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The Impact of Gamification on Entrepreneurial Intention in a Brazilian Technical Business School

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ABSTRACT

This paper aims to evaluate the impact of gamification as a practice of teaching entrepreneurship on the entrepreneurial intention. We applied the FishBanks simulation to entrepreneurship classes of a Brazilian technical business course at the Federal Institute of Rio Grande do Norte (IFRN). We adopted as an identification strategy the use of the methods of difference-in-differences, combined with propensity score matching and quantile regression to investigate the impact of gamification on entrepreneurial intention of the students of a technical business course. The sample was composed of 191 students on a longitudinal panel of two periods, with 106 students in the treatment group and 85 students in the control group, totaling 382 observations. The results indicate a positive and statistically significant impact of the use of the business game on the entrepreneurial intention. Furthermore, we observed a higher impact of gamification in entrepreneurial intention of the students in the first quartile of the entrepreneurial intention.

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INTRODUCTION

The development of skills and capabilities linked to entrepreneurship is a key factor in transforming ideas into entrepreneurial actions (Blimpo & Pugatch, 2021; Kauppinen & Choudhary, 2021), making individuals create and identify business opportunities and excel in highly uncertain scenarios (Agarwal et al., 2020; Chen et al., 2021; Hahn et al., 2017. Given the importance of entrepreneurial activity for socioeconomic growth, especially in developing countries, entrepreneurship skills are becoming a set of essential learning objectives (Chen et al., 2021; Lafortune et al., 2022; Liguori & Winkler, 2020).

As the most consolidated teaching practice in higher education, entrepreneurship education is also relevant for primary and secondary education audiences (Zulfiqar et al., 2019), as well as for the technical/professional education modality (Jones, 2019; Lackéus, 2015; Zulfiqar et al., 2019), with a view to developing entrepreneurial behavior from the beginning of school education (Liguori et al., 2019). Furthermore, the transition from education to work can be time-consuming in undeveloped economies (Alaref et al., 2020), which justifies efforts by academics and policymakers to promote skills associated with entrepreneurial behavior before young people leave the educational system (Alaref et al., 2020; Lafortune et al., 2022).

Research on entrepreneurship education suggests that a gamified teaching approach (application of games and their mechanics) can generate the necessary engagement to improve student learning, stimulating the intention to start a business (Blimpo & Pugatch, 2021; Zulfiqar et al., 2019). The inclusion of digital games in entrepreneurship education allows students to create and manage different businesses, experience setbacks and challenges (Zulfiqar et al., 2019), take risks, think critically, deepen the understanding of theories and models (Takemoto & Oe, 2021), develop skills and competencies about the dynamics of entrepreneurship (Kauppinen & Choudhary, 2021), making them more likely to start a venture before completing the course (Alaref et al., 2020; Lafortune et al., 2022; Takemoto & Oe, 2021).

In the context of higher education, empirical studies have shown positive effects of the use of games on student learning and entrepreneurial intention, demonstrating that such practice results not only in motivation (Grivokostopoulou et al., 2019; Ruiz-Alba et al., 2019) and the ability to memorize theories (Takemoto & Oe, 2021), but, above all, in the intentions of acting according to the lessons learned in the classroom (Alaref et al., 2020; Zulfiqar et al., 2019) and, consequently, greater propensity to start a business (Buil et al., 2020; Fellnhofer, 2018; Fox et al., 2018; Ruiz-Alba et al., 2019). However, little attention has been paid to the effect of gamification on entrepreneurship education at the initial levels of education, as in the case of elementary and secondary education (Zulfiqar et al., 2019) and in professional training (Liguori et al., 2019).

Given the lack of studies in the context of high school, this research seeks to study the effects of an entrepreneurship game on the entrepreneurial intention of Brazilian high school students in the vocational modality. Therefore, this study was guided by the following question: "Does gamification as a practice of teaching entrepreneurship influence the entrepreneurial intention of students of vocational training?" To answer this question, FishBanks was used as an educational resource for gamification. It is a web-based business simulation developed by professors at the Massachusetts Institute of Technology (MIT) (Meadows et al., 2017). In this game, players assume the role of owners of a fishing company and compete, seeking to maximize the economic values of their companies (Sterman, 2010; 2014). In this way, the game allows students to manage their ventures in a scenario of finite resources, making economic, commercial, strategic, and operational decisions (Meadows et al., 2017).

We applied the FishBanks simulation to a sample of 191 students of professional training in administration at the Federal Institute of Education, Science, and Technology of Rio Grande do Norte (IFRN). As an identification strategy, the difference-in-differences (DD) method, combined with propensity score matching, was used to investigate the impact of gamification on students' entrepreneurial intention — measured on the first day of class and at the end of the entrepreneurship course. Additionally, quantile regression results are presented to verify if there was a difference in effect between students with low and high initial entrepreneurial intention. The main results indicate that the use of FishBanks is associated with an increase in the entrepreneurial intention of students, especially those with lower initial entrepreneurial intention, belonging to the first quartile of the distribution.

In this perspective, this study contributes to the understanding of the role of entrepreneurship education in the context of vocational high school and reinforces, in particular, that games can be powerful tools for this purpose. Regarding the practical relevance of the study, the sample used is different from the usual student samples in related studies, as it focuses on technical education students from a developing country, who have few options in the job market besides entrepreneurship. Thus, in terms of public policies, the results of this research can expand the understanding

of the influence of methodological innovations (gamification) in the teaching of entrepreneurship on the entrepreneurial intention of students, as well as helping to define practices to be adopted by the entire Brazilian federal technical education network.

Therefore, using the FishBanks game, this study responds to a need identified in the literature (Lafortune et al., 2022; Moberg, 2021; Ruiz-Alba et al., 2019), which consists of studying the proper use of online games and present practical guidance to assist pedagogues in the field of entrepreneurship education (Takemoto & Oe, 2021), as well as evaluating gamification as a tool to improve learning outcomes and promote innovation skills and positive perceptions about entrepreneurship among students (Lafortune et al., 2022; Moberg, 2021; Zulfiqar et al., 2019).

In addition to this introductory section, this paper is structured as follows. Initially, we present the literature review on entrepreneurial intention, entrepreneurial education, and gamification strategies in the teaching of entrepreneurship. The third section presents the method used. Then, we analyze and discuss the results. Finally, we present the concluding remarks.

THEORETICAL FRAMEWORK

Entrepreneurial intention

Entrepreneurial intention (EI) represents the cognition/motivation that guides an individual to put into action the planned decisions about entering entrepreneurship (Salamzadeh et al., 2022). It consists in the possibility of people making efforts to carry out entrepreneurial behavior (Anwar et al., 2021; Liñán & Chen, 2009; Zhang et al., 2014) and the greater the intention of an individual to become an entrepreneur, the greater the probability that this behavior will be effective (Krueger, 2009; Liñán & Chen, 2009; Liñán & Fayolle, 2015). Entrepreneurial intention can be influenced by a combination of personal and social factors, such as needs, beliefs, values, and desires (Agolla et al., 2019; Esfandiar et al., 2019).

