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Evaluating the educational effectiveness of simulation games: A value generation model

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ABSTRACT

This article investigates the relationships between various types of educational value generated by the Markstrat simulation game. Considering several theoretical models of experiential learning and the research framework proposed by previous studies, an educational value generation model is developed and validated, using primary data collected from 305 UK-based students. Four types of educational value are identified: experience generation, conceptual understanding, skills development, and affective evaluation. The application of structural equation modelling indicates several significant relationships: experience generation has a strong impact on conceptual understanding, and both of them have medium to high direct impacts on skills development. On the other hand, the participants' perception regarding the professional skills developed during the simulation game determines their affective evaluation of the Markstrat exercise. The model presented in this study is generalizable to other simulation games, and to other academic disciplines that implement the same experiential learning approach.

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1. Introduction

Serious games and simulations represent an important revolution in education, providing an effective pedagogical tool for active, experiential, problem-based learning [16,22,24,78]. As experiential learning became increasingly popular for academic and professional training, important questions have been raised about how to understand learners' experience, and how to conceptualise the relationships between learning and learners' perceptions of their experiences [20,92,93].

Despite the widespread use of simulation games in education, little is known about how they work [62]. Most existing studies are focusing either on their operationalisation [26,32,72,80,82,97] or on the objective assessment of learning objectives [3,8,14,54], neglecting the way in which students make sense of this pedagogical exercise or perceive the relationships between various learning outcomes. This knowledge gap is particularly surprising if we consider that simulation games are applied in experiential learning, which is defined as a learner-centred approach [27,56]. Addressing this knowledge gap, our

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study develops and validates an educational value generation model, which presents the relationships between the learning experience and the outcomes of the Markstrat simulation game, as perceived by students.

2. Games and simulations as pedagogical tools: Differences and synergies

Although educational games and simulations are often used as interchangeable concepts [30], several authors [32,78,81] outline their specific characteristics, which impact on their pedagogical application [81].

Games are defined as a goal-directed, competitive activity (against the computer, another player, or oneself), conducted within a framework of agreed rules [63]. The specific attributes of games are:

- *players*: individuals that assume a role or make decisions within the game context [81]. Educational games involve learners who adopt role playing and decision making, either individually or as a group;
- *goals*: represent the predetermined objectives of the game, which justifies players' involvement and confrontation, and shapes the direction and purpose of players' decisions and behaviour [79,81]. Educational games have both explicit (winning the game) and implicit (learning from the experienced situation) goals, that need to be properly aligned and integrated in their design and implementation [32,78];
- *rules*: sets of guidelines that describe and shape the interaction between players and the game environment [47]; they specify the nature, structure, sequence and extent of allowable player action [32,40]. In the case of educational games, these rules structure participants' behaviour to maximise learning;
- *conflict*: in their attempt to reach the game goal, players engage in competitive confrontation [51,53], either against obstacles embedded in the game environment and/or against other players; the challenges raised by this confrontation involve and motivate players to take decisions in pursuit of their final goal [65]. However, the existence of conflict does not eliminate the possibility of cooperation [65]: in team games, group members collaborate to confront game obstacles or the opposing teams [81]. In educational games, conflict provides the motivational and entertainment drives that increase participants' involvement in the learning process [78], while cooperation between group members for problem-solving can represent a primary skills development goal [72];
- *artificial character*: games often propose a fictitious situation without reference to reality [81]. Some authors do not apply this attribute, considering that games may include realistic elements or situations [22,32,78].

On the other hand, a simulation is a simplified model of reality structured as a system, which includes clearly specified variables and dynamic relationships between these variables [81]. A simulation has the following attributes:

- *dynamic*: simulations represent the evolution of a system through the movement and interaction of its components [86]. They allow participants to manipulate and control this system which provides real-time feedback, in order to understand its structure and functioning [36]. The dynamic and interactive character of simulations represents a perfect base for experiential learning, in which participants explore the simulation environment, being confronted with simulacra of real-life problems and situations [78];
- *simplified*: a simulation is an incomplete representation of reality, reproducing only its essential characteristics and introducing a level of abstraction [15]. In educational simulations, the choice of which elements to simplify, and to what degree, is essential for the achievement of learning goals: on the one hand, the simulation should be simple enough to be manageable in the allocated period of time, but on the other hand, its level of abstraction should not result in a distorted model, completely unrecognizable for learners [68,81];
- *realistic*: despite the simplification and abstractisation of reality, the simulation should realistically represent a real-life system and its functioning [66,81]. Only in this situation the learning experience results in transferable skills applicable to real-life problems [80]. The level of realism is often manipulated to enhance the learning experience: for example, time is accelerated in many simulations, allowing the participants to pass through several rounds of decisions and to receive quick feed-back, which in real-life may span over a several years' period [80].

Despite their differences, games and simulations are compatible, and, properly integrated, can successfully complement each other to enhance the effectiveness of the learning process [78]. Simulations games can be defined as simplified and dynamic representations of reality that are structured as interactive games in order to enhance the experiential learning process. Combining the attributes of games and simulations [22], they are designed as simplified but realistic systems, which are experienced through confrontational, challenging and engaging scenarios, with clearly defined goals and rules of interaction [78,82]. Good simulation games are intrinsically motivating [22,32,78]; when interacting with a well-designed simulation game environment, people experience a 'flow state' characterised by high focus, engagement, motivation, and immersion [74].

The recent advances in computer and information technology have created new opportunities for the practical combination and convergence of these two educational tools [24,81,94]. This approach requires a new pedagogical model centred on students' learning experience [23–25]. In this study, we analyse the pedagogical application of Markstrat, a computer-based simulation game designed for the experiential learning of marketing strategy. Our research goal is to develop and validate an

educational value generation model that represents the relationships between the learning experience generated by Markstrat and three categories of learning outcomes: cognitive learning, skill development, and affective evaluations.

