Performance indicators of piauienses in OBMEP: An application using coefficients and indexes based on population

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ABSTRACT

This study aimed to seek a view of the performance of the state of Piauí in the OBMEP. More specifically, the proposal aimed to identify the municipalities whose performance is being influenced by the population variable and the municipalities where this does not happen, in addition to making comparisons of the performance of the state of Piauí with other Brazilian states, analyzing the population influence in the regional and national rankings, in order to obtain more consistent information to evaluate the temporal performance of Piauí in the OBMEP based on the data. The approach adopted is quantitative-qualitative, explanatory in nature, carried out with descriptive and exploratory objectives and with data collection procedures; Methods: statistical, hypothetical-deductive and comparative. As a result, it was possible to identify classifications for the performance of the State, according to association with population data, where it was classified in second position in the regional ranking of the competition, while in the national ranking its classification became in the tenth position. Finally, it was found that the population is among the variables that are related to performance in the OBMEP, in addition to public policies. Thus, it is concluded that this information highlights the good performance of Piauí in the OBMEP.

Keywords: Piauí, Population, Number of medals, OBMEP.

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INTRODUCTION

The theme chosen for this article was the analysis of data from the Brazilian Public School Mathematics Olympiad (OBMEP), a national level project, focused on the Brazilian public and private schools, carried out by the Institute of Pure and Applied Mathematics

- IMPA, with the support of the Brazilian Mathematical Society – SBM, and promoted with resources from the Ministry of Education and the Ministry of Science, Technology, Innovation and Communications – MCTIC. OBMEP was created in 2005 and aims to stimulate the study of Mathematics and identify talents in the area. It is intended, in general, for students from the 6th year of Elementary School to the last year of High School, from municipal, state and federal public schools, and private schools, as well as to the respective teachers, schools and education departments, all located in the Brazilian territory. Since 2005, OBMEP has been proving to be a great mechanism for social inclusion and dissemination of Mathematics teaching. In 2005, there were more than 10.5 million students enrolled in the first phase of the Olympiad and, in 2019, this number had more than 18 million students participating (IMPA, 2020). [1].

The motivation for choosing this theme was due to the experiences of working with projects such as OMDA (Darcy Araújo's Mathematical Olympiads), whose author worked with Mathematical Olympiads in a full-time school of the state public school system.

From the perspective of investigating the performance achieved by Piauí in the OBMEP in the period from 2005 to 2019, the present study sought to describe the results that can be obtained using the number of medals and the population as explanatory variables, in order to answer some relative questions, but first, it asks: What relevant aspects of Piauí's performance in the OBMEP can be evidenced with the use of indexes and coefficients aided by the population variable? So, the general objective of the research is to seek, with the help of the tools mentioned above, a consistent view of Piauí's performance in OBMEP in the period from 2005 to 2019, whose number of medals, alone, is not able to show.

Based on the hypothesis that the performance may be influenced by some kind of variable, in addition, obviously, to the number of medals, it is assumed that there are numerous variables involved, and that the number of inhabitants is one of them that may be influencing the state's Olympic result in the competition. Thus, a research was carried out with a quantitative-qualitative approach, of an explanatory nature, with descriptive and exploratory objectives, carried out with bibliographic procedures and data collection, under statistical, hypothetical-deductive and comparative methods, which should be validated or not, by hypotheses.

THEORETICAL FRAMEWORK

In order to analyze the performance of the people of Piauí in OBMEP, we will learn a little

about their history of this great Mathematics Olympiad in public schools.

OBMEP. The Brazilian Public School Mathematics Olympiad (OBMEP) is a national project aimed at Brazilian public and private schools. It is an initiative of the Institute of Pure and Applied Mathematics (IMPA), with the support of the Brazilian Mathematical Society (SBM) and promoted with resources from the Ministry of Education (MEC) and the Ministry of Science, Technology, Innovation and Communications – MCTIC (IMPA, 2020) [1]. OBMEP was created in 2005 to stimulate the study of Mathematics and identify talents in the area. In the beginning, it was intended only for public school students, but over time it has undergone some changes, among them, it was extended to private schools in 2017, with classification and awards separately from public schools, and in 2018, it created the OBMEP level A, "an Olympiad aimed at students in the 4th and 5th years of elementary school in public schools, where it had its 1st edition in 2018.