Previous studies indicate that entrepreneurial intention is a primary factor for understanding the process of entrepreneurship (Krueger, 2009; Liñán & Chen, 2009; Liñán & Fayolle, 2015; Miranda et al., 2017; Bilgiseven & Kasimoğlu, 2019). Understanding the factors that lead an individual to be predisposed to entrepreneurship has an importance that cannot be underestimated (Zhang et al., 2014), making EI a strong predictor and indicator of entrepreneurial behavior (Ajzen, 1991; Bird, 1988). Thus, the study on intention provides a way to advance research in the field of entrepreneurship, being, therefore, indispensable for researchers to understand what makes a person want to start a business (Agolla et al., 2019; Esfandiar et al., 2019).

The literature points out that increasing the entrepreneurial intentions of individuals through entrepreneurship education represents an important mechanism (Halim et al., 2019; Krüger et al., 2019), since students inserted in classrooms with approaches aimed at the practice and dynamics of entrepreneurship develop greater entrepreneurial intention than students who are not exposed to such education (Chen et al., 2021; Liñán & Chen, 2009; Liñán & Fayolle, 2015).

Regarding the entrepreneurial intention among students, the results of the research developed by Halim et al. (2019) revealed a positive effect between educational support and entrepreneurial intention. Similarly, researchers such as Fretschner and Lampe (2019) also validated the effect of entrepreneurial education on students' intentions to start a business. Thus, considering the potential of education to be configured as an important predictor of entrepreneurial intention, it is relevant to discuss aspects that guide this field of study, as presented in the following section (Pfeifer et al., 2016).

Entrepreneurial education

Entrepreneurial education (EE) can be defined as a method of teaching entrepreneurship, in order to encourage students to use and apply concepts, tools, and practices in this area (Neck & Greene, 2011), thus awakening the entrepreneurial mindset of young students, so that they later develop an entrepreneurial culture (Rauch & Hulsink, 2015; Fayolle & Gailly, 2015). Thus, for the design of programs based on the training of individuals capable of innovating, creating, and starting a business venture, it becomes necessary to understand the teaching-learning strategies, investigating under which conditions such a process contributes to learning, intention, and entrepreneurial behavior (Maresch et al., 2016; Hahn et al., 2017; Nader & Hamdy, 2019; Verduijn & Berglund, 2020).

Entrepreneurship teaching, at different educational levels, seeks to develop entrepreneurial skills in students (Fernández-Pérez et al., 2019), stimulate entrepreneurial mindset and behavior (Zulfiqar et al., 2019; Yen & Lin, 2020), so as to reduce the number of students who, even after completing higher education, remain without place in the market (Jones et al., 2018; Olutuase et al., 2020). In this sense, educators and policymakers must recognize the role of entrepreneurial education in promoting stimulation to entrepreneurship, as this process becomes important to boost the creation of new businesses and, consequently, to fos-

ter socio-economic development (Nader & Hamdy, 2019; Santos et al., 2019).

By contextualizing the relationship between entrepreneurial education and EI, PPiperopoulos and Dimov (2015) observed lower levels of entrepreneurial intentions of university students in courses that used methodologies mainly of a theoretical nature, as well as higher levels of business intentions in courses with active methodologies, focused on practice. Corroborating these results, Hamzah et al. (2016) and Olutuase et al., 2020 highlighted that the teaching method adopted significantly influences the acquired skills, since practical activities are challenging and can arouse, in college students, the interest and desire to start a business venture.

The effect of an entrepreneurship education program on entrepreneurial behavior was the subject of research by Rauch and Hulsink (2015). The authors carried out an experiment with the participation of 96 master's students of entrepreneurship and 57 master's students in supply chain management. The results pointed to an increase in entrepreneurial intentions after participating in the program, and the participants showed an increase in attitudes toward entrepreneurship and perceived behavioral control. Furthermore, the intentions mediated the effect of education on behavior for starting a business.

According to Chen et al. (2021), entrepreneurship education, because it is an approach that requires "learning by doing" (p. 192), should provide the student with practical skills and experiences in an authentic environment (Liguori & Winkler, 2020; Rashid, 2019). Due to the role of entrepreneurial activity as a means to promote economic growth, fight unemployment, and create social capital, EE has become a top priority on political agendas around the world (Grivokostopoulou et al., 2019). Thus, educators need to apply dynamics capable of helping to formulate an entrepreneurial mindset, skills, and competencies (Grivokostopoulou et al., 2019; Takemoto & Oe, 2021). Some research indicates that emphasis can be placed on the use of educational technologies (Chen et al., 2021), such as pedagogical approaches based on gamification principles (Grivokostopoulou et al., 2019; Lafortune et al., 2022; Ruiz-Alba et al., 2019).

Despite the relevant theoretical-empirical framework about the effects of education for entrepreneurship, more recent studies cover interdisciplinary strategies for the training of future entrepreneurs, using gamification as a technical subsidy (Fellnhofer, 2018; Fox et al., 2018; Ruiz-Alba et al., 2019; Buil et al., 2020). The following section discusses the gamification paradigm in teaching entrepreneurship.

Gamification strategies in teaching entrepreneurship

Which are the most suitable pedagogical solutions to strengthen key competences for entrepreneurship are not known for sure, as analyses and reviews on the effectiveness of new resources are still limited (Chen et al., 2021; Rashid, 2019). To respond to this literature need, researchers have explored gamification as an innovative methodology (Lafortune et al., 2022; Ruiz-Alba et al., 2019; Takemoto & Oe, 2021). This concept involves the application of game mechanics and reasoning to motivate and promote knowledge (Blimpo & Pugatch, 2021; Deterding et al., 2011) and represents an opportunity to generate active entrepreneurial learning environments, in which students learn curriculum content in a relaxed, collaborative, dynamic, and experiential context (Grivokostopoulou et al., 2019; Kauppinen & Choudhary, 2021; Ruiz-Alba et al., 2019).

Within the scope of teaching entrepreneurship, a survey carried out by Fellnhofer (2018) sought to analyze the effects of using games on entrepreneurial intention and behavior of students at the secondary level. The author used a small random sample made up of 41 participants who used an entrepreneurial education program based on games. In methodological terms, the author used factor analysis, Cronbach's alpha, and multiple linear regression. The results showed that key elements of the game have a significantly positive influence on attitude, intention, and behavior toward entrepreneurship. Therefore, the study suggests that personalizing the teaching of entrepreneurship, making it more practical and playful, motivates potential entrepreneurs to start a company.

