ARTICLES

GAMIFICATION AND RISK AVERSION: AN EMPIRICAL ESSAY WITH MANAGEMENT STUDENTS

Gamificação e aversão ao risco: Um estudo com estudantes de Administração

Gamificación y aversión al riesgo: Un estudio empírico con estudiantes de Administración

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ABSTRACT

This article evaluates whether the use of gamification in entrepreneurship education is associated with a reduction in risk aversion among students studying at the technical level of Business Administration. As a theoretical framework, we used the Cumulative Prospect Theory. The research was conducted at a Brazilian Federal Institute (IF) of education. We used a sample of 191 participants, and the research instrument was applied at the beginning and end of the course. The data analysis included the Difference-in-Difference, Propensity Score Matching, and Quantile Regression methods. The results indicate that, after the implementation of the gamified pedagogical practice, there was an increase in the participants' propensity to assume risks related to financial allocation decisions and occupational choices. This corroborates the role of gamification in the development of entrepreneurial skills by revealing that its use aids in preparing students to deal with uncertainties and calculated risks.

Keywords: entrepreneurial education, gamification, risk aversion, fishbanks, entrepreneurial competences.

RESUMO

Este estudo avalia se o uso da gamificação no ensino de empreendedorismo está associado à redução da aversão ao risco por parte de estudantes de Administração em nível técnico. Como teoria principal, foi utilizada a Teoria do Prospecto Cumulativa. A pesquisa foi conduzida em um Instituto Federal (IF) de ensino. Utilizamos uma amostra de 191 participantes, e o instrumento de pesquisa foi aplicado no início da disciplina e no seu fechamento. A análise dos dados incluiu os métodos diferenças-em-diferenças, pareamento por escores de propensão, e regressão quantílica. Os resultados indicam que, após a implementação da prática pedagógica gamificada, houve um aumento na propensão dos participantes em assumir riscos relacionados às decisões de alocações financeiras e escolha ocupacional. Isso corrobora o papel da gamificação no desenvolvimento de competências empreendedoras ao revelar que seu uso auxilia na preparação dos estudantes para lidar com incertezas e riscos calculados.

Palavras-chave: *ensino de empreendedorismo, gamificação, aversão ao risco, fishbanks, competências empreendedoras.*

RESUMEN

Este ensayo evalúa si el uso de la gamificación en la educación empresarial está asociado con una reducción en la aversión al riesgo entre los estudiantes de Administración de Empresas a nivel técnico. Como marco teórico, se utilizó la teoría prospectiva acumulativa. La investigación se realizó en un Instituto Federal (IF) de educación. Utilizamos una muestra de 191 participantes y el instrumento de investigación se aplicó al comienzo y al final de la asignatura. El análisis de los datos incluyó los métodos de diferencia en diferencias, emparejamiento por puntuación de propensión y regresión cuantílica. Los resultados indican que, después de la implementación de la práctica pedagógica gamificada, hubo un aumento en la propensión de los participantes a asumir riesgos relacionados con decisiones de asignación financiera y opción laboral. Esto corrobora el papel de la gamificación en el desarrollo de habilidades empresariales al revelar que su uso ayuda a preparar a los estudiantes para lidiar con incertidumbres y riesgos calculados.

Palabras clave: *enseñanza empresarial, gamificación, aversión al riesgo, fishbanks, habilidades empresariales.*

INTRODUCTION

Taking calculated risks is a fundamental pillar in the exercise of entrepreneurial activity (Al-Mamary & Alshallaqi, 2022). Therefore, finding strategies to mitigate risk aversion and promoting its respective analysis are important mechanisms to encourage an entrepreneurial culture, especially in the school environment. In addition, being an entrepreneur requires behavioral skills associated with the willingness to face uncertainties, so these and other skills can be obtained through experiential learning (Zichella & Reichstein, 2022).

According to the literature, gamification in entrepreneurial education has been considered a promising tool to unite theory and practice (Melo et al., 2023; Pérez-Pérez et al., 2021). From this perspective, as a basis for using gamification in entrepreneurship teaching, the Flow Theory (Csikszentmihalyi, 1990) and the Self-determination theory stand out (Deci & Ryan, 2000). The Flow theory describes a state of intense concentration and involvement in an activity; the Self-determination theory emphasizes that the fulfillment of the inherent needs of autonomy, competence, and social connection amplifies motivation and engagement. Thus, gamification represents an important strategy in teaching entrepreneurship and its constituent aspects, such as the perception of risks. Furthermore, this resource can increase risk tolerance on the part of the students involved (Chapkovski et al., 2021) since the challenging situations faced in the narratives of the games help the player to perceive the risks and have a notion of when to take risks, how to evaluate, and control such occurrences (Costin et al., 2019; Thanasi-Boçe, 2020).

In games, the possibility of failure is a hallmark of risk and a crucial component (Fox et al., 2018; Melo et al., 2023) since the absence of this type of immediate feedback leads to unrealistic expectations for players, leading to overconfidence (Fox et al., 2018). Therefore, allowing students to experience business creation in uncertain scenarios, failure simulation, and with limited resources is an important recommendation in this learning process (Chapkovski et al., 2021; Fox et al., 2018). In summary, individuals need to learn to deal with calculated risks, as decision-making based on mere intuition can generate losses and compromise the future of an enterprise (Fox et al., 2018; Thanasi-Boçe, 2020; Zichella & Reichstein, 2022). We used the Cumulative Prospect Theory as a theoretical framework for the object of study of this article - gamification hypothesis testing as a strategy to reduce risk aversion in entrepreneurial behavior (Tversky & Kahneman, 1992), which indicates a human tendency to avoid risks when the chances of success are low and to face them when they are high.

