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Autonomous Work of University Students in Real Situations Related to Business Management

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Abstract

The research article aims to compile the foundations of previous studies and articles addressing the topic of problem-based learning in both educational and professional contexts, while also considering other research on the application of problem-based learning in different professional fields. Additionally, it analyzes the use of Bayesian statistics in research, methodology, and decision-making processes within the context of business management and other disciplines.

Similarly, it addresses the practical implications of Bayesian statistics as an effective tool for reaching conclusive results in various sub-disciplines of business research. As a result, it provides a comprehensive overview of the use of problem-based learning and Bayesian statistics in various educational and professional domains, highlighting their impact on learning outcomes, research methodologies, and decision-making processes.

Keyword*-Problem-based learning, autonomous work, students, education*

Introduction

In education, it is essential for students to be able to work independently in order to meet the objectives of developing learning skills and competencies to strengthen the educational level of students. In the contemporary educational environment, there is a change in teaching methodologies, which are evolving towards more authentic approaches (Lillo et al., 2023). This is why students' autonomous learning should be encouraged to accelerate the transfer of knowledge and experience (Tirunagari & Ding, 2022). Today, students need to be prepared to enter a workplace that differs considerably from what it was a decade ago. The next professionals must be prepared for the challenges that are being generated in the world of work (Vargas-Vera et al., 2023). It has long been argued that problem-based learning (PBL) is a pedagogical model deeply rooted in the integration of diverse disciplinary approaches (Scholkmann et al., 2023). The PBL model is based on a cognitive learning framework, whereby the teacher supports his or her students through modeling and guidance to practice and acquire problem-solving skills (Wynn, 2022).

A methodology used by teachers is problem-based learning (PBL), which focuses on the use of problems to promote meaningful learning and the development of cognitive and metacognitive skills in students. The student learning process is based on a problem (constructed by the teacher or other students) similar to those problems

that the student will face in real life (Perez et al., 2016). There are many techniques to promote students' autonomous work, among them is Problem Based Learning (PBL) which has a variety of characteristics. It is generally accepted that the main defining characteristic of Problem-Based Learning (PBL) is the incorporation of real contexts or problem situations in the studies presented to students (Bai et al., 2023). This methodology stands out for its focus on practical situations and problems that prepare students for the real world. Students are not given detailed information beforehand, but are presented with a problem or scenario to solve. This problem serves as a starting point for learning. It is based on identifying a problematic situation as a starting point for learning a concept or developing a competency (Gallardo Pérez et al., 2020).

The incorporation of problem-based learning (PBL) in education emerged in response to the need to provide students with the opportunity to apply their academic knowledge in real-world situations (Hertlein et al., 2023). By facing real and complex problems, students can develop practical skills and improve their ability to solve real-world challenges beyond simply memorizing theoretical information. Similarly, interdisciplinary learning can be strengthened through Problem-Based Learning (PBL), because it presents a didactic approach that allows students to participate in interdisciplinary learning (Jarrah et al., 2023). This allows them to work in collaborative groups and to identify a problem, learn and apply their knowledge.

The implementation of effective mechanisms to promote autonomous work among students not only improves their ability to take control of their own learning process, but also generates skills such as critical thinking, self-evaluation and self-regulation. In addition, it generates autonomy in students, encouraging them to become independent learners capable of learning on their own. Project-based learning (PBL) provides students with the opportunity to develop knowledge and skills through engaging projects focused on challenges and problems that may end up being real (Ulutas, 2023). In today's dynamic educational landscape, the search for effective methodologies that foster the integral development of students has become an imperative and it is there where problem-based learning (PBL) emerges as an innovative pedagogical strategy, standing out for its ability to stimulate critical thinking and problem solving. The results suggest advantages, such as flexibility, fostering critical thinking and problem solving skills, teamwork, creativity, and the perception of being an enjoyable learning method (Sattarova et al., 2023).

