Impact of the University Business Consulting Office on Entrepreneurial Learning: A Bayesian Approach

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Abstract

The University Business Consulting Office has established itself as a support strategy for Colombian micro-entrepreneurs, promoting entrepreneurial learning and the sustainability of their businesses. This study aims to analyze the perception of learning acquired by micro-entrepreneurs who have participated in training activities within the framework of this consulting office. To this end, a quantitative approach with Bayesian methodology was used, employing the binomial test to classify the responses of 327 entrepreneurs from 16 Social Intervention Centers (CIS) in Bogotá. The results show that 53.8% of the participants expressed being completely in agreement with having acquired significant knowledge in their entrepreneurship, while 27.8% indicated being in agreement. The binary classification analysis also reveals high accuracy in detecting positive perceptions about learning, with a sensitivity and specificity of 80.1%. Additionally, a positive predictive value of 31.5% was identified, suggesting that entrepreneurs who report having learned effectively are the majority. These findings highlight the positive impact of the University Business Consulting Office in strengthening entrepreneurial competencies, promoting business development through continuous training. Finally, future research is suggested to include regional comparisons and longitudinal analyses to assess the sustainability of learning over time.

Keywords: University Business Consulting Office, Entrepreneurial Learning, Micro-entrepreneurs, Bayesian Analysis, Binary Classification.

Introduction

Entrepreneurship has established itself as a fundamental pillar for economic and social development in multiple regions of the world, especially in Latin America, where microenterprises represent a high percentage of the business fabric. According to data from the Bogotá Chamber of Commerce (2023), approximately 92% of productive units in the Colombian capital correspond to microenterprises, which generate employment and boost the local economy. In this context, the **University Business Consulting Office** emerges as an academic initiative aimed at providing technical assistance and training to microenterpreneurs in Bogotá. This program seeks to strengthen competencies in administrative management, financial planning, and market strategies through individual advisory sessions and group workshops. Business consulting is considered a professional service aimed at identifying, diagnosing, and solving problems related to various areas of business management (Mihailović & Radosavljević, 2020).

However, the growth and sustainability of these businesses are limited by the lack of training in business management and technical skills, compromising their ability to adapt and remain in the market. Although there are numerous studies on the effectiveness of business training programs, a significant theoretical gap persists regarding their concrete impact on the learning perceived by micro-entrepreneurs, especially when advanced methodologies such as Bayesian statistical analysis are employed (López & Hernández, 2021). Much of the literature focuses on descriptive approaches that, while providing relevant information, fail to clearly establish causal relationships between training and acquired learning (Gómez & Ruiz, 2020).

This methodological limitation highlights the need to incorporate more robust statistical approaches that allow for analyzing the relationship between training and learning from an inferential perspective. In this sense, Bayesian analysis emerges as a promising alternative, as it allows integrating uncertainty into the interpretation of results and updating probabilities based on new empirical evidence (Gelman et al., 2013).

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This is particularly relevant in contexts where the perception of learning can vary significantly depending on individual and contextual factors.

Addressing this gap is crucial to advancing the design of public policies aimed at strengthening the entrepreneurial ecosystem, especially in urban contexts where informality and lack of resources are recurring challenges. Identifying the effective impact of training programs can help optimize institutional resources and design more efficient strategies for local economic development (Pérez Neri et al., 2024). Additionally, analyzing the perception of micro-entrepreneurs regarding their own learning allows identifying areas for improvement in the teaching methodology applied in business consulting.

In this context, business training programs promoted by educational institutions become relevant as they offer practical tools to strengthen entrepreneurial skills. One of the main advantages of such initiatives is their ability to adapt content to the specific needs of entrepreneurs, enabling significant and sustainable learning (Rojas et al., 2018). Moreover, the use of practical pedagogical approaches facilitates the direct application of acquired knowledge in the work environment, thus promoting business sustainability.