Research in this field is still scarce and is maturing (Thanasi-Boçe, 2020; Zichella & Reichstein, 2022). Recent studies have shown that gamification has helped undergraduate-level students to take, assess, and manage risk more comfortably and confidently (Chemborisova et al., 2019; Costin et al., 2019; Thanasi-Boçe, 2020). Analogously, similar results were identified within the graduation sphere (Zichella & Reichstein, 2022) and outside the educational environment with retail investors (Chapkovski et al., 2021). This suggests that participating in gamification programs positively affects risk-taking, although evidence in this field is still limited (Thanasi-Boçe, 2020;

Zichella & Reichstein, 2022). Therefore, research opportunities exist, including in other educational contexts, such as high school.

This research is motivated by the need to advance knowledge about risk aversion as an element associated with entrepreneurial behavior. Thus, we aimed to evaluate whether teaching entrepreneurship through gamification is associated with reducing risk aversion in technical high school students. Furthermore, the formulated hypotheses are:

H1: Gamification is associated with reduced risk aversion linked to entrepreneurial behavior.

H2: Gamification does not have a constant effect on reducing risk aversion across distribution.

We tested the hypotheses through a quasi-experimental study, which involved the integration of gamification in classes and the application of a research instrument at the beginning and end of an entrepreneurship class in a business administration course at a technical medium level at the Federal Institute of Education, Science, and Technology of Rio Grande do Norte (IFRN). By comparing data from the beginning and end of the course, using quantile regression combined with the Difference-in-difference methods, Propensity Score Matching (PSM), we found significant evidence that individuals with a low level of risk propensity (therefore, more risk-averse before the gamification intervention) are more likely to take risks at the end of the course.

From a theoretical point of view, the study contributes to the academic discussion on pedagogical strategies for assessing risk-taking and entrepreneurial education. Furthermore, this research offers insights into how gamification can influence risk aversion, with implications for the organization of curricula and teaching strategies, especially at the secondary technical level, which has programs aimed at training professionals in areas related to entrepreneurship, such as administration, science, and technology.

By focusing on the Brazilian context and technical high school students, this research significantly contributes to the advancement of knowledge, as these institutions often attract students with varied backgrounds and aspirations, allowing us to investigate how gamification can influence risk tolerance among individuals with different levels of prior knowledge, attitudes, and experiences related to entrepreneurship. It is important to emphasize that high school is a time when students are exploring career options, which can arouse interest in entrepreneurial activity and increase risk tolerance through gamified classes.

LITERATURE REVIEW

Gamification and teaching management

Training potential entrepreneurs requires motivation, realistic experiences, continuous feedback, experiential learning, risk tolerance, and reduced fear of failure (Goi, 2023; He et al., 2023; Lyons

et al., 2023). To meet these criteria, teaching entrepreneurship can be based on innovative educational approaches that use games and their elements to encourage participation and engagement (Blass & Tolnai, 2022; Hu, 2020; Kulpa, 2017; Muriel & Crawford, 2020).

According to Goi (2023), the concept of gamification has been applied in the business educational field to improve the teaching-learning process and establish a more meaningful connection between students and the real world of business. Gamification consists of using game dynamics and mechanics to enrich educational activities (Isabelle, 2020). These applications can range from digital games, such as online platforms and mobile devices, to analog games, such as board and card games, as well as business simulations and educational activities that incorporate game elements, such as challenges, performance-based awards, rankings, immediate feedback, and other features (Chen et al., 2022; Ruiz-Alba et al., 2019).

Hu (2020) suggests that before implementing it in teaching, educators need an in-depth and practical understanding of gamification, including knowledge of its elements, content complexities, functionalities, and technological level. Furthermore, these professionals should check the compatibility between the game and the class profile to understand student behaviors and emotions during game-based learning (Blass & Tolnai, 2022; Hu, 2020). Other authors emphasize that gamification may not be effective in all educational contexts as sociocultural aspects can influence behaviors and preferences (Kulpa, 2017; Muriel & Crawford, 2020). However, they recommend that teachers and instructors explore the interesting possibilities of this approach.

Supporting this discussion, Blass and Tolnai (2022) explain how gamification can increase student engagement, enhance socio-emotional skills, and encourage problem-solving. These authors provide recommendations, such as the development of immersive experiences, the adoption of a learning progression with challenges aligned to the students' skill level, the establishment of clear goals and objectives, the provision of consistent and meaningful feedback, the promotion of collaboration, and integration of the game's narrative into learning to make it more contextualized.

Within this perspective, the literature presents theories related to gamification, highlighting the Flow Theory proposed by the psychologist Mihaly Csikszentmihalyi (1990). This theory describes the state of mind in which a person is completely immersed in an activity, feeling focused, energized, and deeply engaged by the challenge (He et al., 2023). By incorporating rewards, clear goals, success, failure and challenges, gamification seeks to achieve this state of mind to increase student engagement (Goi, 2023; He et al., 2023; Lyons et al., 2023). Therefore, games as a pedagogical approach have the potential to make activities more dynamic and motivating, significantly increasing the likelihood of participants experiencing the state of flow.

The flow theory was used as a theoretical framework by Hu (2020). In explaining the dynamic and entertaining nature of gamification, the author clarifies that a game can affect varied groups of players or students in different ways, as preferences can differ among individuals. To illustrate this point, Hu (2020) emphasizes that male students prefer gamified activities with a higher level of challenge, exploration, and simulation. In contrast, female students prefer games involving fantasy, narrative, and discovery.

Gamification in entrepreneurship teaching is aligned with the principles of the Self-Determination Theory (SDT) (Deci & Ryan, 2000), which explains that individuals have innate psychological needs for autonomy, competence, and social connection. In this context, when satisfying these needs, there is an increase in intrinsic motivation and engagement with the activity (Deci & Ryan, 2000). Through the implementation of game elements, entrepreneurship teaching can be designed to meet these demands, stimulating the interest and involvement of the participants (He et al., 2023).