In general, OBMEP is aimed at students from the 6th year of elementary school to the last year of high school, from municipal, state and federal public schools, and private schools, as well as to the respective teachers, schools and education departments, all located in the Brazilian territory. In 2019, more than 18 million students participated in the Olympiad. According to data from OBMEP, over time, the competition has been growing and with it, the level of its competitors.

In the first edition, in 2005, 10,520,831 students were enrolled in the first phase, distributed in 31,031 schools, reaching a total of 93.5% of the Brazilian municipalities. In the sixth edition, in 2010, these totals rose to 19,665,928 students enrolled in the first phase, distributed in 21,44,717 schools, reaching 99.16% of the municipalities, and was the highest increase in the competition ever recorded. From 2011 to 2019, these values had slight oscillations between 17,839,423 and 19,166,372 enrolled in the first phase (IMPA, 2020). [1].

As is well known, in the scientific world, the individual uses various types of mathematical knowledge to measure a certain performance achieved by a participant in a competition. Among these knowledges, we can mention statistics, often related to relative data, such as index and coefficients**.** To corroborate what has been said, we will now discuss some important points in the view of some authors, where they show the relevance of the use of coefficients or indices in the results achieved in their studies.

In Sousa and Paiva Jr. [2], they used as criteria for comparison between the performances of the municipalities of Maranhão, the IDEB, which is the Basic Education Development Index, and the IMPHA, which they called the Medals per Inhabitants Index, which was calculated through the ratio between the number of medals in each municipality and its total inhabitants. The index given by Sousa and Paiva Jr., the IMPHA, is a quantitative data that they used to synthesize the scenario of each municipality regarding its number of medals. In the investigation carried out, they proved that the capital São Luís has the largest number of medals, however, the fact that excludes the capital São

Luís from the analysis made by them, was its IMPHA indicator, since this relates the number of medals with the total inhabitants, they pointed out that the capital had an indicator of only 0.13, well below the penultimate place in the ranking of a list of the six cities in Maranhão that were highlighted in the OBMEP in that survey.

During their closing remarks, they stressed that an essential part of the execution of that study was the creation of the IMPHA indicator, which showed them the locations with the best medal rates per 1000 inhabitants (PESQUISA EM FOCO, 2020, p. 105) [2]. In Vilarinho's dissertation (2015), the performance index was used to rank the municipalities, where it was given by the total points accumulated during the first nine years of OBMEP, divided by the total number of students selected for the second phase of the same. Thus, each ranked city was assigned a score consistent with its performance, where Dores do Turvo-MG and Cocal dos Alves-PI were the municipalities that led the ranking of best municipalities in the first nine years of OBMEP (VILARINHO, 2015, p. 24) [3].

In the article by Mello, Meza and Lacerda (2012), the authors make use of the population variable with the help of the non-parametric methodology known as Data Envelopment Analysis (DEA), and, in addition, there are other scientific studies with an approach using the DEA with the population as one of the input variables. Among these studies, we can highlight that of Churilov and Flitman (2006) who used the DEA to establish a ranking, whose inputs were some socioeconomic variables (population, GDP, SLI index and IECS index) (MELLO et al., 2012, p.21-22) [4].

Note that the works presented above show a performance based on dynamic performances, where indexes with well-defined values are inserted and always accompanied by at least one independent variable (input variable), and the dependent variable (output variable), the number of medals.

In his research, Silva (2018) sought to analyze the performance of the state of Piauí in the OBMEP, having as a parameter the percentage of medals between the years 2005-2016. In this research, something in particular caught our attention, when discussing the relationship between the number of medals and the scope of participation of the municipalities of the state, the percentage of medals involved when compared with the number of municipalities, revealed something that until then was not yet perceived using only the number of medals: "a significant disproportion regarding the effective participation of the municipalities in the competition, which implies an evident centrality of medalists for just over 30% of the municipalities in the state" (SILVA, 2018, p. 51) [5].

This, certainly, was one of the main reasons that motivated us to try to deepen this theme and, not only that, we realized and found during the research that it was still a bit scarce and that there is a lot to be explored.

METHODOLOGICAL TOOLS

The present research was configured in a quantitative-qualitative research, which, according to Prodanov and Freitas (2013, p.69-70) [6], this type of approach considers that everything can be quantifiable, which means translating into numbers, opinions and information to classify and analyze them. For this analysis, we will require the use of resources and statistical techniques (percentage, mean, mode, median, standard deviation, correlation coefficient, regression analysis, etc.).