3. Computer-based simulation games in marketing management education

Computer-based business simulations are usually programmed as a specific industry game, in which participants learn business skills while managing a virtual company within a dynamic competitive environment [29,58,69,85]. Some simulations cover only a single business function or concept (e.g. Tanro teaches breakeven analysis), while others address a range of functional business areas (e.g. Markstrat), such as marketing, finance, R&D, production, etc., using an integrative approach [85]. As reported by Tonks [90], The marketing game! [67] represents the preferred marketing simulation game for undergraduate students, while Markstrat [59] is the world leading pedagogical game for teaching marketing management in advanced classes and corporate training. To date, Markstrat is used by more than 500 educational institutions in marketing management courses and training [84].

Markstrat successfully combines the characteristics of a simulation – presenting a simplified but accurate and dynamic model of business organisations involved in a competitive market, and of a game – the players are organised in teams, that compete against each other, applying the rules that structure the business activity in this virtual market environment. For each team, the explicit goal of the simulation game is to manage the marketing department of a virtual company as a profit centre, in order to maximise the Stock Price Index [59]. By doing this, they also achieve the implicit goals of Markstrat, which consist in improving students' understanding of strategic marketing concepts and procedures, helping them to develop marketing management skills, and maximising their intrinsic motivation and satisfaction. The pedagogical operationalisation of this simulation game is presented in Table 1, using the framework of analysis developed by De Freitas and Oliver [26].

Markstrat is considered as one of the most realistic simulation games used in marketing education [59]. Moreover, the operational application of Markstrat is highly comprehensive and integrative, covering various inter-related aspects of marketing management [33,34]. Because of its complexity and popularity, Markstrat was considered the most appropriate computer-based simulation for developing and testing a value generation model in marketing management education.

By combining computer–human interaction, inter-team competition in an artificially-designed market environment, and collaboration among team members, Markstrat creates the necessary conditions for a complex experiential learning situation. In the following section we review and discuss the experiential learning theory and models.

4. Simulation games and experiential learning

The concept of experiential learning, introduced by Carl Rogers in 1969, was developed by Kolb and Fry [57]. During experiential learning [46], whether field- or classroom-based, students adopt the approach of learning-by-doing: “Experiential learning exists when a personally responsible participant cognitively, affectively, and behaviourally processes knowledge, skills, and/or attitudes in a learning situation characterised by a high level of active involvement” [45] (p. 25). Existing studies show that experiential learning results in better conceptual understanding, critical thinking and problem-solving skills [37] increased enthusiasm and implication [19], better performance [76], higher level of self-confidence, self-efficacy [89], and enhancement of learning [83].

The most popular representation of the experiential learning process is the Lewinian model [56]. The model has four steps, or phases, ordered as a circular process. Students successively pass through (i) concrete experience, (ii) observation and reflection, (iii) formation of abstract concepts and generalisations, their implications being then (iv) tested in new situations, which leads again to a new (i') concrete experience, and so forth ... The model is student-centred, the learner being engaged in a permanent process of discovering various aspects of reality and making sense of them, which ultimately leads to a continuous enrichment and adjustment of his/her experience [56].

This circular process is a good model for simulation games, which represent exploratory, non-linear learning situations. However, a purely cyclical representation does not fully correspond to the operationalisation of simulation games in a teaching program. Lee [61] indicates two possible instructional modes for simulations: presentation and practice. In the presentation mode, simulation games are used as standalone pedagogical tools, which incite students to explore and discover the simulated system, using a problem-based learning approach. The Lewinian experiential learning cycle is an accurate representation of this instructional mode. However, some researchers outline the danger that students may feel lost without specific directions and explanations of instructional content [72]. From this perspective, the best results of computer-based simulations are achieved in a practice mode, in which students are finishing first an instructional module, using then the simulation to practice and store knowledge in a meaningful way [60,64]. The representation of the practice mode combines an input-process-output model with a cyclical repetition of the simulation game process (structured as a closed loop of user judgments, user behaviour, and system feedback), positioned between two input elements (instructional content and game's characteristics), and resulting in learning outcomes [32].

Although this model provides a clear representation of the main stages and elements involved in a simulation game exercise, the rigid separation between learning process and outcomes contradicts the logic of experiential learning. Kolb [56] states that learning is best viewed as a process and not in terms of outcomes. Knowledge is not an immutable structure that can be accumulated and measured as an inventory, being dynamically formed and re-formed by experience. From an

Table 1
The pedagogical characteristics of Markstrat (adapted from De Freitas and Oliver [26]).

Context	Learner specification	Pedagogic considerations	Mode of representation (tools for use)
Higher education school learning in business (marketing management) studies	Business school or professional learners (students)	This simulation game is a practical application of the Kolb Theory of Experiential Learning	Markstrat uses a friendly and intuitive interface, based on data and information display in the form of tables, graphs and diagrams
Classroom or IT laboratory based (the last Markstrat version can be played using a web platform, which provides scope for inter-institutional interaction at regional, national or international level)	The tool can be used either at Bachelor, Master, MBA or Professional Training level, either formally or informally	Learning outcomes: The participation of team members in the game leads to cognitive, affective and behavioural learning outcomes, related to the conceptual understanding of various business models and theories, team-work, interpersonal communication and collaboration, as well as the application of theoretical concepts and models into practice	The level and method of interactivity is adapted to a progressive experiential learning process derived from data analysis and team decisions taken during several periods. The input of teams is introduced at the end of each game period, being then processed by the software, which returns the data defining the competitive situation at the beginning of the next game period. During each game period, the teams have access to a vast array of data, which can be easily accessed using the game interface
Students interact with the Markstrat software application using computers, either in practice sessions organised during the trimester/semester, in parallel with the associated course lectures, or in specialised residential programs organised at the end of the course, over a few days' period	The tool is designed for team-work	Learning activities: the student learns during interaction with the simulation game, with the team members, and with the tutor Briefing/debriefing: pre-class preparation and post activity reflection and consideration	
The tool supports the curricula of Marketing Management or Strategic Marketing courses at Bachelor, Master, MBA or Professional Training level	Various types or learning styles can be accommodated by this simulation game, since team decisions require complex data analysis and a departmental specialisation of team members		
	The internal flexibility of the simulation game (comprising from nine up to fifteen decision periods) allows the repeated application of the Kolb cycle of learning, leading to a progressive improvement of individual and team knowledge and skills	The simulation game is embedded as a series of practical sessions or a compact residential program into the course plan of the tutor. Individuals and teams need different levels of attention, feedback and support from the tutor at different stages of the learning experience	Learning activities and outcomes achieved through the combination of a friendly interface, and a series of algorithms used for processing team decisions, and which define the competitive conditions that characterise the next game period