In summary, recent studies discuss the concrete application of gamification in entrepreneurial education at elementary school (Cárcamo-Solí et al., 2017), high school (Pratikto et al., 2021), and higher education levels (Isabelle, 2020; Zulfiqar et al., 2019), demonstrating that such methodology has improved engagement, motivation (Fox et al., 2018), and performance, making students more confident to enter entrepreneurial activity (Zulfiqar et al., 2019). Furthermore, gamification in entrepreneurship teaching increases entrepreneurial intention (Ruiz-Alba et al., 2019; Zulfiqar et al., 2019) and entrepreneurial attitude and self-efficacy (Chen et al., 2022). This suggests that games can help students to become aware of the pitfalls and opportunities of entrepreneurship.

Gamification and risk aversion

Given the unstable market conditions, entrepreneurs need to develop skills to act autonomously and innovatively, including skills in assertive decision-making, risk management, problem-solving, communication, and teamwork (Al-Mamary & Alshallaqi, 2022). In this sense, taking risks is an action that is part of entrepreneurship. However, it is up to the entrepreneur to learn to take calculated risks – to measure the level of risk one is willing to accept, in order to increase the possibilities of success (Chapkovski et al., 2021; Zichella & Reichstein, 2022).

The literature highlights that, in real-world situations, the decision-making process occurs in complex and high-risk environments, using recognition as a foundation (Klein, 1999). In other words, individuals can make informed decisions by quickly matching the current situation with patterns they have absorbed from previous events (Klein, 2008). Thus, in the realm of gamification applied to entrepreneurship education, deliberations are based on recognition, where participants make decisions in the face of uncertainty, using the environment's structure to guide their choices (Gigerenzer & Gaissmaier, 2011).

Gigerenzer and Gaissmaier (2011) discuss the role of experiential learning in decision-making, emphasizing the need to understand the context in which this process occurs. Thus, it becomes essential for situations to resemble real life to ensure skill development. Additionally, it is crucial to consider the perspectives of decision-makers and stakeholders, along with their hierarchies of criteria (Saaty & Vargas, 2012). In the gamification context, students analyze and weigh different criteria and alternatives, facilitating evaluation and selecting the best strategy. This reflects the integration of decision and strategy elements within the game dynamics, aligning with the theoretical aspects addressed by Gigerenzer and Gaissmaier (2011), Klein (1999, 2008), Saaty and Vargas (2012), as well as other scholars.

Tversky and Kahneman (1992) proposed the Cumulative Prospect Theory (CPT) to explain that, when making risky decisions, people evaluate the gains and losses and how they perceive the probability of these results occurring. In other words, this theory highlights that individuals tend to be more risk averse when the probabilities of gains are low and more likely to take risks when these probabilities are high. Thus, in the gamification context, how the outcome of a strategic choice is presented, whether in the form of a win or a loss, can influence risk tolerance. If a loss has a greater psychological impact than a gain of equivalent value, it will result in increased risk aversion.

In entrepreneurship teaching, gamification can influence the user's propensity to take calculated risks since in-game decisions are made based on the information and immediate feedback, enabling the analysis of chances of gains and losses (Chapkovski et al., 2021; Lyons et al., 2023). Thus, if the probability of success in the activity is perceived as high, the student may be more inclined to take the risk after the intervention.

The CPT, therefore, engages with the theoretical discussion proposed by other scholars in the field of decision-making in risky situations, encompassing but not limited to Gigerenzer and Gaissmaier (2011) and Klein (1999, 2008). In this sense, decision-making incorporates accumulating information over time (Tversky & Kahneman, 1992) – recognizing patterns learned from previous events (Klein, 1999, 2008). For instance, patterns absorbed during theoretical lessons assist in making more informed choices and risk calculations. Furthermore, one must consider the environment in which this process occurs (Gigerenzer & Gaissmaier, 2011) to benefit from the gradual progression of experiences without neglecting game elements, such as challenges, gains, and losses, strategically presented to students.

It is important to highlight that to obtain positive results in this process of learning and preparing for taking risks, the participant/player needs an experience that involves the decision in scenarios of uncertainty (Fox et al., 2018; Zichella & Reichstein, 2022). However, as argued by Fox et al. (2018), many games fail in their designs by not implementing elements that represent risky circumstances.

Overall, topics such as risk and decision-making have often been neglected in studies that explore gamification in entrepreneurship teaching (Chapkovski et al., 2021; Zichella & Reichstein, 2022). In contrast, there is some evidence that gamification can affect risk aversion in undergraduate students (Kraus et al., 2021; Zichella & Reichstein, 2022). According to Kraus et al. (2021), who used a sample of university students in the United States, the intensity and theme of the game have a moderating effect on risk propensity, so when the intensity of the game is high and involves many risky decisions, the subject's risk-taking orientation increases.

Corroborating this discussion, Zichella and Reichstein (2022) identified, in the context of Denmark, that students of traditional education who enroll in gamified entrepreneurship programs are more willing to accept moderate risks, once they experience the usefulness of that forbearance with the small monetary gains involved in the activities.

On the other hand, participation in these activities does not always affect risk propensity, as some stakeholders prefer more predictable scenarios (Kraus et al., 2021; Pérez-Pérez et al., 2021).

However, researchers indicate that even the most risk-averse perceive the need to be more risk-tolerant in order to grow in the market, reporting that after the gamification experience, they learned to predict and manage risks, especially by analyzing the strategies of teams and opponents (Thanasi-Boçe, 2020).

Given the related literature so far and the arguments explained, the first hypothesis we propose in this study is:

H1: Gamification is associated with reduced risk aversion linked to entrepreneurial behavior.

The impact of gamification in entrepreneurship education on students' risk aversion can vary considerably since several factors can influence this result. Among them, the nature and design of the game or gamified activity stand out (Fox et al., 2018), the individual profile of students and the educational context in which gamification is applied (Chapkovski et al., 2021; He et al., 2023; Melo et al., 2023). Based on this perspective, we formulate the second hypothesis to be analyzed:

H2: Gamification does not have a constant effect on reducing risk aversion across distribution.