PROCEDURES

In general, the research was characterized by the collection of data directly at the source, followed by a quantitative analysis to reach a conclusion about the data collected.

For Gil (2002, p.50) [7], this research can be classified in terms of the procedures as a survey, because "basically, information is requested from a significant group of people about a problem studied, and then, through quantitative research, conclusions are obtained corresponding to the data collected". The author also adds that,

> In most surveys, not all members of the population studied are surveyed. Rather, a significant sample of the entire universe is selected by means of statistical procedures, which is taken as the object of investigation. The conclusions obtained based on this sample are projected for the entire universe, taking into account the margin of error, which is obtained through statistical calculations (GIL, 2002, p.51) [7]

In our case, there was no need to work with sampling, because the survey collected information from all members of the universe studied, and was worked with the populations.

DATA COLLECTION AND POPULATIONS

The data collection instrument in this research consisted of statistical surveys, which are listed below with their respective populations to be considered and extracted from the official websites of each institution. The surveys to which we refer correspond to:

a) the number of medals won by Piauí in OBMEP during the period from 2005 to 20019/number of medals awarded in the same period/number of medals won by each unit of the federation, must be extracted from the official website of OBMEP.

b) to the population number of the municipalities of Piauí, as well as to all federative units, all extracted from the IBGE website.

c) the number of enrollments in Basic Education, GDP, HDI and IDEB, should also be extracted from the IBGE website, and should be related to the municipalities of Piauí and the 27 federative units of Brazil.

In the preparation of these Surveys, we sought to investigate the performance (performance) of the municipalities of Piauí and of Piauí itself as a whole in OBMEP in the period from 2005 to

2019, based on the number of medals won, following as the main one, the number of gold medals, followed by silver medals and bronze medals. The objective is to highlight aspects of this performance.

To this end, we used some of the traditional statistical tools, in particular, coefficients and indexes, in addition to the population number of each medalist municipality in Piauí, whose function will be to reveal how the municipalities are performing in the competition. The coefficients associated with performance will be called Relative Performance Coefficients (CDR), given as a function of the number of medals won by the number of medals awarded.

The CDR expresses, in percentage terms, the share of the number of medals awarded by OBMEP that was won by the State. For example, a CDR of 0.03, which means that, out of 100 granted, the state won 3. The indexes associated with performance will be called the **Gold Medals Index per Inhabitants** (IMOH), and will be given by the number of gold medals won divided by the number of population. The IMOH will show the number of gold medals for every thousand inhabitants. For example, if a municipality has an IMOH of 7, it means that its performance has a ratio of 7 gold medals for every 1000 inhabitants. After collecting the data, we transcribed them into a spreadsheet (Calc) of the LibreOffice package. This computer program is versatile, free, and open source. The LibreOffice suite includes several applications, some of which will be very useful to help with descriptive analysis.

DATA ANALYSIS

We performed descriptive analyses of the data, using tables and graphs, descriptive measures, etc. Subsequently, the following performance indicators were applied: (CDR) and (IMOH), with the objective of highlighting and understanding the existing relationships between the variables involved in the performance process of the State of Piauí in the OBMEP. Thus, this research has a nature identified as descriptive and exploratory, and in agreement with Gil (2002, p.42) [7], we have that descriptive research has as its primary objective to describe the characteristics of a given population or phenomena, or even to establish relationships between variables.

For Gil, "there are, however, studies that, although defined as descriptive based on their objectives, end up serving more to provide a new view of the problem, which brings them closer to exploratory research.

Initially, we verified in which type of medals the State of Piauí stood out the most, that is, if there is a prevalence of any of them. To verify this, the use of relative data is very important, especially the use of indices, rates or coefficients.

According to Crespo (2016, p.31), "relative data are the result of comparisons by quotient (ratios) that are established between absolute data and are intended to enhance or facilitate

comparisons between quantities".

Relative data can be translated, in general, by means of percentages, indexes, rates or coefficients (CRESPO, 2016, p.31) [12]. For the author, although the terms index, rate, and coefficient are expressed as percentages, they have different meanings and need to be differentiated. As has been discussed in previous chapters, coefficients, for example, are ratios between numbers of occurrences of the same species in a relation of part to whole.

