serious games in the workplace”. They also discuss the main characteristics (voluntary, pretend, immersive, limits of time and place, rules, social) of games and provide a definition: “a voluntary activity, obviously separate from real life, creating an imaginary world that may or may not have any relation to real life and that absorbs the player’s full attention” (p. 19). Moreover, concerning “serious games, the authors stress the idea that they “often violate one of the six characteristics...in that they aren’t always voluntary activities” (p. 21). They define serious games as “a game in which education (in its various forms) is the primary goal, rather than entertainment” (p. 17).

Discussing video games, played actively and critically, Gee (2004, p. 48) states that “they situate meaning in a multimodal space through embodied experiences to solve problems and reflect on the intricacies of the design of imagined worlds and the design of both real and imagined social relationships and identities in the modern world”. Based on this rich environment, the issue is related to a player used to such an inventive and imaginative context to keep high motivation levels at school, where the appeal of the traditional environment is, at least, different. The same concept is presented by Gee (2005, p. 15) in another context: “when we think of games, we think of fun. When we think of learning we think of work”.

What games ultimately offer to education is a new way of combining resources and improving the learning process, based on a very different perspective of the user (learner). New generations are first consumers of the gaming industry and later they will be consumers of the education industry. As higher education is the object of study here, this gap is clear.

Beck and Wade (2004), based on their study involving 2,500 participants, mainly business professionals (p. 21), affirm that the “gamer generation”, with an estimate of about 90 million people (p. 59), is self-educating, while also presenting a very different learning style it “aggressively ignores any hint of formal instruction; leans heavily on trial and error...; includes lots of learning from peers but virtually none from authority figures; is consumed in very small bits exactly when the learner wants, which is usually just before the skill is needed” (p. 159). Throughout their study, Beck and Wade (2004) mention a relevant set of characteristics of the **game generation** very different from others, including multitasking, concentration, heroism, team playing, risk taking, problem solving strategies, trial-and-error approach, hands-on learning, first-person perspective and low level of need for authority.

In this line, but concerned with the basis of some results supporting games in education, Zyda (2005) highlights that “while much speculation regarding these benefits is anecdotal, substantive evidence show that game experiences affect digital-game natives positively” and continues by saying that “if researchers construct and perform their studies carefully, they may be able to harness these positive effects for societal gain” (p. 26). This positive view of the power and sophistication of simulations and games is also shared by Foreman (2004), within the context of corporations and universities.

In addition, using the perspective of corporations, Michael and Chen (2006) offer a list of skills in which corporations need their employees trained, with potential for using game-based learning: job-specific skills, people skills, organization skills, communication skills and strategy skills. They also present an incomplete list of corporate universities as potential markets for serious games: McDonald's Hamburger University, JPMorgan Chase Executive Learning Center and Motorola University.

Moreover, virtual reality (VR), the ultimate display based on the concept of illusion, also has its potential use in business and business education. As presented by Mujber, Szecsi, and Hashmi (2004), in manufacturing, VR applications (virtual manufacturing) can make considerable contributions, impacting positively the cost-benefit analysis. With manufacturing design applications (*e.g.*, product design, prototyping) and operations management applications (*e.g.*, planning, simulation, training) the authors discuss a wide range of benefits from VR. Chen and Toh (2005) present a successful instructional use, based on constructivism, of a Virtual Reality (VR) learning environment in car driving training in Malaysia (justified by high rates of accidents), with high potential to overcome the observed limitations of traditional methods.

Based on these concepts of games, simulations and virtual reality and some examples of how they can improve the learning process, mainly considering the business education context, let us consider the instructor's situation and the learner's needs and preferences. Ghosh (2003), after inviting 14,497 educators, all members of ABSEL (Association for Business Simulation and Experiential Learning), ISAGA (International Simulation and gaming Association) and AACSB (Association to Advance Collegiate Schools of Business), gathered feedback from 1,085 respondents on the adoption of business education simulations. With only 31% of adopters, Ghosh stated that business educators were at the late majority group stage, considering simulation game adoption (2003).