The research carried out by the research professors of the Universidad Colegio Mayor de Cundinamarca is strengthened by the investigation and analysis of Problem Based Learning as a methodology that not only seeks to transmit knowledge, but also to cultivate essential skills for professionals of the administration programs that enter the working world. The challenges presented by today's society, which have placed learning at the center of political and educational debates, have significant repercussions on the working lives of graduates (Vasconcelos et al., 2023). Focusing the research on the ability to foster students' autonomous work, exploring how this methodology becomes a vehicle for the development of key competencies, such as self-regulation, initiative and the capacity for continuous learning. Activities based on problem solving, simulations, and project development can lead to positive personal experiences and greater personal belief in the ability to perform a specific task. Problem-based learning (PBL) is one of the strategies to engage online learners and develop higher-order thinking skills and better academic achievement (Zhu and Zhang, 2023).

Through the review of current literature, case studies and practical experiences, this research seeks to shed light on the tangible benefits that Problem-Based Learning brings in fostering student autonomy. The effectiveness of any educational intervention can be evaluated by measuring what and how much students learn, and by determining whether a particular intervention within problem-based learning is more effective than other alternatives in facilitating the learning process (Torres et al., 2022). It also explores new challenges and takes into account some considerations that may be associated with the effective implementation of this methodology in education. In a curriculum based on problem-based learning (PBL), an increase in students' perceived confidence is achieved (Wormley, et al., 2022). There is scientific support that favors the use of Problem-Based Learning (PBL) as a strategy that promotes critical thinking (Suárez Cretton & Castro Méndez, 2022).

Finally, the research seeks to contribute to the existing body of knowledge by providing a comprehensive view on the crucial role that Problem-Based Learning can play in promoting students' autonomous work, allowing reflections and possible proposals to enrich educational practice.

METHODOLOGY

A non-experimental study was developed, based on a quantitative approach. The type of research was cross-sectional with an exploratory and descriptive scope. In order to develop an appropriate evaluation methodology, the results were first identified according to the information analyzed.

Bayesian statistics was used, which is a statistical approach that allows researchers to assign an ex ante distribution (called "a priori distribution" or simply "a priori") to an unknown parameter (u) based on prior beliefs (Giovagnoli, 2008). In other words, the researcher does not discard his or her prior beliefs, but includes them in the analysis. The Bayesian approach is compelling in that it provides a unified approach to modeling, incorporation of prior information, and inference (Rossi and Allenby, 2003). The last three decades have seen a dramatic increase in the use of Bayesian methods in various fields (e.g., forecasting, marketing, etc.), but their application to hotel research has been limited.

On the other hand, as expressed by Pek & Van Zandt (2019) the Bayesian perspective takes into account the probability of the null hypothesis, as well as the relative probabilities of different hypotheses based on the observed data. Bayesian modeling, requires a joint distribution for $(y, \tilde{y}, \theta)$, which is conveniently factored (without loss of generality) into an a priori distribution for the parameters, $p(\theta)$, and the likelihood of the complete data, $p(y, \tilde{y}|\theta)$, so that $p(y|\theta) = \int p(y, \tilde{y}|\theta)d$ (Gelman and Shalizi (2013).

RESULTS

In order to test the validity of the results of this research, we have chosen to use Bayesian hypothesis testing, under Bayesian statistics, because it is considered a more accurate and comprehensive tool for statistical inference.

Table 1.

Bayesian Independent Samples T-Test

	BF_{10}	error %
P7	0.267	0.016

Source: Authors' own elaboration

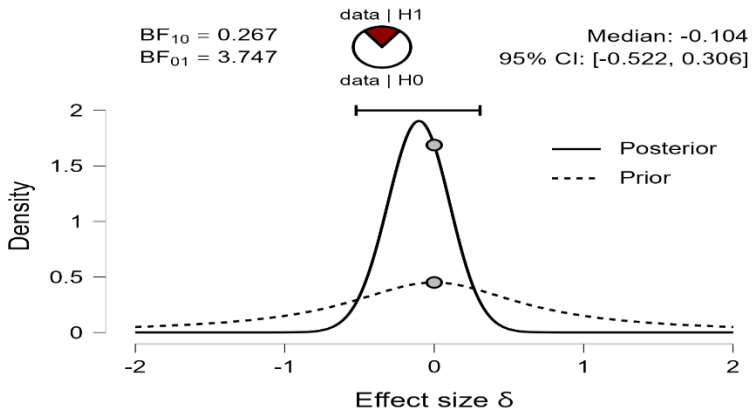
To the question: What mechanisms do you use to promote autonomous work in university students in real situations related to business management? Summary data from the independent sample Bayesian contingency tables are shown with the following results. The independent sample value gave 0.267 with a percentage error of 0.016.