With this, we will be able to compare the relative frequencies of the medal categories with more coherence, since the values obtained in this way do not depend on their nature and magnitude. So, in this comparison, we will use the performance indicative (CDR) and we will make the comparison between the categories and analyze the results found. If there is a difference between the RDFs, we will apply an adhesion test to their respective absolute frequencies.

After the first analysis, in general, we sought to deepen the research, knowing how the medals are distributed among the municipalities. To this end, we carried out a tabulation of the medalist municipalities and a mapping of the medals throughout the territory of Piauí. We used the Calc spreadsheet to tabulate and prepare a ranking of the municipalities in Piauí that stood out in the OBMEP during the period, more precisely the top 10. After mapping, we used QGIS software, which is open source software available under the terms of the GNU General Public License. QGIS is available for Windows, macOS, Linux, and Android on the Qgis website. The software allows the visualization, editing and analysis of georeferenced data. We will use digital meshes provided by the IBGE website to build a thematic map of the distribution of medals by the State of Piauí and we will analyze the results found.

A comparative study was carried out between the municipalities and their respective medalist populations, with the objective of analyzing the performance based on the population number and trying to better understand the disproportion of medals between the municipalities and regions of the state, in addition to verifying the degree of engagement of the population of Piauí in the competition. We also used the comparative method to analyze the differences that exist in the ranking of the municipalities of Piauí that won medals, considering the ranking of gold medals and the ranking where the performance indicators (IMOH) are considered.

Finally, we made a brief study of which variables are most related to the performance of the states in the OBMEP. To accomplish this, a literature review was carried out on which variables are most used by researchers in performance studies. We used a linear correlation test between the main explanatory variables, and based on the correlation coefficient, we identified these variables and the degree of explanation for each of them. The test was done using the R software, which is a free software for statistical computing and graphics, compiles and runs on a wide variety of UNIX, Windows, and MacOS platforms. To download it, just go to the Cran.R6 website. After the analysis

of the test, we exposed the degree of explanation that each variable presents for the performance of the States in the competition, made our conclusions and final considerations.

RESULTS AND DISCUSSION

In this chapter, we approach it in a systematic way, presenting the results found in tables and graphs with the objective of optimizing the visualization, in addition to the use of descriptive measures extracted from the data worked throughout the research.

In the First Section, we analyze how Piauí's performance in OBMEP has been, taking into account the number of Gold, Silver and Bronze medals since the emergence of this Olympiad, in 2005, until the year 2019.

In the Second Section, we discuss how the distribution of medals in the three categories has been in relation to the 224 municipalities of Piauí.

In the Third Section, we made a comparison between the percentages of medalist and non-medalist municipalities with the populations referring to these municipalities in the three categories: gold, silver and bronze.

In the Fourth Section, we made a classification of the municipalities of Piauí that won medals in the three categories based on their performance before the OBMEP and a comparison of this classification with another classification that took into account the number of gold medals per inhabitant.

In the fifth, we analyzed the performance of the state in two moments: in the first, the performance of Piauí in the OBMEP from the comparisons with the states of the Northeast region, one involving the number of medals won by each state and the performance involving the number of gold medals per inhabitant, making the comparison between these two forms of classifications.

In the second moment, we carried out at the national level, in addition to the comparisons already made regionally, a survey of the possible variables that could be related to the performance of the states in the OBMEP and an analysis of these variables, aiming to understand the degree of explanation of them for the values achieved in the period.

Initially, through an analysis of the number of medals won, we noticed that the state had been showing a growth in its performance over the years, and that although the percentages of medals won in each category were different in relation to the whole conquered, they represented statistically equal frequencies when their reference is the whole granted by OBMEP, showing that there was no prevalence of frequencies among the gold, silver or bronze categories at the level of 5% significance. With this, we infer that the number of medals won in each category was directly proportional to the total number of medals awarded in each category by OBMEP in the period from 2005 to 2019.

Also in relation to the medal categories, it was found that they have a high coefficient of

variability, especially the gold and silver categories. The bronze category was the "least heterogeneous", with a coefficient of variation equal to 66.53%. This led to the conclusion that the number of medals won by Piauí in each edition was very unstable, and this could hinder, in a way, the prediction of its future performance, due to the high coefficients of variability of the medals.