On the other hand, we must abide by the saying **the user is king**. In this information and communication technology (ICT) era, hardware and software solutions must mingle with the user. The discussion on cognitive efficiency and workflow sets the tone for this approach. Nevertheless, it is important to consider that this new generation is becoming even more accustomed to well-suited hardware interface between human and machine and must be expecting increasingly more fit. This is to say that alternative improved ways of connecting (input and output) man and machine are expected to come naturally and the educational design must be willing to consider and explore such a natural evolution. Not only hardware but also software related to human-computer interface (HCI) is rapidly evolving in such a way that learning must be supported by more effective activities. Therefore, designing instructional materials and planning and developing educational environments based on this framework require (a) awareness of ICT, followed by a precise set of KSA (knowledge, skills and attitudes) related to exploring the technological potential to an appropriate extent and (b) clear understanding of the users: both learners and instructors. These are all somehow related to fidelity levels.

Aligned with these main elements, Gee (2005) presents a well-constructed line of thought regarding the underlying principles of games in education. Contrasting the gaming solution with the traditional classroom approach, Gee covers aspects of learning focusing on motivation and experience, while providing a generous set of examples focusing on each discussed learning principle. Thus, it is reasonable to consider the relevance of games, simulation and virtual reality as new technologies that can contribute to business education when appropriately used.

Learning from experience: a key concept in adult learning

After connecting these ideas, it is possible to see the clear potential of well-designed games, simulations and virtual reality solutions attached to improved educational environments as a way of moving the learning experience to a new level. Judging by examples from seminal literature (Dewey, 1939; D. A. Kolb, 1984), it seems that this new level includes a great deal of experiential learning (learn by doing), with potential to fail when you can afford to fail, and interacting with variables in such a way that traditional solutions cannot offer. This richness of learning was defended by Dewey

(1939, p. 139) who stressed that “when we experience something we act upon it, we do something with it; then we suffer or undergo the consequences”. The result is a profound construction of meaning that can be directly or indirectly related to the environment where it can be applied. Bill (2003, p. 1) concludes that “knowledge has very little use unless it is associated with a real world application,” advocating the use of computer simulation for experiential learning.

Experiential learning has been analyzed and used by institutions, instructors, scholars, learners and others for a long time as an appropriate way of facilitating adult development. Merriam and Caffarella (1999) discussed the experiential learning model of Usher, Bryant and Johnson from 1997, with the core concept of learning from experience as aiming for an “individualized self who uses experiences as ‘raw materials’ to be acted upon by the mind through the controlled and self-conscious use of the senses (observations) and the application of reason (reflection)” (Merriam & Caffarella, 1999, p. 237). In a similar line, from a current report, A. Y. Kolb and Kolb (2005) stress six propositions involved in experiential learning as opposed to the transmission model: (a) learning is best conceived as a process, not in terms of outcomes; (b) all learning is relearning; (c) learning requires the resolution of conflicts between dialectically opposed modes of adaptation to the world; (d) learning is a holistic process of adaptation to the world (not just the result of cognition); (e) learning results from synergetic transactions between the person and the environment; and (f) learning is the process of creating knowledge. Therefore, learning by doing makes a lot of sense in adult education and in business education, with clear consequences for the levels of fidelity in learning artifacts.

When aiming at promoting changes in behavior, knowledge, skills and attitude, the experiential learning cycle is regularly applied (Keys & Wolfe, 1990). Kolb’s experiential learning theory (D. A. Kolb, 1984) justified the use of rich and active learning environments, such as business games. These ideas from Keys and Wolfe (1990) indicate that, when related to business game facilitated learning, the experiential learning cycle should be considered. This affirmation is stressed by Fripp (1984) while discussing the use of business games in managerial training: “the best known theoretical approach to learning, which supports the need for managers to have an active orientation and, at the same time, a more passive and thoughtful one, is due to Kolb” (p. 27).

The literature offers several positive examples of experiential learning initiatives based on games, simulation and virtual reality, presenting sound indicators of quality and effect on learning. In management, some of these examples include: (a) business simulation in accounting to support critical thinking (Springer & Borthick, 2004); (b) experiential learning methods in business strategy (Joshi, Davis, Kathuria, & Weidner, 2005); (c) simulations in the initial startup phases of eBusiness creation in online economy (Jiwa, Lavelle, & Rose, 2005); (d) eMail-based management simulation (Greenberg & Rollag, 2005); (e) simulation based on team information acquisition and performance (Boone, Olfen & Witteloostuijn, 2005); and (f) HRM development and strategic management simulations (Trim, 2004).