This section demonstrated that although, in the Brazilian context, no other research on the relationship between gamification and risk aversion is identified, there is also a gap in investigations in technical secondary education, a modality that considers entrepreneurship as one of the training itineraries of vocational education students (Resolution No. 3/2018, Art. 12, § 2°). This is, therefore, a contribution sought by this study.

Based on the theoretical context addressed in this topic and the previous one, we elaborated a conceptual model of the research (Figure 1), aiming to systematize the evidence identified.

The theory that motivates the study and the hypothesis test performed is the Cumulative Prospect Theory, providing grounds for the analysis of the hypothesis that gamification in entrepreneurship teaching positively impacts reducing risk aversion.

FishBanks business simulation

In this research, we use the FishBanks business simulation as a gamification strategy. Developed by the MIT Sloan School of Management, the FishBanks game simulates managing a fishing business in a scenario of limited natural resources. Participants need to purchase, sell, and order vessels, and make decisions about fishing locations and allocation of scarce resources. Thus, participants receive financial and resource information each round and make decisions to maximize their net worth. Furthermore, this game is available in English, Portuguese, Spanish, and Chinese, allowing its use in different countries.

Figure 1. Summarized theoretical background

Base Theories	Background and Needs	Implementation of Gamification	Positive Effects
Flow	Immersion / Realistic experience / Challenging tasks / Time and information	Explore clear goals, continuous feedback, success, failure, challenges, rewards, and balance between skills and task level to achieve the state of mind of Flow.	Flow mental state / Notion and Understanding / Focus and Concentration / Sense of control / Satisfaction

Gamification encompasses information that, when assimilated by the person, awakens feelings. For the activity to be truly profitable and satisfying, it is essential that these feelings are positive. In this context, the proper selection of the tool is fundamental, since the quality of the realistic experience is directly linked to the way in which time is used and the way the individual feels when performing a specific task.

Base Theories	Background and Needs	Implementation of Gamification	Positive Effects
SDT	Autonomy / Competence / Social Connection	Through the implementation of game elements, teaching can be designed to meet these needs and increase engagement.	Skill mastery / Sense of accomplishment / Self confidence / Sense of Belonging / Motivation

Effective learning. Student autonomy by having more control over their own learning; competence through challenges and feedback; social connections through interaction with classmates.

Base Theories	Background and Needs	Implementation of Gamification	Positive Effects
CPT	Gains and Losses / Probability of perceived gains / Perceived probability of losses	In gamification, decisions are made based on immediate information and feedback, allowing the player to perceive and analyze the chances of gains and losses.	Analysis and Learning / Decision making with reference / Appreciation of progress / Loss aversion versus rewards / Motivations and behaviors

Individuals tend to be less risk averse when they perceive chances of gain (financial or other). Improves students' decision-making around learning, which can increase tolerance for calculated risk in business.

By showing students the graphs generated in FishBanks matches, it is possible to alert them to various trends (as the more boats they launch, the more they deplete stocks and, over time, the catch on the high seas will decline). Thus, in this scenario of depletion of common use resources (tragedy of the commons), students learn about managing an enterprise with the limits of growth, the need for cooperation, carrying capacity, complexity of balancing resources, fish stock, and resource sustainability (Meadows et al., 2017).

Therefore, the choice of FishBanks for this research is in line with the arguments by Fox et al. (2018) that draw researchers' attention to the need to ensure the suitability of game elements in the teaching and learning process of risk-taking in entrepreneurship. The relevance of the chosen game lies in its ability to teach entrepreneurship and risk management because it simulates a business environment with limited resources and intense competition, where participants must make strategic choices to maximize their profits and minimize their losses, allowing players to experience the consequences of their decisions.

METHODOLOGY

Methodological design

We collected data at the Federal Institute of Education, Science, and Technology of Rio Grande do Norte (IFRN). This institution offers more than 70 technical courses, 21 of which include an entrepreneurship course. In this article, we carried out the research at the Nova Cruz/RN campus. This unit has approximately 1,200 students enrolled in technical and technologist courses in Business Management, Informatics, and Chemistry (Melo et al., 2023).

We applied the research instrument at the beginning and at the end of the course in 8 entrepreneurship classes, which had the same syllabus and teacher. As the random allocation of students into treatment and control groups was not operationally possible, as students remain in their incoming classes until course completion, we randomly sorted at the beginning of the school year to choose which classes would receive the treatment and which classes would be controls. To assure the robustness of our methodological approach, we designed a quasi-experiment strategy composed of the research methods Difference-in-Difference (Diff-in-Diff), Propensity Score Matching (PSM), and Quantile Regression.

Initially, to assess the effect of gamification on risk aversion (hypothesis 1), we used the difference in differences method. In the Diff-in-Diff model, we analyzed the characteristics of the observations before and after using the gamification strategy, which allows for assessing the trajectory of risk aversion before and after the intervention. The Diff-in-Diff method requires a comparison of two groups: a treatment group, which receives the intervention, and a control group, which does not receive it. Ideally, the groups would be identical in every aspect except for the intervention (gamified teaching).

Furthermore, the analysis requires observations before and after the intervention in both groups. The first difference is calculated as the change in the treatment group before and after the intervention, and the second difference is calculated as the change in the control group before and after the intervention. The treatment effect is then estimated as the difference between these two differences (Angrist & Pischke, 2008). Mathematically, this can be represented as:

> Thus, to obtain the result parameter, we established a control group (85 students not submitted to the intervention with gamification) and a treatment group (106 students submitted to the intervention with gamification). The variable of interest is risk aversion (RA). In summary, the impact estimate was obtained by means of a double subtraction Difference-in-Difference): (I) first, the subtraction between the mean RA after the intervention and the mean RA before the intervention is performed, both for the treatment and control groups; (II) a second operation is performed, which consists of subtracting the differences obtained in each group, i.e., the time difference of what occurred in the risk aversion of the treatment group subtracted from the same difference in the control group (Angrist & Pischke, 2008; Melo et al., 2023).