Although business consulting is often seen as a key source for enhancing the innovative capacity of micro and small enterprises, some cases show that its implementation does not always achieve the expected results due to the complexity of managing contracts and resources (Love & Roper, 2005; Hoecht & Trott, 2006). This reality highlights the need to explore new methodologies to optimize the effectiveness of these interventions, especially in transition economies such as Poland, where microenterprises face challenges in innovating (Arendt & Grabowski, 2019; Grabowski & Stawasz, 2023). Given the dynamic business environment and the influential trends shaping organizational functioning—which can generate resistance, anxiety, and confusion, thus affecting employee performance and well-being—it is essential to adopt effective leadership approaches to mitigate these effects (Hamza et al., 2024).

Accordingly, the present study aims to: (1) evaluate the learning perception acquired by micro-entrepreneurs who participated in the University Business Consulting Office; (2) analyze the effectiveness of the program using Bayesian statistical methods, specifically the binomial test; (3) identify factors associated with a positive perception of learning; and (4) provide recommendations for the continuous improvement of university training programs aimed at entrepreneurs. Based on these objectives, this study seeks to contribute to the understanding of the impact of university advisory programs on the formation of entrepreneurial skills, promoting effective and sustainable educational practices.

Methodology

Type of Study

This study adopts a **quantitative approach**, characterized as **descriptive and correlational**, aimed at evaluating the **learning perception** among micro-entrepreneurs who participated in the **University Business Consulting Office**. This approach allows identifying significant patterns in the acquisition of entrepreneurial skills derived from the training received, using advanced statistical tools for data analysis.

Sample Design

The study sample was selected based on representativeness criteria, ensuring that participants adequately reflect the characteristics of the target population. The sample size was determined using the statistical formula for finite populations, aiming to optimize resources and minimize bias in result interpretation. The formula used for calculating the sample size is as follows:

$$n = \frac{\frac{z^2 \cdot p \cdot (1-p)}{e^2}}{1 + \frac{z^2 \cdot p \cdot (1-p)}{e^2 \cdot N}}$$

Where:

 \mathbf{N} = Population size

 $\mathbf{e} =$ Margin of error (percentage expressed as a decimal)

z = Critical value corresponding to the desired confidence level (95%), typically taking a value of 1.96 or 1.65

 \mathbf{p} = Expected proportion of the characteristic to be studied (usually assumed to be 0.5 to maximize variance)

 $\mathbf{n} =$ Sample size

Sampling Procedure

For data collection, 327 entrepreneurs were randomly selected from 16 Social Intervention Centers (CIS) located in the country's capital. These centers include technical assistance spaces and entrepreneurial support managed by the University Business Consulting Office. Participants completed the instrument specifically designed to measure the perception of acquired learning, which was applied through an online survey on the consulting office platform.

The sample selection process considered micro-entrepreneurs who participated in training activities in different academic periods, thereby including both new beneficiaries and recurring participants. This strategy ensured an equitable and heterogeneous representation of those attending training sessions.

The calculation resulted in a representative sample size of 314 entrepreneurs. However, to ensure coverage in case of potential response rate drops, the sampling was extended to 327 individuals. This strategy guaranteed adequate statistical representation and minimized the risk of bias due to non-participation.

Data Collection Instrument

The instrument used was a structured questionnaire, designed to collect quantitative information about the perceived learning acquired after participating in the training program. The survey included closed-ended questions in a Likert format, which facilitated subsequent statistical analysis through Bayesian analysis techniques and binary classification tests.

Justification of the Bayesian Approach

Bayesian analysis was chosen for this study because it provides a robust framework for integrating prior knowledge with new empirical data, offering greater accuracy in estimating the impact of training programs. This methodological choice is especially relevant in educational contexts where the perception of learning may vary considerably among participants. Bayesian methods enable the integration of uncertainty in the interpretation of results, contrasting with conventional descriptive methods that often fail to capture such variability.

Results

General Description of the Results

The results of this study are presented following the methodological phases established, starting with the characterization of the sample and continuing with the Bayesian statistical analysis, including both numerical and graphical results. The presentation is structured through descriptive text accompanied by tables and figures to facilitate comprehension and critical analysis of the findings.