The relevance of non-traditional methods for teaching entrepreneurship was reinforced by Olokundun et al. (2018). They investigated the extent to which teaching methods based on business simulations and experiences stimulate students' interest to start entrepreneurial activities. With a sample of 600 university students and using multiple hierarchical regression analysis, the authors identified that the adoption of practical experimental activities has a positive effect on students' interest and drives the involvement of students in entrepreneurial activities, still during the graduation period.

According to Ruiz-Alba et al., 2019, the use of games and business simulation, in the academic field, is a strong trend that helps educators in the area of entrepreneurship in the task of stimulating the development of entrepreneurial skills in students. The authors sought to analyze how gamification influences the entrepreneurial intentions of a group of users of an online platform. With a sample of 220 university students and using mixed analysis of variance (ANOVA), the results

pointed to a significantly positive effect of the attitude toward the behavior and behavioral control perceived in the entrepreneurial intention, so these effects increased after the gamification experience. Therefore, the study suggests that gamification can influence entrepreneurial behaviors.

Aries et al. (2020) also evidenced the positive effect of a gamification model on students' intentions to become entrepreneurs. When surveying 400 entrepreneurship students, the researchers obtained results that found support in the study by Ruiz-Alba et al. (2019), highlighting that the learning model based on gamification has a positive effect on entrepreneurial intention, being able to shape students' entrepreneurial behaviors.

Buil et al. (2020) analyzed the use of business simulation games in the classroom, as well as their impact on student engagement and learning. In methodological terms, the partial least squares (PLS) regression analysis demonstrated that undergraduate students' perceptions of competence and autonomy, while using business simulation games, have a positive effect on their cognitive, emotional, and behavioral skills. Furthermore, cognitive and emotional involvement has a positive influence on skills development and perceived learning.

Therefore, the use of game mechanisms that simulate business situations provides a dynamic and playful character for learning (Hamari & Koivisto, 2015; Sailer et al., 2017; Fox et al., 2018). For this reason, the participants feel challenged to achieve the objectives proposed in the activities, being directed to compete with each other, to think and make important decisions, assuming, therefore, an entrepreneurial stance, with specific skills of a professional nature (Antonaci et al., 2015; Grivokostopoulou et al., 2019). Gamification strategies in entrepreneurship education give rise to greater student participation, engagement, and motivation so that they become protagonists in the learning process (Nacke & Deterding, 2017; Zulfiqar et al., 2019).

In the context of secondary education in Rwanda, Lafortune et al. (2022) found that after offering gamified entrepreneurship classes, students in the treatment group were much more likely to own a business than participants in control schools (without gamified training). The authors pointed out that the training induced the students to participate more actively in their school's 'business club,' a project that integrated activities aimed at entrepreneurship and that, before the experiment, did not receive many members. Thus, the gamified approach can improve the experience, engagement, and entrepreneurial self-efficacy of the students involved (Isabelle, 2020; Ruiz-Alba et al., 2019; Takemoto & Oe, 2021).

For Lafortune et al. (2022), Ruiz-Alba et al. (2019), Takemoto and Oe (2021), and Vesa et al. (2017), gamification, entrepreneurial education, and entrepreneurial intention are relevant topics, but mainly addressed separately, therefore needing more empirical studies to highlight the relationships between such areas. Because of the discussions that suggest the need to think about the role that gamification, combined with entrepreneurial education, exercises on the intention of individuals to start business ventures, this study sought to conduct an experiment to investigate the effectiveness of gamification in the entrepreneurial intention of vocational training students

Business simulation FishBanks

The FishBanks business simulation is a multiplayer platform in which participants compete to maximize their net worth, in a scenario of management of natural resources. Based on the web, the simulation theme is the fishing sector. The current version was developed at Sloan Management, the business school of the Massachusetts Institute of Technology. The game has already been used in several educational institutions around the world, being applied in entrepreneurial education contexts for vocational training, college, and executive education (Meadows et al., 2017). Furthermore, the simulation is available in English, Portuguese, Spanish, and Chinese, which allows its use worldwide.

FishBanks addresses some of the main challenges of a for-profit business operation. Participants should make decisions about the size of their fleet (fleet expansion and vessel marketing among competitors) and fishing areas for ship allocation. The game allows synchronous and asynchronous application modalities, with deadlines established for each round of decision — both with a maximum allocation of up to ten fishing companies per ocean. The game's instruction manual recommends that synchronous sessions be conducted in an approximate period of 80 minutes. In each round, participants have access to the initial panel that contains the participant's financial information and general ocean resource conditions.

The teams start their participation with a pre-established number of ships (the default game configuration stipulates three for each team) at a given market value — which is based on the total number of vessels, bids made by each team in boat auctions, and commercial prices established by the players. For fleet expansion, participants can order boats at the shipyard — each order limited to half of its fleet in the order round — or participate in boat auctions sold by competing teams.

The average value of the boats is adjusted from the average price of the held auctions. In a scenario of high demand for new boats, prices tend to rise. In the absence of auctions, the price is adjusted based on the net present value of a ship according to the expected catch and operating costs (Meadows et al., 2017).

Another decision that must be made in each round is the allocation of the boats. Each team has three options for each boat: keep the boat in port, fish in coastal waters, or fish in deep waters, with operational costs of USD50, USD150, and USD250, respectively. The fish stocks in the oceans vary according to the allocation decision of the participating teams. Initially, coastal waters have a fish population, ranging between 1,000 and 2,000 units, with a maximum efficiency of 15 fish units per boat yearly. Deep waters have a fish population ranging from 2,000 to 4,000 units, with maximum efficiency of 25 units fished per boat yearly (Meadows et al., 2017), which means that a boat will achieve its maximum productivity (efficiency) when it catches 15 fish per year in coastal waters, and 25 fish per year in deep waters.

The productive capacity is also associated with climatic variations, in terms of technology (standard, low tech, and high tech) and the reproduction rate of the fish, options that can be configured by the instructor in a range of distribution of functions. From a financial point of view, teams receive a starting cash per boat. If they maintain a positive balance throughout the competition, they will be paid interest. If the cash balance becomes negative, the team will pay interest on the negative balance. The winner of the game is the team that maximizes its net worth at the end of the number of established rounds, which consists of the value of the fleet plus the cash balance — the result of operating activity and interest payments (Meadows et al., 2017).

According to Sterman (2014), FishBanks' differential is the student's exposure to business management in a scenario of finitude of natural resources, subject to the 'tragedy of the commons' — free access and unrestricted demand for a given finite resource can lead to its overexploitation, since individuals are acting to maximize their individual utility while it is profitable, without taking into account the sustainability of the resource and the collective interest (Berkes, 1985). Next, we will present the methodological procedures that led to the development of this research.