experiential learning perspective, concepts are continuously derived from, and modified by experience, transforming learning in an emergent process. However, this dynamic perspective creates specific implementation challenges. If experiential learning cannot be defined in terms of outcomes, knowledge assessment becomes impossible, or at least, very difficult [38]. To address this problem, Adelman [1] suggests that instead of trying to assess what participants have learned and how they have changed, they should simply be asked what they have obtained from the learning experience.

In our opinion, the problem is derived from the incapacity of the experiential learning model to connect the learning experience with a specific situational context [21]. In practice, an experiential learning exercise, such as a simulation game, is usually organised and implemented in direct relation to an instructional module/programme [61], having in mind a series of specific learning goals and outcomes [3,90], which condition the choice of the simulation game and the design of the learning experience [70]. These contextual relationships and influences are included the double-loop learning model developed by Moizer et al. [71], but the learning outcomes of the simulation game exercise are not clearly represented.

In contrast with a linear learning exercise, we consider that:

- (i) learning outcomes are realised through an iterative and dynamic process that emerges and evolves during the experiential learning exercise [56];
- (ii) learning outcomes are interdependent, influencing and enhancing each other during the experiential learning process [56];

- (iii) the post-simulation assessment realised by the teacher is based on an inventory of rigidly-defined, static learning outcomes [56];
- (iv) because of his/her central position in experiencing the simulation game, the learner is the only one who can describe and evaluate the internal dynamics of the learning process and the interdependence between various learning outcomes during the learning experience [1];
- (v) the evaluation expressed by the learner is more complete and objective after the simulation, as the participant had the time to reflect on the overall simulation game experience [77].

Taking into account these assumptions, in this paper we propose and empirically validate an educational value generation model that presents the relationships between the learning experience generated during the simulation game and the main categories of learning outcomes, using the post-simulation perception of students involved in the Markstrat exercise. In the next section we present an overview of the existing theories and studies concerning experiential learning outcomes and their inter-relationship during the learning process, which provide the basis for a series of research hypotheses.

5. Evaluating the experiential learning process and outcomes of business simulation games

Existing research points out that business simulation games provide a valid representation of the real-life situations encountered by firm managers [28,48,97], enhancing students' skills in strategy formulation, critical analysis of multiple variables, integration of concepts and tools at strategic and tactical level, and team-work. In addition, business simulation games determine a better understanding and application of fundamental concepts. In comparison with textbook-based learning, the experiential process provides a risk-free, dynamic environment, perceived by participants as more effective in "teaching course concepts, promoting the development of high level skill sets, and providing an overall positive educational experience" [11] (p. 3).

Building on Bloom's taxonomy [9], previous studies identified three main categories of learning outcomes [32,52,80], which can be translated in specific learning goals applicable to business simulations games [3]:

- (i) Cognitive (understanding and retention at conceptual, procedural and strategic level):
 - teach students the terminology, concepts and principles of business in general or of a specific discipline;
 - help students understand the interdependence between various business functions (marketing, finance, production, sales etc.);
 - demonstrate the procedural difficulty of applying business concepts in complex realistic situations;
 - enhance knowledge retention.
- (ii) Behavioural (skill practice and development):
 - enable students to implement course concepts, by taking decisions and experiencing the consequences of their actions in an interactive environment;
 - improve students' team work and relational skills;
 - generate practical experience in taking and implementing business decisions;
 - improve students' analysis and decision skills.
- (iii) Affective:
 - improve student attitudes towards the discipline;
 - enhance students' motivation and engagement;
 - increase students' satisfaction regarding the learning experience.

Considering these outcomes from an experiential learning perspective, it is necessary to evaluate their effectiveness and inter-relationship by using the post-simulation perceptions of directly-involved learners. Although this approach is advocated by theorists of experiential learning assessment [1,20], few studies adopted this line of inquiry [7,11,39,62,70,93].

The necessary basis for learning is the capacity of the simulation game to generate a realistic and engaging experiential situation [80]. The circular experiential learning process starts with students' interacting with a 'concrete experience' situation [56], which, in business simulation games, is a simplified but accurate representation of dynamic systems that require analysis, decision making and implementation during several phases or cycles of learning. Students' dynamic interaction with this simulated artificial environment eventually leads to the achievement of the three categories of outcomes identified in the literature [80]: conceptual understanding, skill development, and affective evaluation.

5.1. The impact of the generated experiential situation on learning outcomes

Building on the instructional content delivered before the simulation game [11], students can develop a deeper understanding of fundamental business concepts and procedures, as well as of their strategic significance [32], during their interaction with the generated experiential situation. This relationship is supported by the succession of phases presented in the Lewinian learning cycle [56], where the interaction with 'concrete experience' leads, through 'reflection and observation', to the 'formation of abstract concepts and generalisations'. In addition, the application of a means-end methodology to study

students' perceptions of the relationship between the main attributes, consequences and values generated during a business simulation game, evidenced a perceived causal connection between 'simulated business operations' – representing the generated experience, and 'understanding business concepts' – as a consequence of interacting with the simulated experience [62]. Considering these findings, we hypothesise that:

H1. Experience generation in the simulation game environment has a positive impact on students' conceptual understanding.

We employ here the expression 'conceptual understanding' rather than 'concept formation', since we consider that the simulation game leads to a better understanding and positioning of concepts already presented during the instructional part of the module [61,72].