Sample Characterization

The study involved 327 entrepreneurs from 16 Social Intervention Centers (CIS) located in the capital of the country. These centers are part of the University Business Consulting Office, providing technical assistance and training to micro-entrepreneurs from various sectors. The distribution of participants by center is detailed in Table 1.

| 1. Social Intervention Center (CIS) | 2. Number of Participants |
|---|---------------------------|
| 3. 12 de Octubre | 4. 20 |
| 5. Anolaima | 6. 18 |
| 7. Barrios Unidos | 8. 12 |
| 9. Bibliored | 10. 10 |
| 11. Bosa Casa de la Participación | 12. 30 |
| 13. Bosa Liceo Nuevos Horizontes | 14. 42 |
| 15. Ciudad Bolívar IED Rodrigo Lara | 16. 44 |
| 17. Cursos de Extensión | 18. 4 |
| 19. Engativá | 20. 20 |
| 21. Garzón-Huila | 22. 31 |
| 23. Jóvenes YMCA | 24. 6 |
| 25. Normandía | 26. 29 |
| 27. Policarpa | 28. 22 |
| 29. Proyectar Futuro | 30. 1 |
| 31. Sopó Alcaldía (Casa de la Juventud) | 32. 7 |
| 33. Suba | 34. 29 |

| Table 1. | Social | Intervention | Centers o | f the | University | Business | Consulting Office |
|----------|--------|--------------|-----------|-------|------------|-----------------|-------------------|
| | | | | | | | 0 |

Source: Own elaboration based on study data.

Statistical Analysis: Binary Classification and Bayesian Analysis

A Bayesian approach was employed for data analysis due to its ability to integrate prior information with recent empirical evidence. This methodology allowed for evaluating the learning perception of micro-entrepreneurs under conditions of uncertainty, providing robust estimates of key parameters.

The Bayesian model yielded the following results regarding classification accuracy and reliability:

Table 2. Binary Classification Results

| 35. | Paramete r | 36. | Estimat e | 37. | Lower Interva 1 | 38. | Upper Interva 1 | 39. | Interpretatio n |
|-----|-----------------|-----|--------------|-----|-----------------------|-----|-----------------------|-----|--|
| 40. | Prevalenc e | 41. | 0.101 | 42. | 0.003 | 43. | 0.337 | 44. | Proportion of the population affected by the condition. |
| 45. | Sensitivit y | 46. | 0.801 | 47. | 0.523 | 48. | 0.972 | 49. | True positive rate: proportion of affected individuals |

| | | | | | correctly |
|-----|---------------------------------|-----------|-----------|-----------|--|
| 50. | Specificit y | 51. 0.801 | 52. 0.517 | 53. 0.972 | 54. True negative rate: proportion of unaffected individuals correctly identified. |
| 55. | Positive Predictive Value | 56. 0.315 | 57. 0.011 | 58. 0.826 | 59. Proportion of positive cases correctly identified. |
| 60. | Negative Predictive Value | 61. 0.971 | 62. 0.862 | 63. 1.000 | 64. Proportion of negative cases correctly identified. |
| 65. | Accuracy | 66. 0.801 | 67. 0.543 | 68. 0.960 | 69. Proportion of correct classifications in the dataset. |

Source: Own elaboration based on study data.

Figure 1. ROC Curve of the Bayesian Model



The ROC Curve (Receiver Operating Characteristic) shown in Figure 1 illustrates the relationship between the true positive rate (sensitivity) and the false positive rate (1 - specificity), providing a measure of the model's discriminative capacity.

The ROC curve exhibits a positive trend, indicating the model's high ability to correctly classify positive cases compared to negative ones. The Area Under the Curve (AUC) is approximately 0.80, suggesting good performance in identifying entrepreneurs who perceived significant skill acquisition after the training process.



Figure 2. Distribution of Positive Probability

Source: Own elaboration based on study data.

Figure 2 shows the Distribution of Positive Probability generated from the Bayesian model applied to the learning perception analysis of trained micro-entrepreneurs. The visualization indicates a strong concentration of positive probabilities in the upper range (close to 1), reflecting the model's high certainty in classifying significant learning perceptions.





Source: Own elaboration based on study data.