Many perspectives can be used when considering fidelity, but three are of particular relevance to this study: according to the synthesis of the literature reviewed by Alexander, Brunyé, Sidman and Weil (2005), (a) physical fidelity (PhF) is defined as “the degree to which the physical simulation looks, sounds and feels like the operational environment in terms of the visual displays, controls and audio as well as the physics models driving each of these variables” (p. 4), (b) functional fidelity (FuF) is defined as “the degree to which the simulation acts like the operational equipment in reacting to the tasks executed by the trainee” (p. 4), and (c) psychological fidelity (PsF) is “the degree to which the simulation replicates the psychological factors (*i.e.*, stress, fear) experienced in the real-world environment, engaging the trainee in the same manner as the actual equipment would in the real world” (p. 4).

Synthesizing evidence in this area Kayes (2008) registers general optimism about experiential learning in management education, stressing the relevance of simulations and the use of electronic technology: “experiential learning encompasses many different types of pedagogical strategies, including critical pedagogy, narrative-inspired self-reflections, simulations and electronic technology” (p. 430). He resumes by claiming “to be optimistic about the future of experiential learning... and ...

more aware than ever that learning is a struggle, both between individual and institution, as well as within oneself" (p. 430).

Fidelity and Transfer of Learning

Virtually present in all instructional design efforts is the quest for a richer transfer of learning, which involves an intense comprehension of the work environment and learner needs (Rothwell & Kazanas, 2004) along with a strong set of learning objectives exploring the wide range of cognitive, affective and psychomotor dimensions. The decision about instructional strategies, artifacts, content and process tends to become easier as these goals and barriers for transfer of learning become better controlled.

In the interest of perfecting management education experiences in light of the transfer of learning and improved realism, simulations and business games appear as relevant artifacts, which can be linked to Henning's (2004, p. 144) concept of "representational practice of the participants in ... diverse learning situations" for improved construction of meaning.

Fidelity or, as mentioned above, the level of realism these artifacts can incorporate from the real world (Alessi, 1988; Backlund *et al.*, 2009), is often considered in the literature because of potential interactions with quality of learning (A. Y. Kolb & Kolb, 2009) and quality of transfer (Gardner & Korth, 1997), to mention only two aspects. Allen *et al.* (2004), when sharing examples of perceived quality or realism of mediated environments, mention that photographic realism is not always relevant, but "omitting key invariants that affect user actions is very likely to adversely affect perceived fidelity" (p. 224).

Beyond the concept of fidelity, scholars considered the idea of fidelity level interacting with learning outcomes, with a proposed association between degree of fidelity and level of learner experience (Alessi, 1988; Backlund *et al.*, 2009). Gredler (2004), when discussing games and simulation and their relationships to learning, stressed important characteristics of simulators:

(a) an adequate model of the complex real-world situation with which the student interacts (referred to as fidelity or validity), (b) a defined role for each participant ... (c) a data-rich environment that permits students to execute a range of strategies ... and (d) feedback for participant actions (p. 571).

Gredler (2004) also indicates the relevance of high-fidelity levels as quality boosters of experiential simulations.

Hays and Singer (1989) pointed out that it could be cost effective for novice trainees to utilize low fidelity devices during the early stages of learning. Based on this, instructional designers would be able to adopt low-fidelity artifacts at the beginning and high-fidelity ones by the end of a program.

Thus, in discussing fidelity level it seems reasonable not only to aim for the highest possible realism, but also to ponder the marginal benefits of increasing a unit of realism, in light of needs assessment, learner characteristics, content, process, environment and required transfer of learning. Blaiwes and Regan (1986) believe that in simulation the goal is to provide a learning environment, not a vehicle for trainees to exhibit perfect performance.

After reviewing relevant literature in this area, Gredler (2004, p. 576) registers a lack of literature addressing "fidelity of the experience for students," with "only sketchy anecdotal evidence or personal impressions of the success". The author goes on to address the dimensions of epistemic fidelity and fidelity of interaction in specific computer-based simulations as enablers allowing students "to develop strategies that are consonant with the demands of real-world situations (reality of function)" (Gredler, 2004, p. 578).