Previous studies [32,38,49] report a positive impact of experiential learning methodologies on students' skill acquisition. Proposing an engaging, dynamic and interactive learning environment, business simulation games put students in a situation of 'learning-by-doing' [2], while the realistic representation of the simulated business systems ensure the transferability of the acquired skills in real-life situations [7]. We express this relationship through the following research hypothesis:

H2. Experience generation in the simulation game environment has a positive impact on students' skills development.

Besides cognitive and skill-related outcomes, simulation games research indicates the existence of affective outcomes, expressed through increased motivation, positive attitudes towards the simulation game experience, engagement, general satisfaction, and enjoyment [3,38,51,62,82]. To express this relationship we formulate the following research hypothesis:

H3. Experience generation in the simulation game environment has a positive impact on students' affective evaluation of the simulation game exercise.

5.2. The relationships between experiential learning outcomes

The theory of experiential learning outlines the dynamic nature of learning outcomes, and suggests that during the iterative experiential learning process, some learning outcomes can impact on the achievement of others [56]. This causal relationship is directly expressed in the experiential learning model, where the 'formation of abstract concepts and generalisations' is a direct output for 'testing implications of concepts in new situations', which represents the basis for skills development.

This relationship was also evidenced in connection to the concept of adaptive expertise [95], which "provides an important model of successful learning" [10] (p. 36). In comparison with routine experts, who are able to solve quickly and accurately only familiar types of problems, adaptive experts can innovate and create new procedures adapted to novel problems and situations [44]. This capability is based on a solid conceptual understanding of the expert area and procedures [43], which facilitates the acquisition of adaptive and innovative problem-solving skills: "Flexibility and adaptability seem to be possible only when there is some corresponding conceptual knowledge to give meaning to each step of the skill and provide criteria for selection among possible alternatives for each step within the procedure" [42] (p. 15). In addition, cognitive knowledge is also necessary in thoughtfully identifying, formulating, representing and solving problems [6].

Considering this approach, which is in line with experiential learning goals and processes, we hypothesise that:

H4. Conceptual understanding has a positive impact on students' skills development.

Although affective outcomes are not explicitly presented and included in the experiential learning model, researchers outlined their importance in simulation games exercises [3,32,38,80,96]. There is, however, little research and scarce evidence regarding the relationship of affective outcomes with the other two categories of experiential learning outcomes. The means-end methodology applied by Lin and Tu [62] has identified an important connection between 'understanding business concepts' – as a consequence of a business simulation game, and the value 'fun and enjoyment of life' – which represents an affective outcome. On the other hand, the study of Brennan et al. [11], concerning the outcomes of a marketing simulation game, indicates that enjoyment is highly correlated with 'analysis' and 'skills'. Considering that conceptual understanding and skills development may logically engender a sense of accomplishment that leads to positive feelings and attitudes, we further explore the relationships between the three categories of learning outcomes, formulating the following research hypotheses:

H5. Conceptual understanding has a positive impact on students' affective evaluation of the simulation game exercise.

H6. Skills development has a positive impact on students' affective evaluation of the simulation game exercise.

The relationships expressed through the six formulated hypotheses are represented in our research model (see Fig. 1). The following section presents the research methodology applied to collect and analyse secondary and primary data.

6. Research methodology

To assess the educational validity of Markstrat, both secondary and primary data have been collected and analysed. The methodology applied in this study comprises seven main stages (See Fig. 2):

- (i) an extensive literature review realised by identifying, accessing and analysing studies on the topics of experiential learning, the application and evaluation of simulation games exercises, the resulting learning outcomes and their interdependence;
- (ii) the choice of a simulation game that successfully embodies the main characteristics presented in the literature;
- (iii) the development, pilot testing and application of a questionnaire as the main tool for primary data collection (filled by students after playing Markstrat);
- (iv) a Principal Components Analysis (PCA) of the collected primary data; the resulting extracted components were associated with the main types of educational value generated by Markstrat;
- (v) for each identified type of educational value, a new aggregate variable was calculated, equal to the average of its corresponding variables (i.e. the variables scoring high on the corresponding principal component and low on all the others), which quantifies each type of educational value. Then, the mean of each aggregate variable was calculated over all the participant students, to estimate the magnitude of educational value types;
- (vi) the hypothesised relationships between the identified types of educational value were estimated using Structural Equation Modelling (SEM) [41,55]. Each value type is considered a reflective construct, which is reflected by its corresponding variables;
- (vii) the findings of stages (v) and (vi) are combined to construct and explain an educational value generation model, which includes the types of generated educational value, their magnitude, and their relationships.

6.1. Literature review

An extensive literature review was realised by identifying, accessing and analysing the existing studies on the topics of experiential learning, simulations games and their application in business education, the educational value of simulation games exercises, learning outcomes and their interdependence. The secondary data collected and analysed at this stage contributed to define our research framework, identify and apply the selection criteria for a good quality business simulation game, develop a primary data collection method, and position the contribution of our study in the general stream of simulation games/experiential learning literature.

6.2. The choice of a simulation game

Since Markstrat is the world leader in marketing management simulation games, it was the obvious choice for this specific study. Moreover, Markstrat meets the all pedagogical quality criteria developed by Cook and Swift [18]:

- (a) facility of use (for students) and administration (for the faculty);
- (b) provides a competitive environment in which the decisions of each team affect the results of the other competing teams;
- (c) enables the tutor to control the number of decision periods used in the simulation;
- (d) high accessibility and flexibility because it is Internet-based;

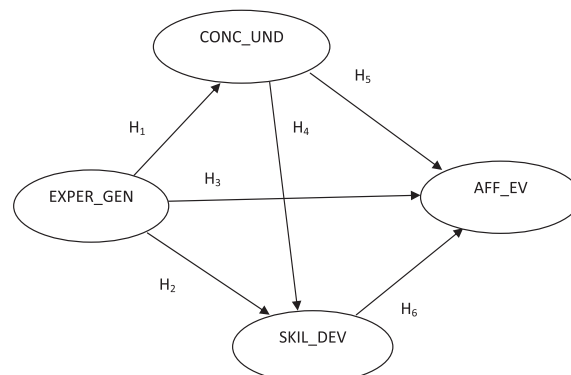


Fig. 1. The model of hypothesised relationships.