Figure 3 presents the distribution of positive probability according to the test result (positive or negative), also differentiating between tested and non-tested cases. This violin plot representation allows the identification of specific patterns in the classification made by the Bayesian model, adding precision to the analysis of learning perception among micro-entrepreneurs.



Figure 4. Aluvial Plot of Classification Results

Source: Own elaboration based on study data.

Figure 4 shows the correspondence between the real condition of micro-entrepreneurs regarding learning perception and the classification made by the Bayesian model. This visualization allows for identifying both correct classifications and errors made by the model, highlighting transitions between positive and negative categories.





Source: Own elaboration based on study data.

Figure 5 presents the distribution of the main Bayesian parameters obtained in the analysis: prevalence, sensitivity, and specificity. These parameters are fundamental for evaluating the model's performance in classifying learning perception among trained micro-entrepreneurs.

In conclusion, the results obtained through the Bayesian approach validate the use of this model to assess learning perception in educational contexts. The high accuracy (80.1%) and elevated negative predictive value (97.1%) indicate the model's strong performance in accurately classifying learning perceptions. However, the lower positive predictive value (31.5%) suggests a need for improvements in identifying those who significantly benefited from the training.

Discussion

The use of Bayesian models in analyzing learning perception among micro-entrepreneurs offers an innovative approach to addressing the inherent uncertainty present in educational studies. Unlike traditional statistical methods, Bayesian analysis incorporates both prior knowledge and observed data, allowing for more robust and nuanced interpretations. This methodological advantage is particularly relevant in the context of entrepreneurial training, where individual perceptions of learning can vary significantly due to diverse backgrounds and prior experiences.

The results obtained demonstrate that the University Business Consulting Office has effectively promoted entrepreneurial competencies among micro-entrepreneurs, as evidenced by the high sensitivity (80.1%) and accuracy (80.1%) achieved in the classification process. These metrics underscore the model's capacity to correctly identify positive learning outcomes, confirming the effectiveness of the training interventions.

However, the presence of intermediate probability cases, as identified in the positive probability distribution graph, reveals a critical insight: not all participants uniformly perceive the impact of the training. This variability may be associated with individual differences in learning styles, previous entrepreneurial experience, or the contextual relevance of the training content. Consequently, these findings highlight the need for more personalized training approaches that can address the heterogeneous nature of the participants. Tailoring training sessions to better accommodate individual learning preferences could enhance the overall impact and foster a more consistent perception of learning outcomes.

Moreover, the relatively low positive predictive value (31.5%) suggests that the model might overestimate the learning acquisition for some participants. This discrepancy highlights the importance of refining the training content and delivery methods to better align with the practical realities faced by microentrepreneurs. Future training programs could benefit from incorporating continuous feedback mechanisms to adapt the curriculum dynamically, thereby increasing relevance and retention.

In conclusion, while the Bayesian model has proven to be a valuable tool for analyzing learning perception in micro-entrepreneurial contexts, the findings also indicate areas for improvement. Future studies should explore integrating qualitative insights to complement quantitative results, providing a more holistic understanding of the factors influencing perceived learning outcomes. Additionally, conducting longitudinal assessments would help evaluate the long-term retention of competencies and the sustained impact of training interventions.

Conclusion

The Bayesian statistical analysis employed in this study provided accurate and reliable insights into the learning perception of trained micro-entrepreneurs. The findings clearly demonstrate the positive impact of the University Business Consulting Office's educational programs, which effectively promote entrepreneurial competencies. However, the results also highlight the importance of customizing training content to maximize individual learning outcomes. The presence of intermediate probability cases suggests variability in how entrepreneurs perceive the training's effectiveness, underscoring the need for more tailored approaches.

Furthermore, the relatively lower positive predictive value indicates that while the model effectively identifies learners who report positive outcomes, it may overestimate the extent of learning in some cases. To address this, future training initiatives should consider incorporating adaptive learning techniques and feedback loops to enhance content relevance and learner engagement. By continuously refining the curriculum and delivery methods, training programs can more accurately address the diverse needs of micro-entrepreneurs, ultimately fostering sustainable learning and improved business practices.

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