In short, regardless of their realism, to society in general, such elements as games, simulations or virtual reality may appear to be well connected with entertainment and mainly with those who can afford the time required to 'play' with them. As we were able to observe, however, this is not the case in the current context of education, where such technologies can, in fact, improve the learning experience and interact with transfer of learning.

Method

Management education, as observed in the literature, may take advantage of specific instructional artifacts to accomplish its main mission. In this study, the main research question is linked to simulation fidelity and the presence of game-based educational technology as an MBA program intervention: To what extent do MBA students tend to recognize specific game-based academic experiences, in terms of fidelity, as relevant to their managerial development? Two distinct game-based interventions, controlling for levels of fidelity (i.e., physical, functional and psychological) were explored. How educational perspectives and theories may help explain such facts, and to what extent this empirical evidence can stimulate management education research on the topic, are issues set to be addressed.

The study set out to explore two game-based management education interventions that have been part of the same MBA program. In this specific MBA program curriculum, students must take two game-based courses: one mirroring a manufacturing organization, and the other mirroring a banking institution. For the purpose of this study, the manufacturing business game is labeled BG₁ and the banking game is labeled BG₂. After many years of application, both courses have come receive a warm welcome from the students and the final impressions (and feedback) are, overall, very positive, although these two interventions offer very distinct characteristics with major differences in fidelity levels. Seven dimensions are explored to represent the characteristics and differences of these two games: (a) infrastructure, (b) system, (c) supporting materials, (d) teams, (e) pace, (f) instructor and (g) fidelity.

First of all, while BG₁ is based on a well-known off-the-shelf product, running over the Internet, BG₂ is based on proprietary software, capable of running over a local area network. Secondly, BG₁ is a robust software solution, capable of handling many more input variables and parameters, with natural massive amounts of outputs, whereas BG₂ has a more limited flexibility in this respect. Thirdly, BG₂ offers print versions of supporting materials, but tends not to rely on them during the experience, while BG₁ has two textbooks, a large student guide and other online materials for in-game consultation. Fourthly, both games operate with the concept of teams of students working together to accomplish goals related to the company they are running as executives, but the actions performed by the teams and team members differ: BG₁ is more strategic-oriented while BG₂ is more operational and transaction-oriented. Fifth, the pace (or rhythm) of the game in BG₁ is lower if compared to the pace of BG₂. In BG₂ students tend to feel much more stress related to approaching deadlines. Sixth, the BG₁ instructor has a more passive approach with the team, tending to keep in-class interventions at a low level (unless it is for the change in parameters, commenting on overall results, and responding when asked for support or help, according to the rules of the game). On the other hand, the BG₂ instructor has a much more active and intervening role, which naturally creates more psychological challenges for the teams. Finally, these two interventions have very distinct characteristics in terms of fidelity levels. Table 1 contains a summary of these differences in the three elements of fidelity as discussed by Alexander *et al.* (2005): (a) physical fidelity (PhF); (b) functional fidelity (FuF); and (c) psychological fidelity (PsF).

Table 1

Game-based Interventions

Elements of Fidelity	BG ₁	BG ₂
Physical	High	Moderate
Functional	High	Low
Psychological	Moderate	High

Across these three elements of fidelity, a symmetrical (complementary) image of these two interventions can be observed. It is noteworthy that BG₂ is much more oriented towards psychological fidelity due to its transactional approach (more operational). BG₁, on the other hand, offers a more complete and bold system solution, with higher levels of realism when compared to real world situations, being an example of high levels of physical and functional fidelity, with implications for the meaningfulness of the experience. Both artifacts were classified based on the application of this framework along with an analysis of their characteristics, after adoption with several cohorts.

As discussed in the literature, low-fidelity simulators (LFS) are expected to reach good levels of learning outcomes when used at earlier stages in a program, while high-fidelity simulators (HFS) tend to offer better results when employed at the end of a program (*i.e.*, capstone course). This research protocol involved these two interventions as capstone courses, right at the end of the MBA program, with students taking both courses at the same time (intercalating sessions). Although the same cohort was taking these two final courses at the same time, the teams were different in each course (different students). Thus, the same student experienced both games, with different teammates, and gave his or her reaction, as requested, shortly after completing the courses. This was designed as a repeated-measures study.

The nine main directional research hypotheses essential for the study, and stimulated by the literature review, are presented next. All hypotheses tests are based on data about participants' self-evaluation collected shortly after the experiences. The first three hypotheses deal with overall perceived quality of the game-based intervention.

