

# Learning Finance with Games: An Empirical Study

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**Abstract**—This paper presents an empirical case study on applying game-based learning in an undergraduate finance course. The paper describes the experimental study context, protocol, and results. Using multivariate regression analysis, a significant game effect on student performance is observed for competitive strategy-based games.

**Keywords**—Game-based learning, empirical study, regression.

## I. INTRODUCTION

Gamification is employed in various areas to improve learning outcomes, customer engagement, and even employee performance ([1], [2]). Generally, gamification is defined as “the application of game design mechanics in non-game contexts” [3]. In education, gamification applies game design components to motivate students [4], whereas game-based learning incorporates games with rules and quantifiable outcomes [5]. Different studies examine the design and application of game elements in higher education [6]. The benefits of gamifying formal education courses is reported in the literature ([7], [8]). While the impact on learning outcomes is not always easy to measure, positive student experiences are described. Gamifying education can support learning by creating a motivational environment that fosters collaboration, critical thinking, and problem-solving skills [9]. In this paper, we describe a use case application of simulation games in finance courses. We present the protocol and results of a carefully-designed experiment studying the impact of game-based learning on student grades.

The remainder of the paper is organized as follows: Section II discusses the related research work in game-based learning. Section III explains the experimental study context and Section IV the experiment protocol. The games proposed are presented in Section V. Data analysis and results are presented in Section VI and Section VII respectively, and discussed in Section VIII. Section IX concludes the paper.

## II. RELATED WORK

Game-based learning can help students develop communication, critical thinking and decision making [10] skills. Numerous game elements can be employed to improve user engagement including rankings, levels, storyline, points, and time limits [2], [11]. The literature review conducted in [12] sheds light on the observed positive impact of game-based learning in motivating and engaging students. Positive effects on student achievements are reported in [13] and [14]. Positive effects of game-based learning is also reported in another review of empirical studies [15]. However, a strong dependence on the application context and target population is expressed. In other studies, novelty-related short-lived outcomes are reported [16].

To study the effect of gamification in educational settings, existing studies rely on both quantitative and qualitative evaluation metrics including focus group interviews, case studies, and observations. A systematic review [17] of empirical evidence for game-based learning benefits stress the lack of evidence for the long-term benefits of gamifying education, and the lack of sufficient guidelines for adapting and tailoring gamified activities to the actual learning context. The same review points out the importance of carefully designing empirical studies assessing the impact of game-based learning.

A few studies tailor empirical experiments on game-based learning in formal finance studies, and inform game design for this domain in particular. In this paper, we present an empirical case study applying game-based learning to an undergraduate finance course; we describe the controlled experiment design, the proposed game characteristics, and rely on quantitative metrics to assess game effect on student performance.

### III. EXPERIMENTAL CONTEXT

The controlled experiment discussed in this paper was conducted in undergraduate finance courses taught at the Swiss Hospitality Management School (EHL) during the fall semester of the 2019 – 2020 academic year. The course was given to a total of 346 students dispersed among 6 classes with around 60 students in each class. Two of these classes were given in French and the other four in English.

The finance course itself, aims to provide students with the necessary tools to evaluate investment decisions on both corporate and personal levels. Simulation games were proposed in three course chapters; Introduction to financial instruments and markets (Chapter 1), Investment decisions (Chapter 2) and Debt and obligations (Chapter 3). For each course chapter, a relevant simulation game was designed, developed, and proposed to different student groups. In addition, a set of exercises and formative quizzes were provided for each chapter, to help students understand the course material and prepare them for the final exam. Chapter 1 was tested in question 1 of the final exam. Chapter 2 was tested in question 2 of the final exam. Chapter 3 was tested in question 3 of the final exam.

### IV. EXPERIMENT PROTOCOL

The course was given to six classes of approximately 60 students each. Every class was split into two teams. The resulting twelve teams were divided into three different groups. Each group participated in two of the three games offered. The first group (teams 1 to 4) participated in simulation games 2 and 3, the second group (teams 5 to 8) participated in simulation games 1 and 3, and the third group (teams 9 to 12) participated in simulation games 1 and 2. Hence, for each game, there were two subject groups and one control group. The team and group distribution is represented in table I.