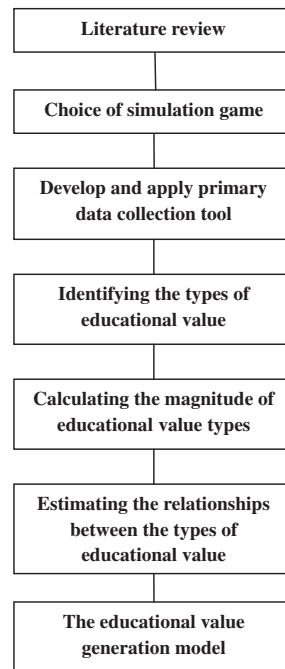


Fig. 2. Stages of research methodology.

- (e) good academic fit with the course content in which it is integrated (BA Marketing, MA Marketing, MBA or Professional Training);
- (f) presents a realistic scenario akin to something students may experience in their professional career; and
- (g) is sufficiently complex to prevent students from solving it with easy and quick decisions.

During this simulation game, several teams of students compete against each other, in an artificially-designed market world. The number of teams is variable, being defined by the tutor at the beginning of the exercise, depending on the number of students involved. In the newest version of Markstrat, which is run on the web platform, the number of possible competing teams is unlimited. Each team is required to manage a company with an existing product portfolio and to launch new products, taking and implementing decisions regarding R&D, manufacturing, distribution and promotion, within budgetary limitations. The simulation game progresses through a series of decision periods (between 9 and 15) organised either during the teaching trimester/semester, or as a residential programme lasting 3–4 full days. The pedagogical process is cyclical: the teams analyse the competitive environment at the beginning of each period and submit decisions, taking into account their strategic objectives and the competitive evolution of the company. The decisions of all teams are then used to run the simulation, and the subsequent results are returned to the teams, representing the starting point of a new decision period. The final team performance is given by the increase achieved in the Stock Price Index of the company, which expresses the growth in returns to shareholders [33]. Through its cyclical methodology, Markstrat successfully combines short-term analysis and decisions with long-term strategic objectives [84].

6.3. The choice, development and application of a primary data collection method

Existing studies regarding students' perceptions of business simulation games' educational value and outcomes apply a variety of qualitative and quantitative research methods, but none attempted to investigate the relationships between various types of generated educational value using a Structural Equation Modelling approach. To apply this type of analysis we decided to collect primary data using a structured questionnaire. The population of study was defined as university students who played Markstrat in an instructional module and were willing to share their perceptions about the experiential learning process.

The development and testing of the questionnaire was realised during several phases:

- (i) based on the analysis of the existing literature on experiential learning and simulation games [3,22,27,56,80] we identified four types of educational value: experience generation and three categories of learning outcomes; conceptual understanding, skills development, and affective evaluation;

- (ii) adapting to our research framework the suggestions expressed by several researchers [75,80] we made an inventory of the learning goals related to the instructional module (i.e. marketing management), and to the use of the Markstrat simulation game (see Table 2);
- (iii) using this learning goal inventory, the meta-list of learning outcomes presented by Anderson and Lawton [3], and the types of questions applied in previous studies [7,11,39,93], we defined and ordered the elements expressing the four types of educational value associated with simulation games. These elements were then validated through in-depth personal interviews with four experts who extensively used Markstrat simulation;
- (iv) using the remarks expressed by the four experts we reformulated the selected value elements and we developed specific questions for each value element. The questions were included into a structured questionnaire, using Likert scales with seven measurement levels;
- (v) the questionnaire was pilot tested on 32 UK-based management students. Following this pilot test, the items considered ambiguous were revised and reformulated;
- (vi) the final questionnaire was applied for primary data collection to 305 students (over five years) who participated in the Markstrat exercise organised by an UK university. The computation of the required sample size with the G* power software provided the value of 270 respondents, for an effect size $f = 0.25$ (medium), an α error probability = 0.05 and a power size ($1 - \beta$ error probability) = 0.80 (as suggested by Cohen [17]). The sample size of 305 was therefore considered sufficient for this study.

7. Data analysis and interpretation

7.1. Initial item analysis

First, an item analysis was applied to the collected primary data. The item-item correlation ranged from 0.264 to 0.690. The item-total correlation ranged from 0.442 to 0.810, significant at the 0.05 level, which indicates a moderately fair discrimination between items.

7.2. Principal component analysis: Identifying the types of generated educational value

Second, a factor analysis [88] was performed using the Principal Component Method, to identify the main types of educational value generated by the Markstrat exercise. The KMO Measure of Sampling Adequacy (0.955) and the Bartlett's test of

Table 2

The inventory of learning goals for Markstrat simulation games exercise.

Experience generation	Conceptual understanding	Skills development	Affective evaluation
Experiment with their marketing ideas	Understand the theoretical foundations of market competition	Learn how to work in a realistic market environment	Increase students' motivation to succeed in the simulation game
Use the simulated environment to take risks that could not be taken in a real business	Understand the concept of the strategic perspective	Learn to assess the success of the implemented strategies	Increase students' motivation to learn about business/marketing strategies
Experience various marketing activities	Understand the theoretical foundations of market behaviour	Enhance learning skills	Enhance the effectiveness of the learning process
	Understand the concepts and theory of marketing communications	Be capable to understand the difference between tactics and strategies	Engage students in the simulation game exercise to increase their understanding and retention of marketing and business issues
	Understand the concepts and theory of distribution	Develop the ability to analyse information more effectively	Engage students in the simulation exercise to the point of experiencing total immersion
	Understand the concepts and theory of pricing	Transfer and apply the developed skills in real-life professional environments	Increase students' satisfaction regarding the overall experience of the Markstrat exercise
	Understand the theoretical foundations of product management	Develop the ability to work more effectively in groups	
	Understand the theories and models of information management	Develop the ability to critically evaluate marketing data	
	Understand the theoretical foundation of business finance	Develop the ability to use information more effectively	
		Develop the capacity to apply the acquired skills in other parts of the course	

sphericity ($p < 0.001$) validated this factor analysis. Four factors with an Eigenvalue > 1 were identified using the Varimax Rotation method: Experience Generation (EXPER_GEN), Conceptual Understanding (CONC_UND), Skills Development (SKIL_DEV) and Affective Evaluation (AFF_EV). The factors (principal components), their respective items and the corresponding factor loadings are presented in Table 3, while Table 4 displays the Eigenvalue and the data variance of each factor. In total, these four factors explain 63.46% of the data variance.