METHODOLOGY

Research design and identification strategy

In this study, we used quasi-experimental design to estimate the effect of using an entrepreneurial environment simulation as an entrepreneurship teaching practice. Then, our main research hypothesis is:

> H1 — The use of gamification as a practice of teaching entrepreneurship is associated with the increase of entrepreneurial intention of students from a vocational training institution

Our identification strategy combined difference-in-differences (DD) and propensity score matching (PSM) techniques. In the DD model, the characteristics of the observations are analyzed before and after a given intervention (the use of gamification as a teaching practice). Thus, to obtain the result parameter, a control group and a treatment group must be established (affected by the variable of interest). Then, the estimate of the impact of the intervention is obtained using a double subtraction. The first difference is the subtraction of the posterior means by the means before an intervention, for both the treatment and control groups. Then, a second operation is performed, which consists of subtracting the differences obtained from the treatment group by the control group (Angrist & Pischke, 2008; Schiozer et al., 2020). The DD method hypothesizes that the temporal trajectory of a given variable can be estimated taking into account its behavior before and after a given treatment. This allows one to predict what the result of an estimate would be if one had not undergone a particular treatment — counterfactual (Angrist & Pischke, 2008; Schiozer et al., 2020). Thus, the validity of the difference-in-differences approach relies on the equal trend assumption, or rather the assumption that no time-varying differences exist between the treatment and the control groups. Thus, unlike the assumptions of the classic linear model of a multiple regression, for example, the DD approach observes the trends of the treatment group and the control group, as well as the non-difference between groups regarding the variables that are relevant to the study (controls used in propensity score matching).

In our work, the variable of interest is the entrepreneurial intention scale, adapted from Liñan and Chen (2009) and composed of five questions. Entrepreneurial intentions were measured on a seven-point Likert-type scale and ranges from seven (strongly agree) to zero (strongly disagree), keeping the original scale. Then, the results were normalized to an entrepreneurial intention index ranging from one up to ten. The treatment was the application of the FishBanks business simulation. To account for other factors that influence student's entrepreneurial intention, we included the following controls. We used a vector of student characteristics as controls,

covering gender, age, grade point average (GPA), and the parents' profession, taking the value one if the student father or mother is an entrepreneur. Therefore, to control the results, the proposed regression model in this study was performed with and without these controls.

An advantage of the DD method is that it allows controlling for unobserved characteristics that remain fixed over time, such as an individual's innate ability. In addition, the technique allows overcoming some of the limitations of the so-called naive models, which compare only one treatment group in the period before and after a phenomenon (without establishing its counterfactual or taking into account events not controlled by the model that could affect its result), or the use of an inappropriate treatment group to compare results (Angrist & Pischke, 2008; Schiozer et al., 2020).

The propensity score matching (PSM) technique was used after the verification that the random selection of treatment and control classes provided distinct characteristics between the treatment and control groups, especially gender. This difference was caused by the fact that two classes assigned in the treatment group had most female students. The PSM allows estimating a counterfactual group that resembles the treatment group through observable characteristics of the units of analysis — in this research, gender, age, grade point average (GPA), and if the individual is the son of an entrepreneurial father or an entrepreneurial mother. When applying the PSM, the only difference between an individual in the treatment group and the control group would be the intervention analyzed. In this way, each element in the treatment group will be paired with its most similar element in the control group (nearest neighbor). This consists of dividing the estimated propensity score distribution into intervals, such that in each block treatment units and control units have the same propensity score on average, which allows the different numbers of participants in each group. After computing the propensity score, each unit in the treatment group was paired with those with the closest score in the control group (Angrist & Pischke, 2008; Pinto, 2012; Rosenbaum & Rubin, 1983). Hence, pairing tries to mimic a random selection between groups. One of the assumptions of the PSM is that there should be common support between the treatment and control groups, which means that the observations of the treatment group must be paired with at least one unit of the control group. The common support chart is available in Appendix A.

By using the technique of DD after the PSM, the risk of bias decreases considerably, since the DD can control for unobservable characteristics that are fixed in time and the PSM can establish a suitable counterfactual group. In this way, the merged use of these techniques allows relaxing some of the hypotheses demanded in the individual use of each one (Pinto, 2012).

To understand the treatment effect over the distribution, we also applied a quantile regression. The quantile regression technique allows estimating the relationship between two random variables by computing the conditional average for any quantiles of a response variable (Koenker & Basset, 1978). Unlike the ordinary least square method, quantile regression can deal more robustly with outliers, since it uses the conditional median as a measure of central tendency (Koenker & Basset, 1978). In this way, it is possible to understand the effect of treatment on specific quantiles of entrepreneurial intention, distinguished if the use of gamification affected the different strata of the sample differently.

Data

The dataset is composed of students from the Technical Course in Administration at the Federal Institute of Education, Science, and Technology of the state of Rio Grande do Norte (IFRN). This institute is part of the Federal Network for Professional, Scientific, and Technological Education, established under the Law No. 11,892/2008 (Lei n. 11,892, 2008), which currently has approximately one million students enrolled. The Federal Network is composed of 38 federal institutes, two federal centers of technological education, one technological university, 22 technical schools linked to federal universities, and Pedro II College, totaling 661 units in all Brazilian states. The institutes of the Federal Network act primarily in technical and technological education. In 2020, IFRN had approximately 40,000 students in its 21 units distributed in all mesoregions of the state. It is emphasized that IFRN offers 69 technical courses, 21 of which have the discipline of entrepreneurship. In addition, the institute has 20 technologist courses at a higher level, and nine of these courses offer the discipline of entrepreneurship.

The survey was conducted on the Nova Cruz campus. This unit has approximately 1,200 students enrolled in technical courses and technologists in administration, informatics, and chemistry. The campus offers courses morning, afternoon, and evening shifts, with classes ranging from 15 to 40 students. The discipline of entrepreneurship is part of the curriculum of the courses Technical in Administration, Technologist in Analysis and Development of Systems, and Technologist in Chemical Processes.

We collected the data at the opening (time t) and closing (t + 1) of the discipline. The sample consisted of classes that attended the curricular component in 2017,

2018, and 2019, with 106 observations composing the treatment group, and 86 observations the control group, totaling a longitudinal panel of 382 observations. We chose which classes used gamification as a pedagogical strategy varying the class shift: in the first semester of 2017, the chosen class belonged to the morning shift, in the next year in the afternoon shift, etc., until 2019. The treatment group was composed of four classes — two morning shifts and two afternoon shifts, and the control group was composed of four classes — two morning shifts and two afternoon shifts. Due to the impossibility of randomly allocating students into treatment and control groups, classes were allocated into treatment and control groups by drawing lots. Thus, as it was not possible to conduct a pure experiment, the DD methodology, allied to propensity score matching, was chosen to overcome any limitations generated by the non-randomization of individuals.