Table I  
TEAM AND GROUP DISTRIBUTION

Team	Group	Game-1 participation rate	Game-2 participation rate	Game-3 participation rate
I	1	-	82%	76%
	2	-	74%	62%
	3	-	64%	42%
	4	-	71%	82%
II	5	74%	-	30%
	6	85%	-	42%
	7	85%	-	78%
	8	77%	-	62%
III	9	96%	89%	-
	10	92%	88%	-
	11	74%	63%	-
	12	92%	81%	-

The data related to the student groups, the participation to different simulation games, along with exam grades per chapter were collected. The participation to any game was kept optional.

### V. GAME DESCRIPTIONS

Three games were proposed during course hours. Each game had its own rules and objectives in relation to its associated chapter. Game 1 is designed for Chapter 1 and consists of a stock market simulation game. Game 2 is an investment decision group game designed for Chapter 2. Game 3 is a bond group simulation game developed for Chapter 3.

#### A. Description of Game 1

The first game consists of a financial market simulation game that should be played individually and can be described as a competition, simulation and role-play game. It aims at providing a practical introduction to the concept of financial markets. The game is based on a quarter-time basketball match showed on a screen and is played during the first chapter course for 40 minutes. At the start of the game, four markets receive 1,500 HEL bitcoins and 100 shares and they should advertise the price at which they are going to buy and sell securities at. The rest of the class play the role of investors who can only trade their securities through market makers and receive 500 EHL bitcoins and 5 shares. The share price is determined by the difference in score between the two basketball teams. Investors should only bet on the evolution of the number of points spread and not on who will be the winner at each quarter-time. The winner is the one with the highest wallet value at the end of the game. The characteristics of Game 1 are represented in Table II. A snapshot of the simulation game is shown in Fig. 1 where the winning team's score is 95 and the losing team's score is 86. Depending on the score gap, and the supply and demand, they will continually adjust their price.

Table II  
CHARACTERISTICS OF GAME 1

<b>Name</b>	Stock market simulation - basketball game
<b>Targeted skills</b>	Understand: -the functioning of financial markets -the role of the Market Maker -the impact of the arrival of information on prices
<b>Game Objective</b>	Obtain the greatest wallet value at the end of the game
<b>Type</b>	Simulation role play
<b>Material Needed</b>	-Screen to broadcast the match -Banknotes stocks
<b>In group / individual</b>	Individual
<b>Time</b>	-Total time: 40 minutes -10 minutes of explanations -20 minutes of play -10 minutes of feedback
<b>Game Rules</b>	4 "bookmakers" who advertise the price at which they buy and sell securities. The rest of the class are investors who can only trade their securities through bookmakers.
<b>Winner (s)</b>	Bookmaker and investor whose portfolio value will be greatest at the end of the game.

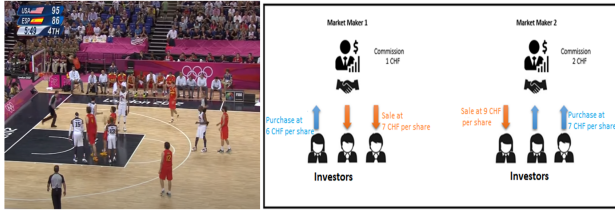


Figure 1. Exchange between Market Maker and investors, when the price of action is 7

### B. Description of Game 2

The second game consisted of an investment decision game that tackles the second chapter on the topic of investment decisions. The game is played in the classroom for sixty minutes in groups of five or six students. The purpose of this simulation is to apply the tools previously studied in class to help in decision making. At the start of the game, an introductory sheet that sets the context for the simulation was distributed, in addition to six sheets corresponding to the six levels. Each group had to rapidly answer computation questions, true or false, and multiple choice questions corresponding to each of the six levels on a paper or an excel file. Once one level has been completed and validated by the teacher, the group can move on to the next level. The first group to correctly complete the six levels wins. Game 2 details are represented in Table III and a sample question is shown in Fig. 2.