From an educational viewpoint, these four factors can be interpreted as follows:

- (i) Experience Generation: includes items associated with the generation of relevant experiences. Markstrat gives the participant a chance to experiment with various marketing management activities and to gain a valuable experience by implementing strategic decisions in a competitive environment;
- (ii) Conceptual Understanding: includes items associated with understanding the concepts of critical importance for marketing management, which represents an essential objective of the Markstrat exercise;
- (iii) Skills Development: is associated with the skills acquired through the practical experience realised during the Markstrat exercise;
- (iv) Affective Evaluation: represents the level of motivation, engagement and satisfaction resulting from the Markstrat exercise.

7.3. The magnitude of educational value types

For each of the four identified factors, an aggregate variable was calculated as the average of its variables. Then, for each individual and aggregate variable, the mean of values introduced by respondents was computed, indicating the magnitude of each corresponding educational value aspect or type. The results are shown in the fourth column of Table 3, and should be interpreted in relation to the seven levels of the Likert scales used to assess the variables: 1 – very low value, 2 – low value, 3 – moderate to low value, 4 – moderate value, 5 – moderate to high value, 6 – high value, and 7 – very high value. On average, participants perceive a moderate to high value for Conceptual Understanding, Overall Impression and Experience Generation (5.13, 5.21 and 5.26, respectively), and a slightly less than moderate to high value for Skills Development (4.95). The differ-

Table 3
Factors and corresponding items with factor loadings, mean and variance values.

Factors	Items	Factor loadings	Mean	Variance
Experience generation	Experiment with marketing ideas	.575	5.03	1.570
	Take risks I could not take in a real business	.669	5.66	1.577
	Experience a range of marketing activities	.660	5.10	1.397
	Experimentation aggregate variable		5.26	
Conceptual understanding	Market competition	.657	5.18	1.334
	A strategic perspective	.700	4.91	1.445
	Market behaviour	.619	4.80	1.277
	Marketing communications	.493	5.09	1.259
	Distribution	.491	5.12	1.510
	Pricing	.603	5.42	1.297
	Product management	.713	5.11	1.523
	Managing information	.677	5.82	1.466
	Financial issues	.679	4.72	1.395
	Conceptual understanding aggregate variable		5.13	
Skills development	Work in a realistic environment	.502	4.26	2.220
	Evaluate the success of particular strategies that were adopted	.601	4.93	1.575
	Learn issues that I would not normally have picked up in a classroom situation	.529	5.33	2.062
	Recognise the difference between tactics and strategies	.571	4.73	2.028
	Learn to analyse information more effectively	.637	5.17	1.346
	I will be able to use the learned skills in future jobs	.728	4.93	1.801
	I will be able to work more effectively in groups	.492	5.09	1.618
	I will be able to critically evaluate marketing data	.703	5.04	1.254
	I will be able to use information more effectively	.683	5.16	1.171
	I will be able to use the skills gained in other parts of the course	.727	4.85	1.711
	Skills development aggregate variable		4.95	
Affective evaluation	Motivated me to want to succeed in the simulation	.714	5.27	2.226
	Motivated me to learn about business/marketing strategies	.620	4.97	1.954
	I find this type of experience conducive to learning effectively	.677	5.01	1.991
	I find a competitive environment helpful in learning marketing and business issues	.640	5.36	1.672
	This type of learning requires total immersion in the exercise	.699	5.45	1.535
	Overall, I found the exercise useful	.564	5.24	1.994
	Affective evaluation aggregate variable		5.21	

Table 4
Factors, reliability analysis, eigenvalues, percentage of variance and the cumulative percentage of variance.

Factors	Reliability (Cronbach's Alpha)	Eigenvalue	% of Variance	Cumulative % variance
Conceptual understanding	.889	13.593	48.548	48.548
Experience generation	.861	1.896	6.770	55.318
Skills development	.924	1.255	4.484	59.802
Affective evaluation	.913	1.024	3.657	63.458

ences between the means of component variables allow the identification of specific strengths (i.e. corresponding to individual variables with higher means) and weaknesses (i.e. corresponding to individual variables with lower means) for each educational value type. For example, the Conceptual Understanding value is relatively high for information management and pricing (means of 5.82 and 5.42, respectively) and relatively low for the theoretical foundations of market behaviour and financial issues (means 4.72 and 4.80, respectively). On the other hand, the variance of each component variable indicates the spread of students' perceptions, helping to identify the instructional topics in which the learning convergence among students was lower (see Table 3, column five).

7.4. Estimating the relations between various types of educational value

Structural Equation Modelling (SEM) methodology was applied to test the overall fit of the proposed model and the formulated research hypotheses. Before performing SEM, a Confirmatory Factor Analysis (CFA) was realised to validate the investigated constructs, using AMOS 16.0 software. As suggested by Thompson and Daniel [88], CFA is especially useful for a priori testing a model. The maximum likelihood method was selected as it is considered the most appropriate approach for the theory testing and development [35,55].

The results are shown in Table 5. Overall, all items loaded significantly and substantially on their underlying constructs, providing evidence of convergent validity; for this reason all items were retained in the model (there was no need for 'purification'). To assess the overall model fit without being affected by sample size, the following fit indices were selected: the goodness of fit index (GFI), the adjusted goodness of fit index (AGFI), the comparative fit index (CFI) and the root mean square error of approximation (RMSEA) [12,50,55]. For a good model fit, the literature recommends a GFI higher than 0.90, AGFI higher than 0.80, CFI higher than 0.9 and RMSEA lower than 0.05 [41,50]. The calculated indices indicate an acceptable model fit: GFI = 0.900; AGFI = 0.872; CFI = 0.969; RMSEA = 0.042.