To test the research hypothesis, we adopted two distinct pedagogical strategies between the treatment and control groups. For the sample, we considered students from the classes of the entrepreneurship curricular component, taught in the third year of vocational training, with a workload of 60 hours. The classes allocated to the treatment group were conducted through lecture classes and application of FishBanks as a complementary activity, over a semester, with eight rounds of the simulation held weekly. The students in the control group had the same lecture classes, syllabus, and workload as the treatment group, but instead of participating in FishBanks, they did business case studies — textbook support material by Dornelas (2008).

In summary, the entrepreneurship classes in all eight classes involved in the research (four classes in the control group and four classes in the treatment group) were taught by the same instructor, so that the same contents were explained. Thus, as inclusion criteria, it is highlighted that all students registered at the beginning of the course who remained until its completion were selected. As they are high school students, it is noteworthy that the distributions associated with gender, age, income, and family background are in line with the population of students from technical schools in the state of Rio Grande do Norte, as observed in Melo, Sampaio, and Oliveira (2020). Furthermore, the course for the students who formed the control group was similar to that offered for the treatment group, except for the fact that they did not receive the treatment (FishBanks as a complementary activity, over a semester), and, therefore, would be a good control group.

ANALYSIS OF RESULTS

Table 1 presents the descriptive statistics of the treatment and control groups. The mean entrepreneurial intention in the period before the application of the FishBanks simulation was 6.20 for the control group, and 6.22 for the treatment group. In the period after the FishBanks, the mean entrepreneurial intention of the students in the control group was 6.54, with an increase of approximately 0.3 points. The treatment group had a mean of 7.58, with an increase of roughly 1.3 points.

Table 1. Descriptive statistics of the control and treatment groups.

	Control Group					Treatment Group				
Variables	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max
EI period 0	85	6.209	2.543	1	10	106	6.227	2.120	1.500	10
EI period 1	85	6.541	2.378	1.7	10	106	7.589	1.683	3.3	10
FatherEnt	85	0.188	0.393	0	1	106	0.236	0.427	0	1
MotherEnt	85	0.0706	0.258	0	1	106	0.0943	0.294	0	1
GenderM	85	0.600	0.493	0	1	106	0.368	0.485	0	1
GPA	85	75.82	9.165	55.59	96.72	106	73.85	9.216	43.91	92.78
Age	85	17.27	1.117	15	21	106	16.93	0.988	15	20
StudentsClass	85	21.49	2.379	19	25	106	28.57	7.319	17	37

Note. Source: Authors' own elaboration.

Regarding the controls, only the variable GenderM (dummy for male gender) had a considerable difference between the groups, male students being 60% in the control group and 37% in the treatment group. This difference is explained by the allocation of the morning shift class of 2017, which was composed of 19 women of a total of 23 students.

Because of this difference, we used the propensity score matching approach to find the best counterfactual for each of the treatment group's observations. Table 2 presents the difference test of means of the control and treatment groups in the period before the application of FishBanks

After pairing, none of the variables showed statistically significant differences. Appendix A presents the common support charts among treatment and control groups, a comparison between groups before and after pairing, and the test of difference of means between groups without the use of PSM.

Table 2. Mean difference test between treatment and control groups at the beginning of the course using propensity score matching.

Variables	Mean Treatment	Mean Control	Diff	t	Pr (|T|>|t|)
EI	6.369	6.219	-0.150	0.44	0.6595
GenderM	0.369	0.368	-0.001	0.02	0.9841
Age	16.961	16.934	-0.027	0.19	0.8489
GPA	73.517	73.845	0.328	0.26	0.7988
FatherEnt	0.233	0.236	0.003	0.05	0.9593
MotherEnt	0.113	0.094	-0.019	0.42	0.6766
Observations	106	86			

Note. Propensity scores estimated using the Kernel model with a 0.06 window and probit matching. Source: Authors' own elaboration.

Table 3 presents the results of the effect of applying FishBanks on entrepreneurial intention with models of difference-in-differences after the use of propensity score matching and, in model 6, a difference-in-differences approach without the use of PSM. We emphasize that a sensitivity analysis of the model was performed with a vector of individual characteristics as controls.

The difference-in-differences parameter was statistically significant at 10%, and positive in all estimates, with the parameter ranging between 0.95 and 0.98 (models 1 to 5). Thus, the results indicate a positive impact of the use of the gamification strategy by the FishBanks business simulation on the entrepreneurial intention of students in the discipline of entrepreneurship. According to the results, students increased their entrepreneurial intention when comparing the beginning and end of the discipline. However, in gamified classes, they showed an average increase of 9.5 percentage points on the scale compared to the counterfactual.

Table 3. Entrepreneurial intention and the use of FishBanks simulation as a pedagogical practice.

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Time	0.370	0.368	0.351	0.340	0.359	0.332
	(0.468)	(0.461)	(0.457)	(0.455)	(0.409)	(0.334)
Treatment Group	-0.150	-0.171	-0.313	-0.150	0.145	0.0179
	(0.364)	(0.442)	(0.386)	(0.395)	(0.377)	(0.317)
Diff-in-Diff	0.950*	0.952*	0.969*	0.980*	0.961*	1.030**
	(0.513)	(0.540)	(0.497)	(0.524)	(0.490)	(0.448)
Constant	**6.369*** **	**6.390*** **	**6.532*** **	**6.369*** **	**6.074*** **	**6.209*** **
	(0.327)	(0.362)	(0.342)	(0.332)	(0.299)	(0.236)
Observations	382	382	382	382	382	382
GenderM	Yes	Yes	Yes	Yes	Yes	No
Age	Yes	Yes	Yes	Yes	No	No
GPA	Yes	Yes	Yes	No	No	No
FatherEnt	Yes	Yes	No	No	No	No
MotherEnt	Yes	No	No	No	No	No

Note. Source: Authors' own elaboration. *** p < 0.01, ** p < 0.05, * p < 0.1. To capture time-varying effects, difference-in-differences takes the before-after difference in the comparison (control) group, which was exposed to the same set of environmental conditions as the treatment group (the second difference). Then, difference-in-differences drops all time-varying factors from the first difference by subtracting the second difference from it (Angrist, J. D., & Pischke, J. (2008). Mostly harmless econometrics: An empiricist's companion. Princeton University Press).

To understand whether the relationship between the application of business simulation and EI has different effects on the distribution of students with low and high entrepreneurial intentions, we analyze the same results above using the quantile regression method. Table 4 presents the results of the relationship between the gamification strategy and the entrepreneurial intention of students in quantiles 0.25, 0.50, and 0.75, using a vector of student characteristics as control.

Table 4. Results of quantile difference-in-differences.