H1a. Participants perceive a high overall quality (over 80%) of BG₁.

H1b. Participants perceive a high overall quality (over 80%) of BG₂.

H1c. Participants perceive a higher overall quality of game-based intervention in BG₁ in comparison with BG₂.

The second set contains six hypotheses. It deals with quality elements of each game-based intervention, according to each main variable of the data collection instrument.

H2a. Participants rated system operation of business game BG₁ as more clear and objective in comparison with BG₂.

H2b. Participants rated conditions for testing strategies present in business game BG₁ as better than those present in BG₂.

H2c. Participants rated business and market models present in business game BG₁ as better than those present in BG₂.

H2d. Participants indicated that business game BG₁ better complements the program curriculum in comparison with BG₂.

H2e. Participants indicated that the pace in business game BG₁ better stimulates learning in comparison with BG₂.

H2f. Participants indicated that the fidelity level of business game BG₁ better supports real world performance in comparison with BG₂.

Study Type

This is a non-experimental study with descriptive and causal-comparative designs, developed in light of the exploratory framework (Gall, Gall, & Borg, 2003). This empirical study involves exploratory research due to the facts described above concerning the characteristics of research on fidelity and management education, while also focusing on the support of further initiatives in this field. According to Creswell (2003, p. 7) “we cannot be positive about our claims of knowledge when studying the behavior and actions of humans”. However, we may interpret our findings based on sound research designs. This approach involves gaining proper knowledge of an object on which sufficient information is lacking (Selltiz, Jahoda, Deutsch, & Cook, 1959).

The study is based on direct measurement (Rea & Parker, 1997), involving a set of techniques to collect, record, compile and analyze data, supporting the quantitative interpretation of facts. It relies on a quantitative approach while surveying students using a valid instrument. Also based on the framework proposed by Creswell (2003), the survey is the main strategy of inquiry in this study, with a quantitative orientation. Moreover, the literature review sustains the analysis of prior research, providing the necessary foundation required by this study.

In addition to descriptive statistics, studies and tests on the comparison of means were conducted in order to achieve the established goals. Calculations and statistical tests were developed with SPSS[®], adopting the .05 significance level for all the directional hypotheses.

Sampling, Dataset, and Instrument

The sample was obtained via a non-probabilistic method, employing intentional sampling due to both access and the purpose of the study. Selltiz, Jahoda, Deutsch and Cook (1959, pp. 514-515) mentioned that “in nonprobability sampling, there is no way of estimating the probability that each element has of being included in the sample, and no assurance that every element has some chance of being included”. Data from a top-ranked MBA program in Brazil were collected during the second academic semester of 2009. The institution was intentionally selected, due to its reputation (especially relevant for this study), providing a convenience sample. This sample includes 31 formally enrolled MBA students, all in the last stage of the program. All subjects participated on a voluntary basis and signed a consent form, in accordance with usual research procedures required by the institution in question. By adopting paired *t*-test analyses with this sample size, the study has design sensitivity to render the appropriate power level for detecting effect sizes of 0.4, based on the significance level of 0.05. According to Bickman and Rog (1998), the power level of a two-tailed test under these conditions is 0.4, lower than what was obtained here due to the adoption of one-tailed tests.

The data collection instrument was prepared based on constructs from the literature and pilot-tested for comprehension following discussion with two specialists. Students answered the instrument in three parts: (a) simulation fidelity (six five-point Likert scale items), (b) positive and negative assessments of the two learning experiences (four open items), and (c) relevance of fidelity for management development (one open item). Data from the second and third parts of this instrument were not targeted by this study. Variables in the first part are: F₁ (clear and objective system operation), F₂ (good conditions for testing strategies), F₃ (good business and market models), F₄ (experience complements the program curriculum), F₅ (game pace stimulates learning), and F₆ (fidelity level favors real world performance).

All results from the paper-based instrument were recorded in a MS-EXCEL file and double-checked for errors. After all the auditing, the dataset was exported to SPSS®.

Data Analysis and Findings

Descriptive statistics

Data from the sample ($n=31$) of formally enrolled MBA students were first used to gauge their responses (repeated measures) related to each of the two game-based interventions. The descriptive statistics, including means and standard deviations, are shown in Table 2.