The Composite Reliability (CR) of constructs has values ranging from 0.829 to 0.919 (see column four of Table 5), which exceeds the recommended cut-off value of 0.80 [31,41,50]. In addition, the Average Variance Extracted (AVE) calculated for each construct (see the fifth column of Table 5) exceeds the recommended cut-off level of 0.5 [4,31], indicating convergent validity. Finally, the results of the Principal Component Analysis (PCA) provide an assessment regarding the discriminant validity. For each factor, all the pertaining items have loadings higher than 0.5, while all the other items have much lower loadings, which ascertains the existence of discriminant validity. The results of the above tests for reliability, convergent validity and discriminant validity provide strong evidence regarding the internal and external validity of the scales used in this study [5].

Since no measurement problem was identified in the model, SEM was then performed to estimate the path coefficients [35,55] using the Maximum Likelihood (ML) estimation. The main results (the structural part of the model – statistically significant paths among constructs) are shown in Fig. 3. The overall model fit is good since all the measures are within the acceptable limits ($\chi^2 = 487.161$, $df = 315$, $p = 0.001$; GFI = 0.900; AGFI = 0.872; CFI = 0.969; RMSEA = 0.042).

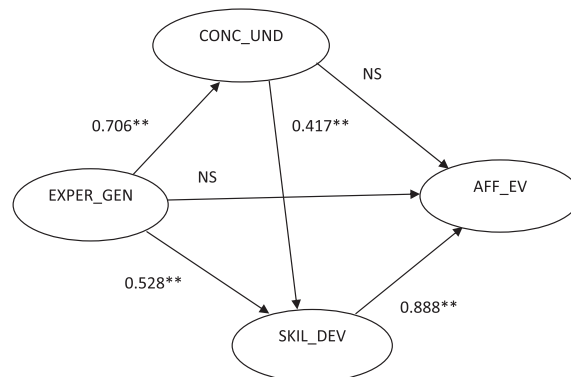
These results indicate that:

- the experience value generated by Markstrat has a very strong impact on conceptual understanding (standardised coefficient 0.706). Therefore hypothesis H1 is supported, indicating that the specific mechanisms of experiential learning are highly effective to induce a clear understanding of relevant marketing management concepts;
- both learning experience and conceptual understanding have medium to high direct impacts on skills development (standardised coefficients of 0.528 and 0.417, respectively), which validates hypotheses H2 and H4. The experience value generated by Markstrat affects skills development both directly and indirectly. The total effect is $0.528 + 0.706 * 0.417 = 0.822$, from which 64% ($0.528/0.822$) is direct, while the remaining 36% is realised indirectly through conceptual understanding. This confirms that experiential learning and conceptual understanding induced by Markstrat exercise lead to skills development relevant for marketing management analysis, decision and implementation;
- the affective evaluation of the Markstrat exercise depends strongly on skills development (standardised coefficient 0.888). On the contrary, the direct effects of experience generation and conceptual understanding are statistically non-significant. Hypothesis H6 is therefore supported, while hypotheses H3 and H5 are invalidated. This indicates that students' perception regarding the level of acquired professional skills exclusively determines their affective evaluation of the Markstrat exercise.

Table 5
Assessment of the measurement model.

Factors	Items	Standardised loadings	CR	AVE
Experience generation	Experiment with marketing ideas	0.792**	0.829	0.618
	Take risks I could not take in a real business	0.778**		
	Experience a range of marketing activities	0.787**		
Conceptual understanding	Market competition	0.698**	0.906	0.518
	A strategic perspective	0.736**		
	Market behaviour	0.717**		
	Marketing communications	0.713**		
	Distribution	0.615**		
	Pricing	0.792**		
	Product management	0.824**		
	Managing information	0.728**		
	Financial issues	0.628**		
Skills development	Work in a realistic environment	0.694**	0.919	0.532
	Evaluate the success of particular strategies that were adopted	0.745**		
	Learn issues that I would not normally have picked up in a classroom situation	0.796**		
	Recognise the difference between tactics and strategies	0.672**		
	Learn to analyse information more effectively	0.711**		
	I will be able to use the learned skills in future jobs	0.846**		
	I will be able to work more effectively in groups	0.562**		
	I will be able to critically evaluate marketing data	0.74**		
	I will be able to use information more effectively	0.745**		
	I will be able to use the skills gained in other parts of the course	0.750**		
Affective evaluation	Motivated me to want to succeed in the simulation	0.743**	0.905	0.619
	Motivated me to learn about business/marketing strategies	0.852**		
	I find this type of experience conducive to learning effectively	0.895**		
	I find a competitive environment helpful in learning marketing and business issues	0.782**		
	This type of learning requires total immersion in the exercise	0.526**		
	Overall, I found the exercise useful	0.865**		

** Significant at $p < 0.01$.



Note: ** significant at $p < 0.01$; NS statistically non-significant

Fig. 3. The value generation model.

From a representational point of view, in addition to the path coefficients (the relations between various types of generated educational value), Fig. 3 also indicates the mean for each construct (the magnitude of each corresponding type of educational value). Therefore, this value generation model presents in a compact and easily comprehensive manner the main types of generated educational value, their magnitudes, and the relations between them.

8. Discussion

Although the value generation model presented in the previous section was empirically validated for the specific context of Markstrat, the same research methodology and framework of analysis (see Fig. 2) and can be successfully applied to other

simulation games and educational areas. The three types of educational values identified are not specifically related to business studies, since in any other discipline adapted for experiential learning (e.g. medicine, communication, flight training, etc.) the pedagogic process involving simulation games will attempt to develop and/or reinforce conceptual understanding, experience of the discipline and professional skills, while also attempting to enhance the motivation, engagement and satisfaction of participants. On the other hand, the relationships between the types of educational values may be different than in the present study, depending on the discipline, the specificity of the educational process, the selected simulation game, and learners' characteristics. For this reason, it is of paramount importance to achieve coherence and integration between the purpose of the learning exercise, the profile of learners, the learning context, and the pedagogical characteristics of the simulation game [26]. This framework of analysis can also provide a better understanding of the results obtained in this study.