Variables	Quantile Model 0.25	Quantile Model 0.50	Quantile Model 0.75
Time	0.1000	0.500	0.1000
	(0.617)	(0.771)	(0.627)
TreatmentGroup	0.500	-0.300	-0.900*
	(0.588)	(0.692)	(0.495)
Diff-in-Diff	1.600**	1.100	0.900
	(0.728)	(0.819)	(0.692)
Constant	4.400***	6.400***	8.600***
	(0.459)	(0.620)	(0.490)
Observations	382	382	382

Controls: Gender, Age, GPA, entrepreneurial father (FatherEnt), and entrepreneurial mother (MotherEnt)
Note. *** p < 0.01, ** p < 0.05, * p < 0.1. Source: Authors' own elaboration.

The results were statistically significant at 5%, with a positive parameter of 1.6 in the 0.25 quantile (first quartile). Thus, the use of business simulation is effective with students with low entrepreneurial intentions, providing greater engagement and interest in entrepreneurial activity. To analyze these results in depth, we performed an additional quantile regression using a 10% interval over the distribution, resulting in nine deciles. Figure 1 presents the results of the relationship between the gamification strategy and the entrepreneurial intention of students in deciles 0.10 up to 0.90, using a vector of student characteristics as control.

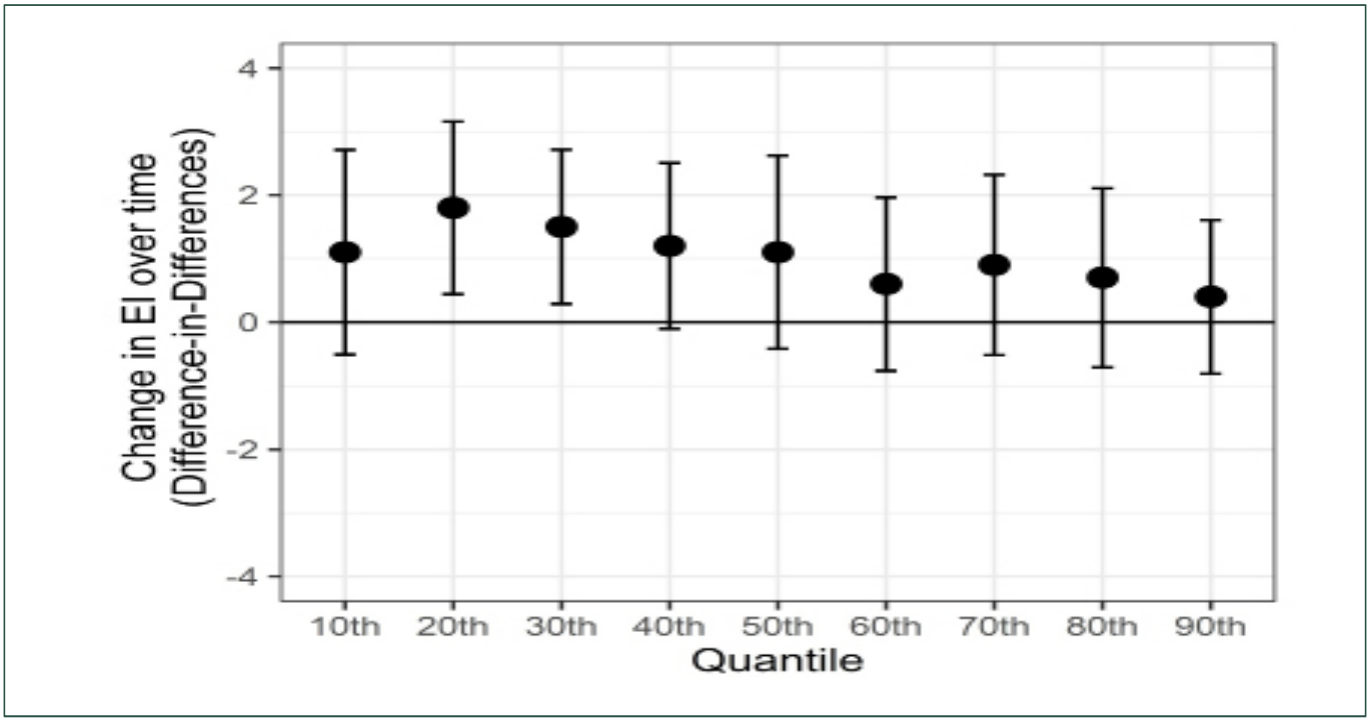

Figure 1. Difference-in-differences with propensity score matching and gamification regression on entrepreneurial intention analyzed by quantile for model 1.

The results were statistically significant at 5%, with a positive parameter in the 0.20 and 0.30 quantiles (deciles). These findings support that gamification resulted in an increase in the intentions of students who, at the beginning of the course, were less prone to entrepreneurship. Thus, business simulation is associated with students with low entrepreneurial intentions, providing greater engagement and interest in entrepreneurial activity. The following section discusses some evidence for possible explanations of such effects.

DISCUSSION OF RESULTS

In this study, the use of the gamification strategy with the FishBanks business simulation shows a positive impact on the entrepreneurial intention of students of an entrepreneurship course. Considering the results presented above, we argue that entrepreneurial intent can be effectively developed through gamification, helping students to determine whether to choose entrepreneurship as a career path. These findings are in line with a strand of the literature that has found

evidence of higher efficacy when entrepreneurship education uses innovative curricula and technological resources rather than exposing students to traditional academic environments (Chen et al., 2021; Isabelle, 2020; Lafortune et al., 2022; Takemoto & Oe, 2021).

The results of our study corroborate what has been found by Ruiz-Alba et al. (2019), Aries et al. (2020), and Buil et al. (2020). For instance, Fox et al. (2018) argue that games add value to the educational process of entrepreneurship by allowing students to learn by doing and testing decisions in immersive and engaging environments. Thus, the simulated environment promotes a playful way to stimulate participants' willingness to start a business venture. Considering the pragmatic character of gamification, we emphasize that this type of strategy promotes intrinsic motivations for different attitudes (Hamari & Koivisto, 2015), which may justify the increase in entrepreneurial intention after participating in a program based on gamified education. Thus, the simulation establishes connections between students and active learning, in order to influence the interest in starting a business venture (Fellnhofer, 2018; Olokundun et al., 2018; Zulfiqar et al., 2019).

Based on these empirical results, we can infer that challenging situations in games can result in knowledge about the practice of starting an enterprise and increase students' entrepreneurial intention. The dynamics of FishBanks, the game used in this study, involves a scenario of scarce resources whereby participants need to conduct risk assessment, anticipate failures, and think about contingency plans — valuable skills for entrepreneurs. Together, the game offers to students multiple opportunities to learn from the experiences, successes, and failures related to entrepreneurial activity, but in the context of a game where players make key decisions. Our results also have theoretical and empirical support from previous assessments such as that of Zulfiqar et al. (2019), in arguing that the development of entrepreneurial skills and abilities in classes requires students to apply diverse business concepts to operate ventures with the support of a gamification platform. These tools help students to connect theory with practical implications and, thus, to know and stimulate interest in the entrepreneurial career.