Table 2

Mean, Standard Deviation, Confidence Interval, *t* test, and Cohen's *d*

Variables	Descriptives: BG ₁ and BG ₂				<i>t</i> test ^a	Cohen's <i>d</i>
	BG ₁		BG ₂			
	Mean (SD)	CI 95% ^b Max Min	Mean (SD)	CI 95% ^b Max Min		
F ₁ - Clear and objective system operation	3.74 (0.93)	4.08 3.40	3.68 (0.95)	4.02 3.33	.389	0.0638
F ₂ - Good conditions to test strategies	4.42 (0.81)	4.72 4.12	3.10 (1.14)	3.51 2.68	.000	1.3538
F ₃ - Good business and market models	4.19 (0.83)	4.50 3.89	3.84 (0.86)	4.15 3.52	.020	0.4142
F ₄ - Experience complements the program curriculum	4.45 (0.81)	4.75 4.15	3.94 (0.96)	4.29 3.58	.000	0.5763
F ₅ - Game pace stimulates learning	4.29 (0.74)	4.56 4.02	3.84 (1.04)	4.22 3.46	.012	0.5056
F ₆ - Fidelity level favors real world performance	4.06 (0.89)	4.39 3.74	3.61 (0.88)	3.94 3.29	.021	0.5085
Overall	4.19 (0.60)	4.41 3.97	3.67 (0.72)	3.93 3.40	.001	0.7879

Note. $n=31$; ^a= one-tailed paired *t* test; ^b= confidence interval (95%).

Overall, scores gathered from students' responses are well above the mean point of the adopted five-point Likert-scale. When looking for extremes, both the highest and the lowest score in the variable F₂ can be identified (good conditions for testing strategies): the lowest reported mean score was 3.10 (BG₂), and the highest mean score was 4.42 (BG₁). Considering that BG₂ has lower levels of both physical and functional fidelity (low-fidelity simulator, or LFS), the idea of better conditions for testing strategies in BG₁ seems plausible.

In all other variables, the average means for BG₁ always exceed those for BG₂, with no exceptions. In this case, and accepting the natural limitations of the sample, a higher psychological

fidelity level (which is the case for BG₂) tends to generate not as much influence over these elements when compared to the combination of higher levels of physical and functional fidelity. It is important to stress that the pace in BG₂ was much faster, creating a higher level of psychological fidelity along with all the intended consequences attached to it (e.g., stress, hurry, less-than-ideal information gathering, etc.), based on responses to open-ended items. This approach is expected to mirror, in a better way, the actual real-world negotiations explored by the game-based intervention. However, the psychological experience and outcomes tend to limit students report about the addressed variables. Somehow this is reflected by the variance (second higher level) present in responses to item F₅, for BG₂.

Tests of overall perceived quality

Following the descriptive analysis, the variables were tested for normality, and all directional hypotheses were tested using parametric statistics. Results from the first set of hypotheses related to overall perceived quality of the game-based intervention are explored first.

After testing the hypothesis that participants perceive a high overall quality (above the established threshold of 80%) for BG₁ (hypothesis 1a) and BG₂ (hypothesis 1b), there is evidence to support hypothesis 1a ($t(30) = 1.793, p = 0.041$, one-tailed, $M = 4.19, SD = 0.60$). However, hypothesis 1b was not supported ($t(30) = -2.582$, n.s., $M = 3.67, SD = 0.72$). The third hypothesis was intended to check whether participants perceive higher overall quality of BG₁ when compared to BG₂. Results supported hypothesis 1c ($t(30) = 3.582, p < 0.001$, one-tailed). Therefore, these findings reveal higher overall perception of quality towards BG₁.

Test results for the second set of hypotheses are analyzed next. All hypotheses in this set dealt with quality elements of each game-based intervention, according to each main variable of the data collection instrument. When studying hypothesis 2a (focusing on variable F₁), the results did not support the assumption of difference in participants' perceptions ($t(30) = 0.284, p = 0.389$, one-tailed). In other words, they found that the levels of system operation, in terms of being clear and objective, for BG₁ were not higher than those for BG₂.