Table III  
CHARACTERISTICS OF GAME 2

Name	Investment Decision
Targeted skills	Understand: -How a company or an investor should make a rational investment decision based on decision support tools -The links between all the decision-making support tools
Game Objective	Get all the correct answers of the 6 levels as fast as possible
Type	Case Study in the form of an escape game (6 levels, increasing level of difficulty)
Material Needed	-Case Study printed on sheets of paper (1 sheet per level) -An Excel file with the figures
In group / individual	Per group of 5 or 6 students
Time	Total time: 60 minutes -5 minutes of explanations -45 minutes of play -10 minutes of feedback / correction
Game Rules	Complete each level as quickly as possible. Once the level has been completed and validated by the teacher, the group can move on to the next level.
Winner (s)	Group that finishes the Case Study first (with all the correct answers)

Thanks to petite Fleur, Philippe chose the projects in which to invest. He would like to fully use these investments by creating synergies between nightclubs.  
To do this, he would like to implement a stock management program common to the different nightclubs. Philippe hesitates between several programs whose lifespan is more or less long and whose performance varies.  
He therefore asks Petite Fleur to decide which program to choose based on the EAA.

**\*\* Synergy: concept according to which the combined value of two companies is greater than the sum of the individual values. Synergies take the form of increased revenue and / or reduced costs.**

Program	Lifetime (year)	Synergies total (CHF)	Discount rate	EAA (CHF)
Micros Fidelio	10	12'594	11%	2'138.48
Zebra	6	6'985	11%	1'651.09
Oracle	8	7'523	11%	1'461.88
Vatel Economat	3	4'875	11%	1'994.91

Which program Petite Fleur should she advise Philippe based on the EAA ? Micros Fidelio

Figure 2. A sample question from Game 2

### C. Description of Game 3

The third game consisted of a bond simulation game where the main goal is to illustrate the theory of bond operations. It provides a better understanding of how an economic situation impacts interest rates and earnings and illustrates the various sources of risk affecting bond investments. This simulation took place in class, in groups of five or six students and was projected on a screen. It lasted for about twenty-five minutes divided into six periods: one initial period followed by five play periods. At the beginning of the period, the teacher distributed a piece of paper where students are required to write their group number and the bonds they wish to buy or sell. During the initial period, students has access to several economic data that provided them with information on the current situation. Based on this data, they should be able to allocate their capital and invest in the following three types of bonds: government bonds with maturities of five or twenty years or in corporate bonds. For every period, each group had to manage a bond portfolio by selling and buying bonds. Once all the group orders have been passed and transcribed into Excel by the teacher, playing groups can move on to the next period. At the end of the five play periods, the group with the greatest portfolio value wins the simulation. The characteristics of the third game are summarized in Table IV.

## VI. ANALYSIS METHODS

The variables collected and analyzed are listed in Table V. Various methods are employed in the literature to model or predict student grades such as multivariate linear regression [18], neural networks [19], K-Nearest Neighbor [20], decision trees [21] and Naive Bayes [22]. We model the problem of predicting student grades as a regression task and run a multivariate regression analysis.

Table IV  
CHARACTERISTICS OF GAME 3

<b>Name</b>	Bond Simulation
<b>Targeted Skills</b>	Understand: -The link between the rate of return and the price of a bond. -The link between the economic situation and the interest and yield rates. -The sources of risk affecting the value of an investment in bonds.
<b>Game Objective</b>	Obtain the best performance from a bond portfolio
<b>Type</b>	Evolutionary simulation (5 periods of play)
<b>Material Needed</b>	-Screen to broadcast the simulation. -Sheet of paper for students to enter their bond buy /sell orders.
<b>In group / individual</b>	Per group of 5 or 6 students
<b>Time</b>	Total time: 45 minutes. -10 minutes of explanations. -25 minutes of play 10 minutes of feedback / correction.
<b>Game Rules</b>	Distribute your capital among 5 different bonds in order to create the best performing portfolio that is resistant to economic conditions.
<b>Winner (s)</b>	Best Performance

Table V  
VARIABLES STUDIED

Variable	Description/Value
Group did not play	Group participation in a game. 1 if the group has not participated in the game.
Student played	Student participation in a game. 1 if the student actually participated in the game
Gender	Student gender. 1 if female
Q1	The number of points obtained for the question relating to chapter 1
Q2	The number of points obtained for the question relating to chapter 2
Q3	The number of points obtained for the question relating to chapter 3
Previous semester grade	Student's previous grade in similar courses
Participation rate in the game	The participation rate in a specific game per team.