In the analysis of the municipalities, it was observed that the municipalities with the best results are located in the north and central-north mesoregions and those with the worst results in the southeast and southwest, the latter mesoregion still without medals in the gold category. Of the 224 municipalities, only 81 won some type of medals, among them, we can highlight, the ten municipalities in Piauí that won the most medals in OBMEP in the period 2005-2019 were: Beneditinos, Lagoa Alegre, Campo Maior, Piracuruca, Oeiras, Capitão de Campos, Parnaíba, Piripiri, Teresina and Cocal dos Alves.

These last two are the ones that concentrate most of the collection of medals won by the state in the period, alternating the leadership in the silver, gold and bronze categories, respectively. In this analysis, it was also detected that, although most of the municipalities of Piauí have not yet achieved a good performance against the competition, the largest portion of the state's population is statistically engaged. Because, while the medalist municipalities represent 36.16% of the total municipalities in the state, the medalist population represents 69.11% of the entire state, and as we know, it is from the population that the true talents that OBMEP proposes to find or reveal originate. Thus, we infer that the performance that the state has been having with OBMEP is much more significant than that obtained by observing only the number of municipalities included in the competition, which according to the numbers, is very small, but concentrates the It is not possible to show the real performance of the State.

The performance of the municipalities as a function of the number of gold medals per inhabitant (IMOH) revealed some highlights, among them Capitão de Campos and Lagoa Alegre. In this scenario, the municipality of Lagoa Alegre was considered the great Olympic highlight, as it went from the last classification in a list of 9, to 3rd place on the same list, due to the population factor. Capitão de Campos, on the other hand, went from fifth place to second place, also due to the population variable.

Also through the use of the performance index applied to the municipalities with the highest number of medals in the OBMEP, we could see that the municipalities of Teresina, Piripiri, Parnaíba, Oeiras and Campo Maior seemed to be negatively influenced by the population number, as the classification of these municipalities fell in the ranking with the use of the performance indicator-IMOH. On the other hand, the municipalities of Lagoa Alegre, Piracuruca, Capitão de Campos and Cocal dos Alves showed signs of suffering a positive influence, as their rankings rose in the ranking with the use of this indicator.

In comparison with the states of the Northeast region, the state of Piauí ranked 4th. Position in the ranking of OBMEP medalists, and when compared, considering the population number, that is, using the performance index-IMOH, the state appeared in second, behind only the state of Ceará. Here the state's performance was clear, as its performance even surpassed states with a population level much higher than its own. However, it was evident that a good performance is influenced by other variables, in addition to the population number.

In comparison with other Brazilian states, Piauí occupied the 13th position in the medal ranking, again achieving a result above the median. However, we observed that most Brazilian states, including Piauí, have a much lower number of medals than the states of Minas Gerais and São Paulo (leader and vice-leader of the competition). When we reclassified the states using the performance indicator - IMOH, the state of Piauí became the 10th position in the number of gold medals per inhabitant, rising three steps in relation to its previous ranking.

The first and second place positions that previously belonged to Minas Gerais and São Paulo, respectively, now belonged to the Federal District and Minas Gerais, respectively. It was also detected that in some states the population variable did not influence anything, as was the case of Acre and Amapá, which always remained in the last two positions of the ranking.

The correlation test showed that among the variables that most influence the performance of the Brazilian states in the OBMEP were the population, enrollment in elementary school, GDP and HDI. However, the literature[1] shows that there are numerous variables linked to the student's daily life that are directly related to this performance, which we did not propose to work on in our research.

FINAL THOUGHTS

We understand that studies on OBMEP are relevant to the academic environment, as they deal with a program that promotes social inclusion through the dissemination of knowledge, aims to improve the quality of Mathematics Teaching and serves as an instrument to stimulate the search for new techniques and forms of articulation to improve school education. assisting the work of education professionals.

For the author, working with this theme represents more than a new perspective of trying to understand the involvement of the state of Piauí in OBMEP, it is a way of seeing and analyzing the good result of 15 years of efforts and dedication of all the people involved in the execution of the largest mathematics competition in Brazil. aiming to motivate them to continue participating and encouraging thousands of students to continue acquiring new knowledge to be able to improve their lives, the country's education.

As it is a theme related to the promotion of important pedagogical actions for life in society, such as stimulating the formation of citizens capable of acting with intelligence, naturalness when

having to face their day-to-day problems, whether they are of a social, political or economic nature, OBMEP works with problem-situations capable of developing intellectuality, autonomy, the encouragement of individual or team work, always aiming at the improvement of basic education, using for this purpose, a mathematical knowledge of good quality and accessible to all.