Additionally, when comparing data collected from the beginning and end of the course, we identified that individuals who have a low level of initial entrepreneurial intention have greater engagement and interest in the entrepreneurial activity at the end of the course. This indicates that business simulation games are potential resources to promote entrepreneurship education, especially among students with low entrepreneurial intentions. This argument corroborates the findings of Kauppinen and Choudhary (2021), Lafortune et al. (2022), and Ruiz-Alba et al. (2019), as these authors emphasize that with a traditional methodology it seems challenging to promote the diffusion of entrepreneurial dynamics for students who do not have previous interests in the activity. Thus, we argue that FishBanks and other games with designs aimed at simulating opening and conducting business represent an important addition to the educator's toolkit, particularly for teaching entrepreneurship courses, a point also stated by Chen et al. (2021) and Grivokostopoulou et al. (2019).

Thus, the discussions highlighted in this research expand previous studies on the positive effect of EE on entrepreneurial intention (Chen et al., 2021; Liguori & Winkler, 2020; Rashid, 2019), emphasizing the importance of gamification for this purpose (Isabelle, 2020; Grivokostopoulou et al., 2019; Kauppinen & Choudhary, 2021; Lafortune et al., 2022; Ruiz-Alba et al., 2019; Takemoto & Oe, 2021). Furthermore, these findings have relevant implications, as the literature points to a positive impact of gamified teaching approaches on students' entrepreneurial intention, but also stresses that this is still an open research field, especially for subjects outside the context of higher education, as stated by Ruiz-Alba et al. (2019), Takemoto and Oe (2021), and Zulfiqar et al. (2019).

Based on the results presented above, as well as recent scholarly contributions by Aries et al. (2020), Isabelle, 2020, and Zulfiqar et al. (2019), we can derive important implications for educators. First, the data for this study was collected from students at the secondary level of education, that is, outside the context of higher education, more frequently featured in the scholarly literature. The findings show that experiential learning with online gamification helped to raise the entrepreneurial intention of teenagers, who are still in vocational high school, in the context of a developing country. Thus, secondary school educators who seek innovative teaching techniques can use game-based learning methods to gain the attention and interest of these young learners. Our findings show that participants at this age group can develop their entrepreneurial intent while gaining more knowledge of the practical challenges of running a business.

Another implication worth highlighting is that there can be pedagogical challenges in the implementation of instructional material based on simulation/gamification, especially for choosing games and preparing instructors. In this study, the entrepreneurship classes in all eight classes involved in the research

(four classes in the control group and four classes in the treatment group) were taught by the same instructor, who was familiar with the tool and was able to engage and support the students. For the success of this pedagogical strategy, it is very likely necessary to train faculty and teaching assistants in new technologies and teaching methods, so that they can improve creativity and learning performance in the context of entrepreneurship education. These arguments are consistent with Fox et al. (2018), who point to the fact that to increase entrepreneurial intention, games that involve student participation, engagement, and deeper critical reflection are critical components. In addition, the involvement and preparation of the instructors are also key ingredients so that they can deal with any methodological difficulties in the classroom and run the game smoothly.

As we showed, the use of games can be an effective tool to accomplish key learning outcomes of entrepreneurship courses. Such pedagogical benefits and challenges for instructors have also been discussed by Fox et al. (2018) and Zulfiqar et al., 2019. Because business simulations are oriented to replicate entrepreneurial activity, the learning environment allows students to take a previous entrepreneurial stance (Buil et al., 2020; Olokundun et al., 2018) to experience the challenges in opening and managing businesses (Neck & Greene, 20111; Rauch & Hulsink, 2015). Therefore, students, especially those with little interest in this field, can appreciate aspects of the entrepreneurial process and awaken the intention to create future businesses with the use of this tool (Fox et al., 2018; Hahn et al., 2017; Ruiz-Alba et al., 2019).

The fact that the results show an effect in the first quartile can be interpreted as a catalyst for the use of business simulation as a practice of teaching entrepreneurship. Thus, gamification can provide greater engagement of students not prone to entrepreneurial activity, narrowing the gap between class members and promoting a more effective entrepreneurial education scenario (Buil et al., 2020; Fellnhofer, 2018; Fox et al., 2018; Ruiz-Alba et al., 2019). Then, the FishBanks simulation can play a key role in keeping students on the lower quantiles more engaged and motivated, promoting a more effective entrepreneurial education environment (Alaref et al., 2020; Lafortune et al., 2022; Ruiz-Alba et al., 2019; Takemoto and Oe (2021)). However, it is important to awaken, especially, EI in students with lower initial entrepreneurial intentions. Hence, the significant results for students in the lower quantiles suggest that adolescents and young people can acquire entrepreneurial skills with a gamified approach in classes.

On the other hand, our results suggest that for students who already start the course with greater entrepreneurial intentions, gamification may not have a significant effect on increasing this variable. This finding is in accordance with Ruiz-Alba et al. (2019), who discuss that business games/simulations are able to influence behavior of students with less developed EI, given that there is a great relationship between the input (student characteristics, intrinsic and extrinsic motivations) and the output (effect of the gamified activity). Thus, intention and behavior can be influenced by different motivations of students (Buil et al., 2020; Fellnhofer, 2018). Moreover, corroborating the discussion presented by Catalán and Salinas (2018)), if students already have aspirations for entrepreneurship, gamification can stimulate other factors other than EI, such as the development of cognitive skills and/or more generic skills (identifying opportunities, working in environments of uncertainty and pressure, taking risks, making decisions, working in teams, among others).

Therefore, using FishBanks has proven to be a gamified approach for students to experience the dynamics of entrepreneurship, going beyond a purely theoretical learning approach. Our results highlight positive impacts of gamification on the development of entrepreneurial intention, resulting from entrepreneurial engagement and self-efficacy, since the challenges and risks faced in the game can awaken the student's conviction that he/she is capable of performing a specific task associated with opening businesses. Altogether, the use of a gamification approach in entrepreneurship courses can be beneficial to students and faculty.

CONCLUDING REMARKS

This study aimed to evaluate the relationship between gamification as a practice of teaching entrepreneurship and the entrepreneurial intention of vocational training students. The results showed positive and statistically significant effects compared to a traditional teaching strategy, rejecting the null hypothesis. We emphasize that the use of FishBanks simulation showed a higher effect on those students with lower entrepreneurial intentions, providing a greater interest in the topic of those less prone to entrepreneurial activity.

Thus, the main contribution of this research is to present an avenue for increasing the average engagement of vocational training entrepreneurship classes and, above all, reducing the gap of the entrepreneurial intention of students, generating information for the promotion of entrepreneurial education. From a ped-

agogical perspective, because of the greater scope of teaching entrepreneurship at the secondary level, given the Common National Curricular Base, this study helps teachers in this field by providing a possibility of an educational resource validated as a teaching practice that fosters perception and interest in the act of entrepreneurship.