From a representational point of view, Markstrat is a relatively simple simulation, with a very abstract interface design. The newest versions have changed little the internal functioning of the software application or the user interface, the technological improvements being focused almost exclusively on adapting the simulation game to a web platform. However, despite the relatively simplified representational interface, this simulation game is considered one of the most successful experiential tools for teaching marketing management to students and professionals [91]. On the other hand, the findings of this study indicate that the affective evaluation of the Markstrat exercise was exclusively determined by students' perceptions regarding the professional skills developed during the simulation game. It seems logical that such a simulation game should use more complex representational elements, in order to create a more immersive environment, as similar as possible – from a graphic and interactive point of view – with the real-world professional situation for which the participating students are prepared.

This apparent paradox is easily solved when applying the general framework of analysis proposed by De Freitas and Oliver [26]. In reality, the simulation game is only an element of a complex pedagogical setup, which, in its totality, creates a realistic representation of the future professional situation. Markstrat software provides the basis for the technical aspects of the professional training (e.g. data analysis, strategic planning, decision making and implementation), while the 'soft' elements of interpersonal collaboration and coordination are implicit to the simulation game, being experienced during team work.

In most large and medium-sized firms, marketing managers are coordinating a team of specialists, taking decisions after a collective analysis and interpretation of the available organisation data and market intelligence. Often they have no, or very little, direct contact with the physical products manufactured and commercialised by the firm, although they are expected to know well their technological characteristics and usage value. In these conditions, the required professional skills at individual level are good inter-personal communication and collaboration, team work and coordination, the capacity to analyse and interpret abstract information in the context of a given organisational and market context, taking and implementing complex decisions, high flexibility and reactivity to unexpected competitive situations, and continuously improving the management process through balancing tactical decisions with long-term, strategic objectives. Properly organised and coordinated by the tutor, the Markstrat exercise addresses all these issues, combining real-life team work with the analysis of abstract information provided by the simulation game. This indicates that an advanced technology and a high representational quality may contribute to, but not fully determine, the effectiveness of a simulation game. From this perspective, the generation of educational value is enhanced by the coherence and integration of the simulation game exercise with the other elements of the experiential learning process.

The simplified representational graphics of Markstrat provides, however, a limitation for the application of this simulation game to geographically-dispersed students. Although the Internet-based information technology tools provide an effective channel for information exchange between virtual team's members [59], the Markstrat interface could be graphically-enriched to permit the interaction of geographically-distant students into a three dimensional virtual space, using avatar persona, and/or by including other virtual team activities (e.g. visits of the manufacturing line, experimentation and visual analysis of new product prototypes, selection and comparison of advertising elements), which can significantly enhance learners' immersion into the Markstrat world [2,13].

The importance given by students to the professional skills developed during Markstrat demonstrate the necessity to combine simulations and game attributes in an integrated educational tool: the simulation ensures the similarity between the learning situation and the future professional setting, while the game generates dynamic challenges which enhance students' engagement and motivation. From this perspective, Markstrat represents a successful example of a serious game, which effectively uses simulation and game characteristics to create a learning experience that helps students to develop and/or reinforce conceptual understanding, management experience, and professional skills.

9. Conclusions

This paper makes a threefold original contribution to the simulation games/experiential learning literature: first, we analyse and evaluate the representational effectiveness of several experiential learning models; second, we investigate, discuss and hypothesise the relationships between the three main categories of learning outcomes defined in the literature, as well as their connection with the concrete learning experience generated by the simulation game; third, we develop and empirically validate an educational value generation model representing (i) the relationships between four types of educational value, (ii) the direction and (iii) the magnitude of these relationships, in the context of the Markstrat exercise.

We identify four types of educational value generated by the Markstrat exercise: the concrete learning experience, the understanding of relevant concepts, models and theories, the development of professional skills, and the affective evaluation of the Markstrat exercise in terms of motivation, engagement and overall satisfaction. Thus, Markstrat leads to a better understanding of marketing management concepts, reinforcing the cognitive outcome of pedagogical process [3,45]. In addition, the capacity of the simulation game to provide an interactive learning environment allows the participants to take strategic decisions and analyse their impact on the overall profitability of a virtual company. Despite the simplification and abstraction of the simulated environment, these processes reproduce the responsibilities of a real-life marketing manager working under pressure to implement correct organisational decisions. Findings confirm that Markstrat is effective in developing decision-making abilities in complex and dynamic situations [73]. On the other hand, Markstrat enhances students' motivation for learning strategic marketing theory and practice, which confirms the conclusions of previous research [32], but contradicts the findings of Tao, Cheng and Sun [87], indicating a need for further research in this area.

The application of Structural Equation Modelling indicates several significant relationships between the identified types of generated educational value. Experience generation has a strong impact on conceptual understanding, and both of them have medium to high direct impacts on skills development. On the other hand, the participants' perception about the professional skills acquired during the simulation determines their affective evaluation of the Markstrat exercise.

This study has several limitations that should be addressed by future research. First, additional constructs could be added to the model (e.g. input elements related to the characteristics of the instructional module and of the simulation game), to understand in more detail the educational value generated by a simulation game and the value generation process. Second, it is necessary to conduct a longitudinal study to assess the utility and relevance of this experiential learning for exercise the professional career of participants. Third, this study should be extended to other simulation games used in disciplines that adopt an experiential learning approach. Fourth, a number of control variables could be introduced in the model, such as the personality type or the learning styles of the participants. Fifth, the qualitative approach adopted by this study should be further supported and complemented by additional qualitative research methods, including observation and ethnographic studies, that may give a deeper insight into the complex factors that lead to learning in a simulation game exercise. The further development of this research stream can help designers and educators to develop and adapt simulation games for different types of students, to further enhance learning experience and outcomes.

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