The test results for hypothesis 2b (focusing on variable F₂) supported the assumption of BG₁ being perceived as offering better conditions for testing strategies when compared to BG₂ ($t(30) = 4.864, p < 0.000$, one-tailed). Likewise, hypothesis 2c (focusing on variable F₃) was also supported ($t(30) = 2.160, p < 0.020$, one-tailed). Thus, evidence was found to support the assumption that business and market models are better in BG₁.

The test on whether the BG₁ experience was a better complement to the program curriculum, when compared to BG₂ (F₄) provided sufficient evidence to support hypothesis 2d ($t(30) = 3.542, p < 0.000$, one-tailed). Similar results were found when testing whether the pace in BG₁ offered better conditions to stimulate learning, in comparison with BG₂ (F₅). Thus, hypothesis 2e was also supported ($t(30) = 2.373, p < 0.012$, one-tailed). Finally, the test results supported hypotheses 2f ($t(30) = 2.133, p < 0.021$, one-tailed), which dealt with the assumption that the fidelity level of BG₁ better supported real world performance, when compared to BG₂.

To sum up, these findings show that participants rated BG₁ as (a) better for testing strategies, (b) offering better business and market models, (c) having a pace that better stimulates learning, and (d) presenting fidelity level that better supports real world performance (all in comparison to BG₂).

Conclusion

Agents involved with postsecondary business education and corporate training not only observe but also sense the relevance of technology to the improvement of the learning experience. However, some agents decide not to fully operate, or cooperate, in this direction due to conditions such as traits, emotions, or expectations. Thus, by overcoming this obstacle we may improve the power of the decision and, consequently, the final results. This can be achieved with actions during all phases related to the use of these technologies in management education, for instance: acting on awareness, instructional strategies, methods, examples and clear reports about achieved results (both positive and negative).

One of the roles of games, simulations and virtual reality, as components of the learning process, is to narrow down the gap between the use of technology by those providing support for learning (*e.g.*, institutions and instructors) and avid consumers (*e.g.*, students). Merely comprehending the generation gap, in terms of these technologies, is not enough. Promoting changes in management education to take advantage of such situations is a required action. It is noteworthy that, based on the established discussion, the presence of these new technologies does not tend to be superficial, but dense and intense, by promoting experiential learning.

As observed in this study, we can ponder the balance of the educational technology function in management education between the extremes of **motivator artifacts** and **real and in-depth** components of learning. It is clear that certain types of educational technologies will act on motivation and attention levels, improving the learning experience (*i.e.*, in-class remote devices, document camera, course websites). However, when comparing a different educational solution that changes the traditional passive relationship between students and instructor to the chalk-and-talk approach, we are talking about an entirely new, real and in-depth component of learning, with potential impact on the meaningfulness of the educational experience. Elements such as interaction, experience, peer-learning, participant-centered, fidelity, alternative scenarios, fun and immersive involvement are just some characteristics of games, simulations and virtual reality solutions that can be used to improve management education as in-depth components of learning.

Based on the results of this study, it is important to highlight that these educational solutions have a potential to bring positive aspects to learning. Nevertheless, in order to actively obtain such benefits, all agents must be motivated and willing to explore the new and, sometimes, the unknown, dealing with negative emotions, feelings and fears. It involves the readiness to try and err, and also to learn collaboratively. Thus, it is a matter of being able to appropriately plan, design, select, decide, test, implement, use, track and adjust a particular new educational solution to a particular learning process.

These results showed the relevance of high fidelity levels of game-based interventions in management education, mainly in terms of physical (PhF) and functional (FuF) dimensions, with overall great learning outcomes from the student's standpoint. This is critical for management education, where transfer of learning and focus on the application environment tend to be relevant. From these results it can be claimed that students tend to welcome instructional strategies focusing on higher fidelity (physical and functional), which tends to minimize the gap related to transfer of learning in business environments. Thus, this study, assuming its limitations and reach, arrives at the conclusion that MBA students tend to recognize, to a large extent, that specific game-based academic experiences are relevant and meaningful to their managerial development, mostly with heightened fidelity levels of adopted artifacts.

New challenges are present (every day) in higher education and corporate training, especially in management education, due to dramatic changes in socioeconomic contexts in the world and the emphatic response from the business world (*e.g.*, corporations), in such a way that agents of the educational process (*e.g.*, institutions, instructors, learners) simply cannot afford to disregard such high-level educational technology solutions.

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