A premise of the Diff-in-Diff model is the parallel trajectory, the trends of change in the variables of interest are similar between the treatment group and the control group before the intervention. Thus, we need to ensure that both groups are comparable on all relevant variables (Angrist & Pischke, 2008; Melo et al., 2023).

To ensure that the treatment and control groups do not have statistically significant differences, we used the Propensity Score Matching (PSM) technique. The objective of PSM is to create a control group comparable to the treatment group in terms of observable characteristics so that any difference between the groups can plausibly be attributed to the tested intervention. Through PSM, individuals in the treatment and control groups are matched based on similarities (nearest neighbor). Thus, each participant in the treatment group is paired with their closest counterparts in the control group (Angrist & Pischke, 2008; Melo et al., 2023).

Lastly, to identify the effect of gamification on risk aversion across the distribution, we employed the quantile regression method. This technique estimates the effect of an independent variable on specific quantiles (percentiles) of a dependent variable rather than just on the average, as in ordinary least squares linear regression. In simple terms, while linear regression provides an expected relationship between the independent variable and the average of the dependent variable, quantile regression allows us to understand this relationship at different points in the distribution of the dependent variable (Angrist & Pischke, 2008; Melo et al., 2023).

Figure 2 systematizes the methodological strategies adopted in the research.

Figure 2. Quasi-experiment conduction flow
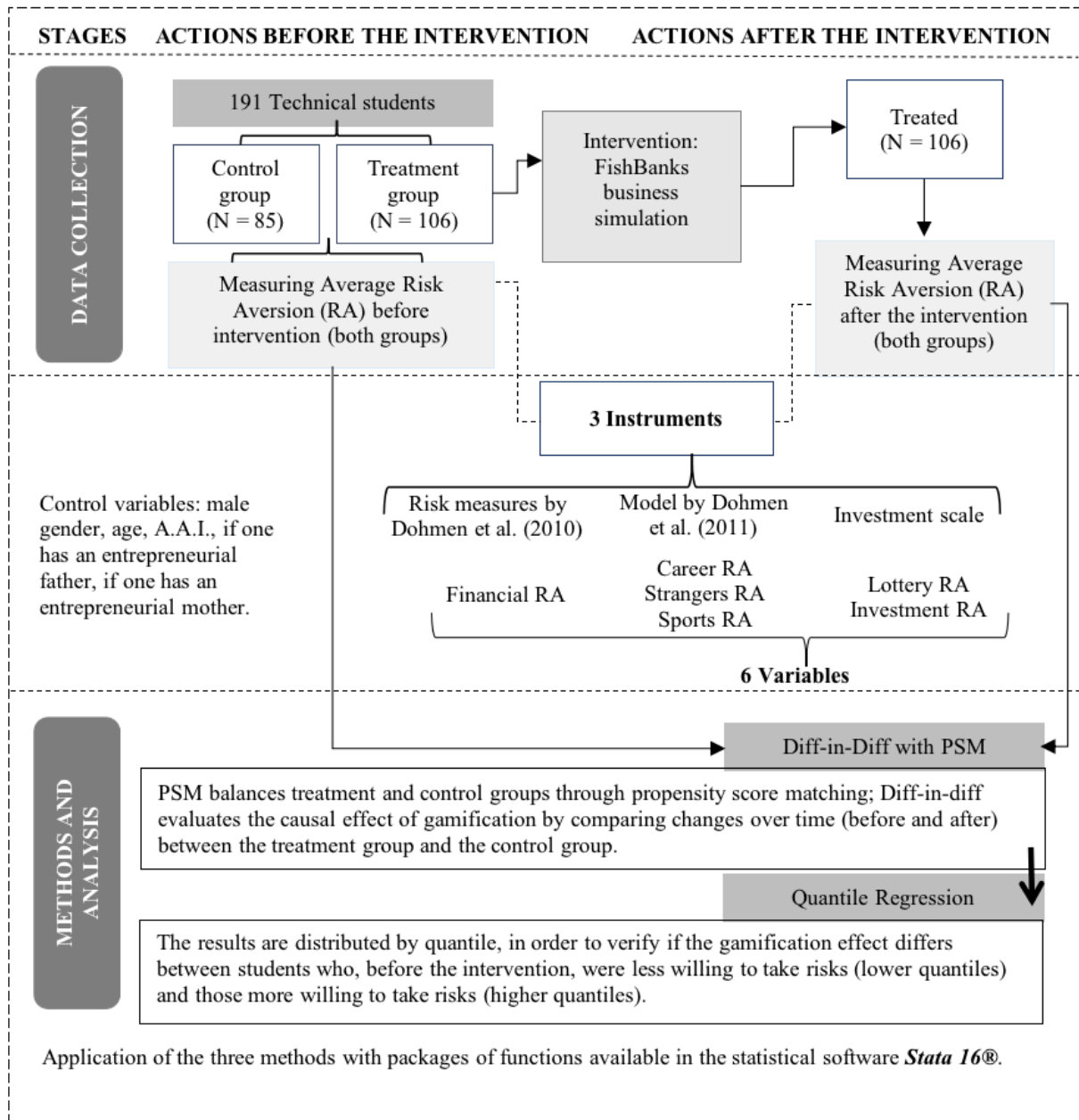
Risk measurement variables

We used three instruments already validated in the previous literature to measure risk aversion:

I.   Adaptation of risk measures by Dohmen et al. (2010): list of 10 decisions with two options each, the first with known probabilities and the second with a certain return. The scenarios had the option of 50% probability of receiving BRL 300.00 or 100% certainty of receiving a fixed amount (In the first scenario, the fixed amount was BRL 25.00, with an increase of BRL 25.00 for each new decision-making scenario until reaching the value of BRL 250.00 in the tenth scenario);

II. Adaptation of the model by Dohmen et al. (2011): a scale of propensity to take risks, from 1 to 10 (1 for "completely risk averse" and 10 for "fully willing to take risks"), in different dimensions of life: making career decisions, making financial decisions, playing extreme sports, and trusting a stranger. Decisions to trust strangers and practice extreme sports were included as placebos, verifying whether risk aversion was impacted only in economic and occupational choice spheres or in other spheres of risk aversion/propensity;

III. Scale of investments to simulate risk propensity: concerns the allocation of financial resources. Participants started from the following hypothetical situation "Imagine that you won BRL 100,000.00 in the lottery. Almost immediately, you receive, from a reputable bank, the chance to double your money within two years. The probability of doubling your money is equal to losing half of the invested amount (50% chance of winning twice the invested amount and 50% chance of losing half of the invested amount). How much would you agree to invest?" There were six possible options, starting from BRL 0.00 to BRL 100,000.00, separated into BRL 20,000.00 ranges.