Like any work, this one also has some difficulties and limitations. Among the difficulties encountered, we can mention, the scarcity of studies that deal directly with the use of indices and coefficients in competitions, and as limitations we can mention, insufficient data collection, since two indicators were apparently explored, that is, a very limited number of indicators, and the case of the materials available through the websites, which are sometimes not available to speed up the data collection process. because in the case of OBMEP, the number of enrollees in each municipality was not found, nor by federation units. This would certainly make the analysis more accurate and efficient, as the The number of entries in each phase of the competition would be a more precise explanatory variable than the population, as it is the public directly involved in the competition.

However, this research proposed to present a proposal that had as its general objective to seek a consistent view of the performance of Piauí in OBMEP in the period from 2005 to 2019. To do so, simple statistical tools were used, such as coefficients and indexes, aided by the variables number of medals and number of population.

We believe that this research presented only some relative aspects, due to the limitations of the tools used and the set of variables used to explain the phenomenon studied. Among the most important aspects, we can mention: the way in which the performance in the medal categories is evolving, with no prevalence among them; the behavior of the relative performance of Piauí in the OBMEP over the years, showing that the categories maintained a similar behavior for most of the period (2007 to 2015), reducing the difference in performance observed at the beginning of the competition; the representation of the variability of the medal categories using the box plot was compatible with the levels of variability presented by the coefficients of variation, all of which was verified with the application of the CDR coefficient, based on the number of medals.

Through the population of the medalist municipalities, we noticed that the largest portion of the population (69.11%) is also the one that centralizes the medals won by the State, which led us to believe that the population is a good explanatory variable for the large disproportion of medals in some regions. With the application of the indices (IMOH) we were able to identify the municipalities whose population boosts its placement up in the ranking and others, which it boosts down, in addition to those in which it seems not to be influencing apparently, that is, the position in the ranking is always the same, regardless of the population number.

The indices were also used to analyze the influence that the population exerts on the rankings: regional and national. The population variable partially fulfilled its role in this context, as it can

provide, according to the correction test, a 69% explanation for the performance shown. However, some questions arose during the research that remained open, such as:

- Why does the capital Teresina, which has more than 25% of the state's population, underperform some less populous municipalities, such as Cocal do Alves, Capitão de Campos, Lagoa Alegre and Piripiri?

- What makes a municipality that has 0.2% of the state's population surpass the most populous city in the state in number of gold medals?

- Despite the fact that the largest portion of the population is being awarded medals in the OB-MEP, what makes 143 municipalities, that is, a population of 1,011,222 inhabitants, not be able to win a single medal in this competition?

- Is OBMEP in fact managing to reach all basic education students in Piauí?

Unfortunately, we do not have answers to these questions and other questions that may arise, we recognize that we need to delve further into this topic. In view of this, we observed some weaknesses in the research, one of them was that, as in other Olympic competitions, it used the criterion considered the most important, the number of gold medals, the second most important refers to the number of silver medals and the third represents the bronze medals. This, in a way, encourages an excessive valuation of gold medals, which generates distortions in the final ranking of municipalities and states in the competition.

Breaking this form of classification is a criterion that can be used in future studies, however, it may not be enough for us to carry out a more complete analysis, but it makes all the difference, imagine the following situation! A state may be gradually improving its OBMEP performance and not have its ranking keep up with this development. This is because, if a state obtains a single gold medal, it will perform better than another with 10 silver and 20 bronze. Another point is related to the limitation of the regression resources used, because at the end of this study, we analyzed the correlations of some variables with the performance obtained by the States in the OBMEP, and these were analyzed separately, weakening the analysis.

We believe that the use of these variables and others, combined with the study of multivariate techniques, can add to this work, new results related to the performance of the State in this competition. As future studies, we propose a work with the use of Data Envelopment Analysis (DEA) developed by Charne, Cooper and Rhodes (CCR). The method considers, according to authors, performance as a ratio between outputs and inputs, uses a methodology of analysis of optimized efficiency revealed, comparing the optimized efficiency with the efficiency of the other units analyzed.

With this methodology, we can establish an indicator to evaluate the relative efficiency between the input variables and the output variable, and the best part, the DEA technique can be done

by several free programs, including using the R software. number of teachers and investments in education and outputs, the number of medals won in each municipality.

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