With a BF_{10} of 0.267, the evidence in favor of the null hypothesis regarding the mechanisms employed by students for the development of autonomous work is approximately 3.74 times more likely than the evidence in favor of the alternative hypothesis. This value suggests a certain favorability towards the null hypothesis, being moderately strong. An error of 0.016 can refer to the standard error associated with the estimation of the parameter of interest; this value is generally used to calculate confidence intervals around the point estimate. It is important to note that a standard error of 1.6% (0.016 expressed as a percentage) is quite small, indicating a relatively high precision in the estimation.

Inferential Plots

For the question What mechanisms do you use to promote the autonomous work of university students in real situations related to business management? It reflects that a Bayes factor of 0.1 (1/10) indicates that it is ten times more likely that there are no differences than that there are differences. In this study, BF01 gave 3.747 as three point seventy-four times more data compatibility with H0 compared to H1.

Figure 1.P7 - Prior and Posterior



Source: Authors' own elaboration

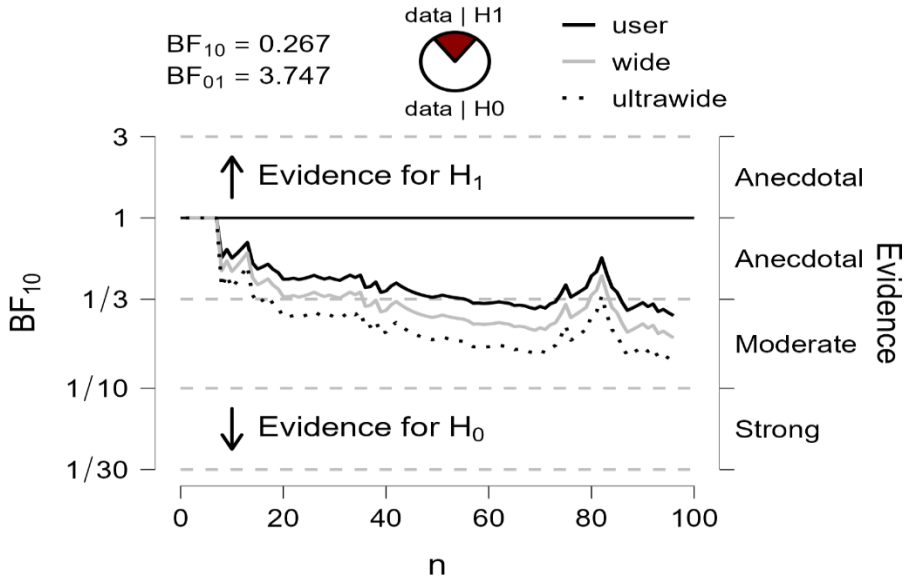
The analysis shows that with the evidence observed in the study and considering neutral a priori beliefs, the updated probability is 95 % in favor of a differential effect between treatments versus 0.5 % in favor of being equal.

Log Odds Ratio graphs allow us to analyze the effect of the relationship between qualitative variables on other dichotomous variables. It is used for retrospective experimental designs, i.e., for those in which it is already known what has happened and which are usually cross-sectional. In this case, the aim was to determine the prevalence of the question: What mechanisms do you use to promote the autonomous work of university students in real situations related to business management?, obtaining the following results.

The Odd ratio gave -0.104 with a 95% confidence interval between -0.522 and 0.306. The BF10 gave 0.267 which means that it is ten times more likely that there is a difference than not. A Bayes factor of less than one (1) is also informative.

This analysis also allows us to determine the least probable estimate of the difference (-0.104 mm less) and its possible variation, i.e. this is the 95% credible interval.

Figure 1.I sequential Analisys



Source: Authors' own elaboration

The sequential Bayes analysis here compares the Bayes factor (BF) to evaluate the evidence in favor of an alternative hypothesis (H_1) compared to a null hypothesis (H_0), according to the values provided:

BF_{10} = 0.267 (evidence in favor of the alternative hypothesis H_1)

BF_{01} = 3.747 (evidence in favor of the null hypothesis H_0)

The following can be inferred:

As is known, BF_{10} provides evidence in favor of the alternative hypothesis H_1, where:

- A value less than 1 suggests evidence in favor of H_0.
- A value greater than 1 suggests evidence in favor of H_1.