Based on these instruments, we defined six variables: (I) "RA Lottery" indicates the amount in Reais (from BRL 0.00 to BRL 100,000.00) of the capital received in a lottery, which the individual would be willing to allocate in a risky investment; (II) "Investment RA," which refers to the level, on a scale of 1 to 10, of willingness to take investment risks; (III) "Financial RA," indicates the level (10 sensitivity levels) of choosing an option, having a certain percentage of chance of receiving an amount or the certainty of receiving another fixed amount; (IV) "Career RA," from 1 to 10, indicates willingness to take a career choice risk; (V) "Strangers RA," which represents how much, on the same scale, the individual is willing to trust strangers; and (VI) "Sports RA" indicates willingness to choose an extreme sport (from 1 to 10).

The controls for the models were the variables Age and Academic Achievement Index (A.A.I.). Additionally, categorical variables were introduced to capture specific attributes.

These are designated as 'FatherEnt,' where the value is assigned 1 if the individual's father is an entrepreneur and 0 otherwise; 'MotherEnt,' where the value is assigned 1 if the individual's mother is an entrepreneur and 0 otherwise; and 'GenderM,' where the value is assigned 1 if the individual is male and 0 if the individual is not male." Regarding the execution/operationalization of the model, we used packages of functions available in the statistical software Stata 16®

Data and difference of means

Table 1 shows the differences in means between treatment and control groups, after using the Propensity Score Matching technique (PSM).

Table 1. Difference in means test at the beginning of the entrepreneurship classes

	Mean Control	Mean Treated	Difference	|t|	Pr(|T|>|t|)
Lottery RA	3.542	3.302	-0.240	1.19	0.2357
Investment RA	3.450	3.189	-0.262	1.42	0.1565
Financial RA	6.092	5.679	-0.412	1.22	0.2256
Career RA	6.826	6.340	-0.487	1.32	0.1880
Strangers RA	6.421	5.925	-0.497	1.46	0.1455
Sports RA	4.913	4.557	-0.357	1.27	0.2072

Note. There were no statistically significant differences observed in the control variables GenderM, Age, FatherEnt, MotherEnt, and A.A.I.

As noted, there are no statistically significant mean differences between the treatment and control groups. This allows validating the comparison between groups to identify the effect of gamification on risk aversion. It is noteworthy that we used the Kernel model, with a confidence interval of 0.06 in pairing the groups. By using this bandwidth for the Kernel model, the average across individuals in each group is accurately estimated, thus reducing the likelihood that a significant difference in results is caused by inadequacy in the selection of individuals. Given this validation, the study advances to the analysis of the results obtained.

RESULTS ANALYSIS

Table 2 presents the results for each of the six models considered, using the Diff-in-Diff technique combined with propensity score matching.

Table 2. Diff-in-Diff of risk aversion (RA) with PSM

Variables	I	II	III	IV	V	VI
	Lottery RA	Investment RA	Financial RA	Career RA	Sports RA	Strangers RA
Time	0.118	0.0706	0.165	0.200	0.165	0.188
	(0.192)	(0.179)	(0.320)	(0.325)	(0.269)	(0.344)
Treated	-0.190	-0.209	-0.318	-0.354	-0.254	-0.314
	(0.187)	(0.174)	(0.312)	(0.317)	(0.263)	(0.336)
Diff-in-Diff	0.647**	0.458*	0.722*	0.725*	0.533	0.736
	(0.257)	(0.240)	(0.430)	(0.436)	(0.362)	(0.462)
Constant	6.572***	6.233***	12.04***	12.90***	10.43***	13.91***
	(1.294)	(1.206)	(2.162)	(2.193)	(1.818)	(2.325)
Observations	382	382	382	382	382	382
R-squared	0.110	0.105	0.093	0.099	0.099	0.096

Note.*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

The first model evaluated the decision to invest resources arising from winning a lottery (Lottery RA). The parameter was positive and statistically significant at a 5% level, with an estimated difference of 0.647 points on the scale. This indicates an increase in the propensity to use capital for a risky investment. Therefore, compared to individuals who were not subjected to gamification, students who underwent the intervention with the FishBanks game experienced an increase in their willingness to take this type of risk.

With regard to the willingness to take investment risks, the second model (Investment RA) verified such a difference in the individual's perception. We used a scale from 1 to 10, so the higher the value, the greater the individual's willingness to take risks. The parameter showed a positive and statistically significant result at 10%, in the order of 0.45 points on the scale, indicating a greater propensity to take investment risks after the gamification strategy.

The third model (Financial RA), in turn, used a scale of financial decisions. The individual had ten levels of sensitivity in decision-making. Each sensitivity level presented the option of having a 50% chance of receiving BRL 300.00 or the certainty of receiving a fixed amount. Level 1 started at BRL 25.00, and level 10 had a value of BRL 250.00. We assessed the level of decision change at which the individual changed their choice. The results indicate that risk aversion decreased for students submitted to the game as a complementary activity, since there was an increase of 0.722 in the propensity to take financial risks, statistically significant at the 10% level.