Regarding the practical implications of this study, the results are of interest to educators and program managers focused on entrepreneurship education, as well as others involved in academic activities in high school or professional education, as they confirm that the entrepreneurial intention of students can be effectively developed through gamification. Furthermore, the approach used in this work can also be adapted to a variety of courses and desired learning outcomes.

From a methodological point of view, this work contributes to the literature by using a robust identification strategy that allowed us to estimate the treatment group's trajectory if it had not been treated. Furthermore, we were able to control for unobserved effects fixed over time, which would not be possible through cross-section data.

Regarding the limitations, we emphasize that we only used two periods, and it is not possible to assess the duration of the effect of the gamification strategy on the entrepreneurial intention of the students. Furthermore, the entrepreneurial intention construct, despite being widely used in the literature, is a subjective behavioral scale, not necessarily materializing in entrepreneurial activity and entrepreneurial behavior in a future moment. Finally, generalizations must be adopted cautiously since the study covered just one institution.

As avenues for future research, we suggest the construction of longitudinal data to assess the duration of the gamification effect after the end of the simulation. We also recommend the evaluation of other gamification tools and at different levels of education, as well as analyzing other innovative entrepreneurial education strategies, such as active methodologies and Action Learning. In addition, future research may explore the impact of gamification on students that already started a program of entrepreneurial education with high EI, understanding possible spillover effects of gamification in other variables of entrepreneurial behavior, such as self-efficacy and risk-aversion.

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APPENDIX A

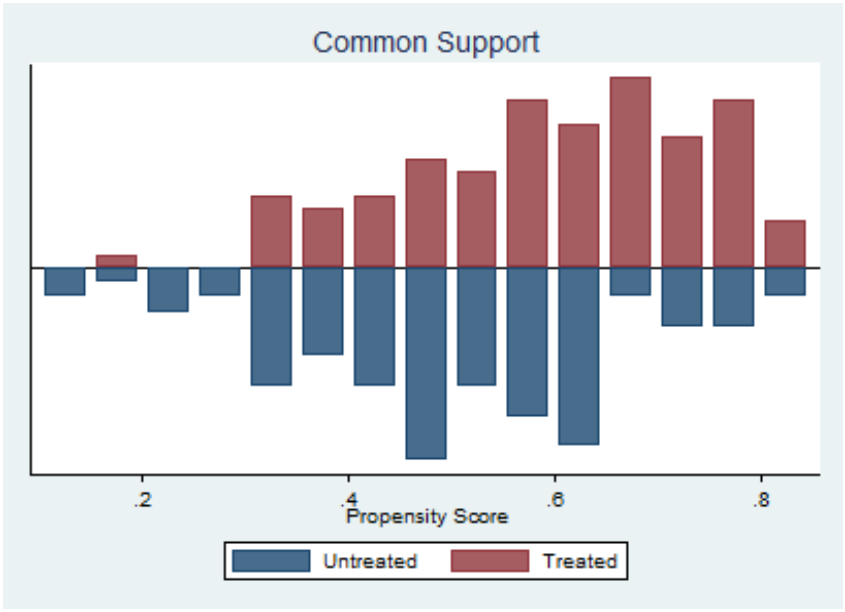

Figure A1. Common support between treatment and control groups.

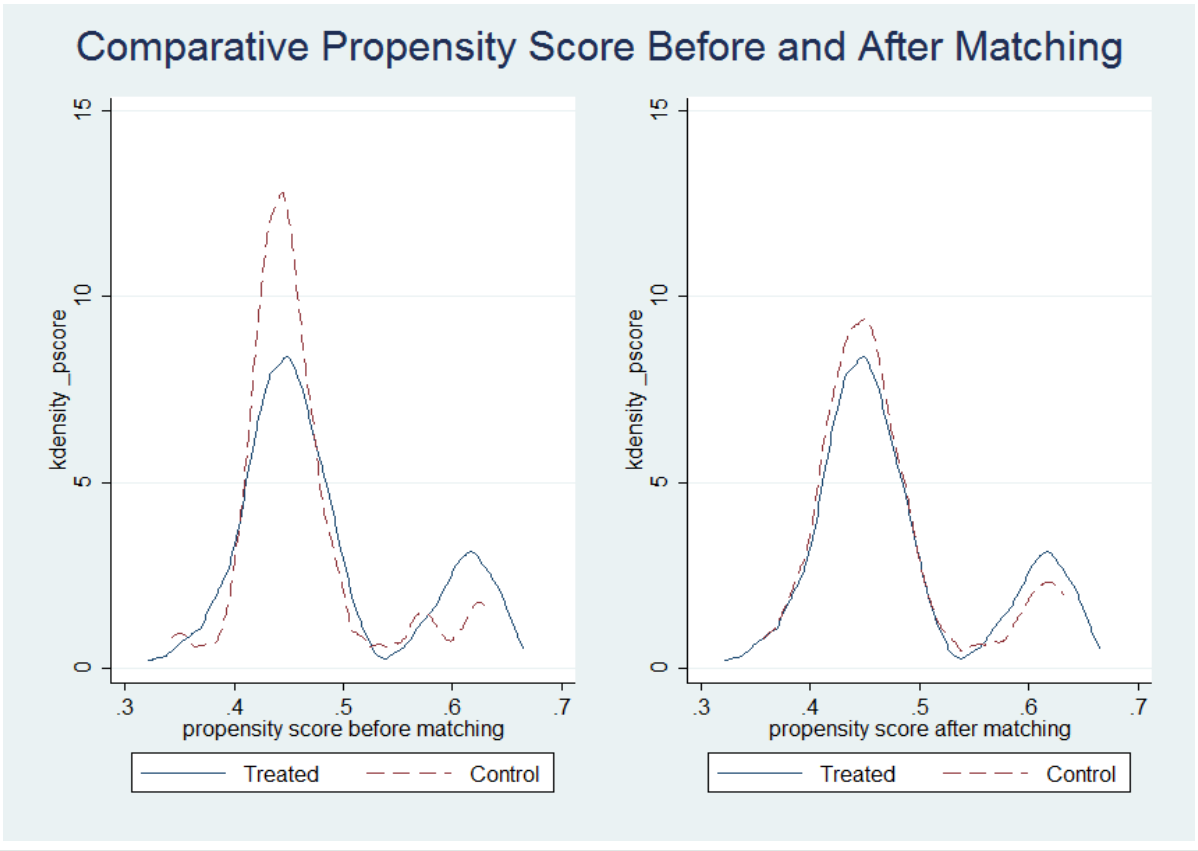

Figure A2. Comparison between treatment and control groups with PSM.