For this case, BF_{10} = 0.267, which indicates that the evidence in favor of H_1 is moderate.

On the other hand, BF_{01} is evidence in favor of the null hypothesis H_0, where:

- A value less than 1 suggests evidence in favor of H_1.
- A value greater than 1 suggests evidence in favor of H_0.

For this case, BF_{01} = 3.747, indicating that the evidence in favor of H_0 is also moderate.

According to the above, the BF_{10} and BF_{01} values suggest moderate evidence for both H_0 and relatively moderate evidence for H_1. What this means is that there is no strong preference for any of the hypotheses based on the data and BFs provided. More information or further analysis is required to make a conclusive decision.

According to Masson (2011), once the mutually exclusive and exhaustive hypotheses have been established, their Bayesian a priori probability (credibility level) is determined. This probability can be expressed as a ratio (pre-result odds or a priori odds):

$P(H_1)/P(H_0)$

Where:

$P(H_1)$ = Probability of veracity of the hypothesis of difference or association.

$P(H_0)$ = Probability of no difference or no association.

As the value of $BF_{10} < 1$, and the value of $BF_{01} > 1$, then both values suggest evidence in favor of the null hypothesis (H_0), which means that the probability P1 positing that the design of autonomous activities. (research, case studies, analysis of business situations and projects), does not conclusively answer the question: What mechanisms do you use to promote the autonomous work of university students in real situations related to business management?

Figure 3. Descriptives

							95% Credible Interval	
	Group	N	Mean	SD	SE	Coefficient of variation	Lower	Upper
P7	0	27	0.519	0.509	0.098	0.982	0.317	0.720
	1	69	0.580	0.497	0.060	0.858	0.460	0.699

Source: Authors' own elaboration

CONCLUSIONS

Log Odds Ratio graphs allow us to analyze the effect of the relationship between qualitative variables on other dichotomous variables. It is used for retrospective experimental designs, i.e., for those in which it is already known what has happened and which are usually cross-sectional. In this case, the aim is to know the prevalence of the

question: What mechanisms do you use to promote the autonomous work of university students in real situations related to business management? Odd's ratio with a confidence interval, which concludes that it is ten times more likely that there is a difference than that there is not, and a lower Bayes factor that is also informative.

In conclusion, the Bayes factor is a great methodological contribution that presents a practical implication in making important decisions based on the confirmation of results that are effectively conclusive, whose application is inclusive for the various sub-disciplines of research in the business sciences, specifically business management in this case. In other words, it can be concluded that the autonomous work of university students in real situations influences activities related to business management.

References

[1] Bai, S., Jiang, H., Wang, T., et al. (2023). An acceptability study of the introduction of total online or partial online PBL in a large classroom setting in biochemistry. BMC Medical Education, 23(1), 912. https://doi.org/10.1186/s12909-023-04767-3

[2] Gallardo Pérez, H. J., Vergel Ortega, M., & Rojas Suárez, J. P. (2020). Teaching the wave concept through problem-based learning. Journal of Physics: Conference Series, 1672(1), 012017.

[3] Gelman A, Shalizi CR. Philosophy and the practice of Bayesian statistics. Br J Math Stat Psychol. 2013;66(1):8-38. DOI: 10.1111/j.2044-8317.2011.02037.x

[4] Giuliano Bianchi & Cindy Yoonjoung Heo (2021) A Bayesian statistics approach to hospitality research, Current Issues in Tourism, 24:22, 3141-3150, DOI: 10.1080/13683500.2021.1896486

[5] Hertlein, K., Suresh, V., Brown, T., Davis, E., & Hechter, S. (2023). A Case Example of Integrating Team-Based and Problem-Based Learning in Sex Therapy Courses in the U.S. and Austria. *Journal of Problem Based Learning in Higher Education, 11*(3), 44–60.

[6] Jarrah, M., Girmay, B., & Ezezika, O. (2023). Interdisciplinary Pedagogy through Problem-Based Learning: A Case Study in Global Health Education. *Journal of Problem Based Learning in Higher Education, 11*(3), 105–118.

[7] Lillo, E. G., Azagra, M. J., & Ferrero, C. L. (2023). ¿Cómo se Construye la Problematización en el Aprendizaje Basado en Problemas en Biología? *Revista Signos*, *56*(112), 234–259.