Next, the fourth model analyzed the willingness to take risks in a career choice decision (Career RA), using a scale from 1 to 10. The parameter was positive and statistically significant at 10%, with a value of 0.725 points. Finally, models five and six assessed the willingness to

take risks when practicing extreme sports (Sports RA) and trusting strangers (Strangers RA), respectively. We included such indicators as placebos in the study to assess whether there are differences between the perception of economic-financial risk and generalist risks. Neither generalist model showed statistical significance.

On the other hand, the significant effect on the first four models, which make up the set of economic-financial decisions, strengthens the proposition that gamified activity influences the assumption of risks associated with entrepreneurial behavior. In summary, we found that the classes that used gamification had a statistically significant increase in the financial spheres of investment and career, corroborating the research hypothesis (H1: Gamification is associated with reduced risk aversion linked to entrepreneurial behavior).

Difference analysis in quantile differences

Table 3 presents the difference-in-difference results, with PSM and quantile regression (at quantiles 0.10, 0.25, 0.50, and 0.75) for variables that were statistically significant in the financial, investment, and career spheres.

Table 3. Diff-in-Diff results with psm, distributed by quantile (percentiles 0.10, 0.25, 0.50 and 0.75)

	Percentile 0.10	Percentile 0.25	Percentile 0.50	Percentile 0.75
Lottery RA	0.591*	0.768***	0.579	0.394
	(0.306)	(0.290)	(0.593	(0.478)
Investment RA	0.501*	0.507***	0.457	0.347
	(0.300)	(0.285)	(0.302)	(0.385)
Financial RA	0.702**	0.827	0.773	0.754
	(0.276)	(0.735)	(0.517)	(0.619)
Career RA	0.910***	1.250*	0.395	0.628
	(0.165)	(0.719)	(0.697)	(0.550)
Observations	382	382	382	382

Note.*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

The Lottery RA variable showed statistically significant and positive effects in the lowest quantiles, 0.10 and 0.25 (first quartile), indicating that, for those who performed gamified activities compared to students who studied entrepreneurship without the support of gamification, the effect of the intervention was significant for participants who had low-risk propensity before the experience, i.e., in those students who are more risk averse. We also noticed that the effect followed the same logic for investment (Investment RA) and career (Career RA) risk aversion with positive and significant effects on the first percentiles of the distribution.

Regarding the scale of financial risks, in which students stated their level of willingness to make financial decisions, the effect was concentrated at the 0.10th percentile, indicating a

greater impact on those students who were less likely to take financial risks. Therefore, there is no evidence to reject the second research hypothesis (H2: Gamification does not have a constant effect on reducing risk aversion across distribution) since the results indicate that the impact is not constant, concentrating on the first quartile.

DISCUSSION OF RESULTS

In this research, for students taking entrepreneurship courses, the use of gamification with the FishBanks business simulation resulted in positive effects on the tendency to take risks as the probability of return increases, corroborating elements of the Cumulative Prospect Theory (Tversky & Kahneman, 1992).

This research identified statistically significant increases in risk propensity for a set of economic-financial decisions linked to the entrepreneurial career (investment, financial, and career choice risks). In light of these results, risk management and assertive decision-making skills can be effectively developed through gamification, helping students identify risks associated with entrepreneurship and analyze whether they should assume them and what strategies to mitigate them.

When choosing a tool that incorporates financial elements and decision-making scenarios, we can encourage students to make informed choices, taking advantage of learning financial strategies to reduce risk aversion. The Cumulative Prospect Theory (Tversky & Kahneman, 1992) supports this argument, indicating that individuals tend to be less risk-averse when they perceive chances of financial gain. This simulated process resembles real entrepreneurial activity. Therefore, the gamified experience of this study directed students to solve business problems in a dynamic that encouraged reflection. These skills can make participants more prepared to deal with uncertainty and reduce risk aversion. This is particularly relevant for entrepreneurial training, as the modern world of work requires professionals to be able to assess and analyze contingency situations, using this information to solve problems and make smart choices (Chen et al., 2022; Isabelle, 2020). The gamification strategy offers this knowledge base that emulates the relevant managerial experience so that students become aware of the difficulties of entrepreneurship (Pérez-Pérez et al., 2021).

Such arguments corroborate the previous literature, meeting the studies by Chapkovski et al. (2021) and Zichella and Reichstein (2022). These authors applied gamification and found evidence that this pedagogical resource encourages participants to take more risks. For Zichella and Reichstein (2022), these programs are relevant and necessary since individuals have limited rationality and can be influenced by systematic biases in high-risk business processes. From this perspective, we can infer that the choice of suitable games for the intended objectives (in this case, a game that simulates resource finitude scenarios in the fishing sector) can support the organization of curricula capable of providing students with training and awareness of the cognitive mechanisms involved in decision making, especially with financial risk.

Such results contribute to a literature of recent empirical investigations, which presents arguments that the relationship between gamification and risk-taking has a significant impact on entrepreneurship teaching. In this regard, we highlight research such as Chapkovski et al. (2021), Chemborisova et al. (2019), Costin et al. (2019), Thanasi-Boçe (2020), and Zichella and Reichstein (2022), who identified positive effects. In contrast, a smaller body of work on this topic provides contradictory evidence. Thus, Kraus et al. (2021) and Pérez-Pérez et al. (2021) showed that some participants prefer more predictable scenarios when exposed to games, not showing a greater propensity to choose risk over certainty. Therefore, this article can contribute to confronting these apparently opposite findings.

It is worth resuming the discussion of the positive effects identified in this study with regard to the set of economic and financial variables. In summary, this evidence suggests that, by simulating operations to maximize the equity of a business, FishBanks explores a narrative so that the player can deal with scarce resources and financial and operational decisions in a context of uncertainties, which are competencies directly associated with entrepreneurial activity and its challenges (Meadows et al., 2017; Melo et al., 2023), especially investment and financial.