## VII. RESULTS

We start by comparing the average grades of all inter-class students on question Q1. A positive effect of game play on student performance is suggested by the statistically significant difference in average grades for Q1 between students who played game 1 and those who have not played it. This result is illustrated in Fig. 3. It is worth noting that no correlation was found between game participation and general student performance measured by previous semester grades (using Point-Bisseral Correlation Coefficient). In addition, grade distribution in the population of students who chose not to play did not change from the overall grade distribution. These two observations indicate that participation to games is not determined by overall student performance.

A multivariate linear regression analysis is conducted to further understand differences in grades illustrated in Fig. 3 and analyze the impact of game participation on student performance. The regression model predicts student grades for each exam question ("Q1","Q2" "Q3") based on general student performance represented by previous semester grade and student participation to the corresponding game (1, 2, 3 respectively). The regression test results are summarized in Table VI. Participation in game 2 had no significant effect on performance in question Q2. The positive coefficient for the variables "student played game 1" and "student played game 3" (with a p-value of 0.0 and 0.008 respectively) indicate a significant and positive relationship with Q1 and Q3 respectively.

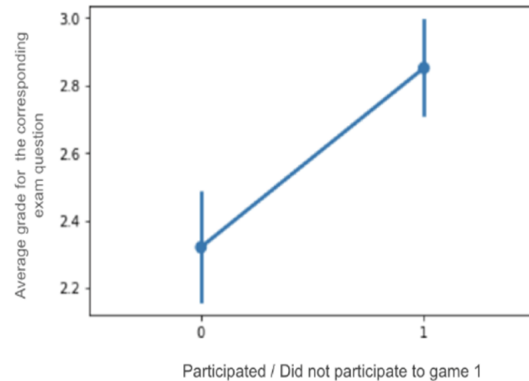


Figure 3. Difference in the average grade of participants and non-participants of Game 1

Table VI  
MULTIVARIATE LINEAR REGRESSION RESULTS FOR Q1, Q2 AND Q3

Dependent variable	Independent variable	Coefficient	p-value
Number of points for Q1	constant	0.372	0.322
	student played game 1	0.108	0.0
	previous semester grade	0.4202	0.0
Number of points for Q2	constant	1.0702	0.0
	student played game 2	0.0601	0.448
	previous semester grade	0.2728	0.0
Number of points for Q3	constant	0.9459	0.145
	student played game 3	0.5104	0.008
	previous semester grade	1.0923	0.0

## VIII. DISCUSSION

The highly significant and positive relationship found between student performance in question 1 and the participation to the corresponding game 1, cannot be due to a class effect. Indeed, for every game, each class was split into two teams which were then merged with teams from a different class to form a control or test group. One explanation can reside in the fact that Game 1 is played individually (and so is the examination). Game 2 and 3 were designed as group games where the active participation and involvement might

differ from one member to the other. Another impact factor could reside in the game characteristics itself, indeed game 1 was more immersive and playful, compared to game 2 which involved traditional exercise solving wrapped in every game step.

## IX. CONCLUSION

This paper presents an experimental case study of using game-based learning in formal education and more specifically for a bachelor-level finance course using quantitative analysis. The experiment proposes three simulation games. Each game was associated with a specific course chapter and a corresponding exam question. A statistically significant game effect on student performance was observed for two games. Results shed light on the positive effect of gamification on the learning outcome while showing a stronger effect in the two games that incorporated excitement, competition, and strategy. Repeated experiments and future research work will examine the impact of game design on student participation and performance and provide further insights on applying game-based learning in undergraduate studies in finance.

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