[8] Masson, M. E. (2011). A tutorial on a practical Bayesian alternative to null-hypothesis significance testing. *Behavior research methods*, *43*, 679-690. DOI: 10.3758/s13428-010-0049-5

[9] Pek, J., & Van Zandt, T. (2019). Frequentist and Bayesian approaches to data analysis: Evaluation and estimation. Psychology Learning & Teaching, 19(1), 21-35. https://doi/10.1177/1475725719874542

[10] Pérez, C., Orduña, J. M., & Soriano, F. R. (2016). A nested virtualization tool for information technology practical education. *SpringerPlus*, *5*(1), 443.

[11] Rossi, P. E., & Allenby, G. M. (2003).) Bayesian statistics and marketing.Marketing Science,22(3), 304–328. https://doi.org/10.1287/mksc.22.3.304.17739

[12] Sattarova, U., Arsenijevic, J., & Groot, W. (2023). An Analysis of Problem-Based Learning vs. Traditional Teaching among Students in Azerbaijan. *Educational Sciences*, 13(11), 1167. https://doi.org/10.3390/educsci13121167

[13] Scholkmann, A., Stegeager, N., & Miller, R. K. (2023). Integrating the Integration: The Role of Problem-Based Learning in Bringing Together Social Science and Humanities (SHH) and Science, Technology, Engineering and Mathematics (STEM). *Journal of Problem Based Learning in Higher Education*, *11*(1), 98–123. https://doi.org/10.54337/ojs.jpblhe.v11i1.7371

[14] Suárez Cretton, X., & Castro Méndez, N. (2022). Contribución del aprendizaje basado en problemas en el Pensamiento Crítico. *Revista Interuniversitaria De Formación Del Profesorado. Continuación De La Antigua Revista De Escuelas Normales*, *97*(36.3). https://doi.org/10.47553/rifop.v97i36.3.96182

[15] Tirunagari, S., & Ding, J. (2022). Application of Experiential Education Based on Modern Teaching Concept in College Management. *Mobile Information Systems, 2022*, 8077157. https://doi.org/10.1155/2022/8077157

[16] Torres, A., Hu, J., Sriraman, V., Martínez-Ortiz, A., & Membrillo-Hernández, J. (2022). Assessing the Effectiveness of Problem-Based Learning Across Two Concrete Construction Courses. *International Journal of Instruction*, *15*(4), 473–496.

[17] Ulutas, B. (2023). Using Problem-Based Learning (PBL) in an Undergraduate Ergonomics Course. *Journal of Problem Based Learning in Higher Education*, *11*(3), 90–104. https://doi.org/10.54337/ojs.jpblhe.v11i3.7886

[18] Vargas-Vera, R., Placencia-Ibadango, M., Placencia-Ibadango, S., Vargas-Silva, K., & Alencastro-Placencia, S. (2023). Aprendizaje Basado en Problemas: Una experiencia curricular con estudiantes del internado de Ginecología. *Investigación En Educación Médica*, *12*(47), 91-97. https://doi.org/10.22201/fm.20075057e.2023.47.23517

[19] Vasconcelos, M.J., Caspurro, H. y Costa, N. (2023). Aprendizaje basado en problemas: componer en el aula como reto de aprendizaje musical. *Revista Electrónica de LEEME*, 52, 111-140. doi:10.7203/LEEME.52.26865

[20] Wormley, M. E., Romney, W., Veneri, D., & Oberlander, A. (2022). Doctoral physical therapy students' increased confidence following exploration of active video gaming systems in a problem-based learning curriculum in the United States: A pre- and post-intervention study. *Journal of Educational Evaluation for Health Professions*, *19*(7). https://doi.org/10.3352/jeehp.2022.19.7

[21] Wynn, C. (2022). Facilitating Postformal Thinking Through Problem-Based Learning in the History Survey Course: An Empirically Tested PBL Model. *Journal of Problem Based Learning in Higher Education*, *10*(1). https://doi.org/10.54337/ojs.jpblhe.v10i1.7288

[22] Zhu, M., & Zhang, K. (2023). Promote collaborations in online problem-based learning in a user experience design course: Educational design research. *Educational Information Technology*, 28(1), 7631–7649. https://doi.org/10.1007/s10639-022-11495-6