The reasons that can explain the statistically significant results only for the risk aversion variables in this economic-financial context (Lottery RA, Investment RA, Financial RA, and Career RA) are diverse but due to the quantitative nature of this work, one can only assume the influence of the elements involved (game design) to encourage risk tolerance (Fox et al., 2018); certain tools involve a kind of "financial literacy," resulting in stronger effects on these variables (Chapkovski et al., 2021; Zichella & Reichstein, 2022), and immediate feedback on successes and failures allows students to invest in, fail, analyze risky situations, and learn to resolve them in a controlled manner (Chemborisova et al., 2019; Costin et al., 2019; Thanasi-Boçe, 2020), with spillover of these learnings to individual risk aversion, outside the context of the simulation. Thus, knowledge of financial education can increase tolerance for calculated risks in business and, consequently, encourage entrepreneurship. However, we suggest new studies with mixed methods (qualitative and quantitative) involving self-reports to expand the evidence about these assumptions.

The results highlighted the importance of gamified teaching tools that explore financial aspects. Furthermore, we emphasize that Fishbanks is focused on the creation of fishing businesses. Therefore, it would be relevant to expand the investigations to other types of enterprises and carry out investigations in other sociocultural and educational contexts. In addition to financial variables and entrepreneurial career choice, other aspects can be tested. As highlighted by Fox et al. (2018), these suggestions require that researchers choose and/or develop games aligned with learning objectives. We suggest that such resources be focused on different sectors of activity of future entrepreneurs.

Additionally, when comparing the beginning and end of the course, using quantile regression combined with the Diff-in-Diff and PSM methods, we could find evidence that the individual who has a low level of propensity to risk (consequently more risk averse) before the intervention, is more likely to take risks at the end of the course. This is particularly interesting and indicates

that educators and public policy-makers can explore the potential of gamification to encourage these skills in groups that have less tolerance for getting involved in risky situations in the business context and, for this reason, need training and immersion to have prior experience with this decision-making process. This argument corroborates the findings by Chapkovski et al. (2021), who identified that the effect is stronger for inexperienced participants with less knowledge.

The difference in using quantile regression as an identification strategy lies in the need to present a thoughtful argument and adopt the idea that taking risks can be circumstantial. For different reasons, some individuals will be more susceptible to gamification stimuli (Chapkovski et al., 2021). In particular, we can highlight that, in general, the business simulation strategy used here affected the behavior of entrepreneurship students differently, demonstrating that a possible factor that can influence this difference is the intensity of risk aversion that the individual presents before experiencing the gamified activity.

To ensure robust analysis and validity of results, we selected control variables, including age, Academic Achievement Index (A.A.I.), and relevant categorical variables, such as male gender and the presence of entrepreneurial fathers or mothers. Thus, we were able to control and consider possible external influences that could confuse the results and distort the conclusions.

Therefore, the theoretical contributions presented broaden academic discussions of the literature, strengthening the idea that learning based on game elements - when well planned, validated, and properly implemented - can bridge the gap between practical and theoretical knowledge and skills associated with risk-taking.

CONCLUDING REMARKS

This study evaluated the relationship between gamification in entrepreneurship teaching and risk aversion in technical high school students. The results showed that students who participated in the gamified experience with the FishBanks business simulation reduced their risk aversion, increasing the propensity to take risks associated with career, financial, and investment decisions, according to aspects of the Cumulative Prospect Theory. In addition, students with greater risk aversion at the beginning of the course benefited the most.

This study contributes to the literature on entrepreneurial education and helps to build policies aimed at strengthening entrepreneurial behavior, enabling educators, professionals in the field, public policy-makers, and entities that promote entrepreneurship to consider gamification as another innovative pedagogical resource, with the potential to train the student, as the immersive experience of gamification can lead participants to apprehend knowledge about making informed and data-based decisions, assess risks and opportunities, realistically understanding the consequences of their simulation choices.

Through measures such as integrating gamification into the school curriculum and training teachers, it is possible to create an environment more conducive to the development of entrepreneurial skills and the reduction of risk aversion, encouraging young people to consider

entrepreneurship as a career option. The target audience for these policies would be students, especially in high school and vocational education, who are at a crucial stage of career choice and have the opportunity to develop entrepreneurial skills from an early age. In addition, teachers and educators would also benefit from training and resources to implement gamification in entrepreneurship education effectively.

Although the sample size is a limitation, this article presents practical implications so that researchers and those interested in the subject can explore this field of study. In relation to previous works, this study presents two differences worth highlighting. Firstly, the sample is made up of technical high school administration students, presenting scientific evidence in younger groups who have not yet chosen a professional career and who, through gamification, could awaken interest in entrepreneurship. Second, the risk aversion variable has been little analyzed (Chapkovski et al., 2021; Fox et al., 2018; Zichella & Reichstein, 2022). Therefore, we can shed light on the valuable contributions of gamification as a possible resource to prepare students, making them more confident and informed when dealing with situations of risk and uncertainty in their future fields of work.

As limitations, we emphasize that the study only monitored the initial and the closing periods of the course, not following the durability of the effect after the experience. Furthermore, we emphasize that the research was conducted in a single institution, and the generalization of the findings in the research should be considered sparingly. Therefore, we suggest carrying out longitudinal studies that accompany the students, experiments that measure the effect considering longer periods after the intervention, and verifying whether the results found are maintained over time. Finally, it would be interesting to conduct similar studies with mixed methods in different educational and sociocultural contexts to obtain evidence to support or reject the hypotheses addressed in this article.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

AUTHORS' CONTRIBUTION

Felipe Luiz Neves Bezerra de Melo: Conceptualization; Data curation; Formal Analysis; Investigation; Methodology; Project administration; Supervision; Validation; Visualization; Writing – original draft; Writing – review & editing.

Ana Maria Jerônimo Soares: Conceptualization; Formal Analysis; Investigation; Methodology; Visualization; Writing – original draft; Writing – review & editing.