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Data Analysis of Educational Indicators in Brazil

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Abstract*—The implementation of teaching and learning assessment to evaluate educational systemscan be consideredindispensable to Governmentsdue to the necessity for planning education public policies. In Brazil, the National Institute of Studies and Educational Research Anísio Teixeira (Instituto Nacional de Estudos e PesquisasEducacionaisAnísio Teixeira – Inep) evaluates annually about 6 million students of 71 thousand units of public and private education, in more than five thousand Brazilian'scities.This article presents a data analysis on the educational indicators of Tocantins State in Brazil. The data were collected on the website of Inep. The students' grades investigated in this work are from the5º year of public and private elementary schools of Tocantins State, in 2015.The research's objective is to analyze the Inep indicators of "teacher effort", "teacher formation adequacy", and "teacher regularity". These indicators were correlated with the students' average grade in the BraziliantestofPortugueselanguage and Mathematics. To achieve the purpose of this study, analytics software tools, statistics methods, and machine learning algorithms,were usedto statistically mine the database.This analysis allowed identifying teachers' indicators with statistical significancerelated to the schools that had better performance in the Inep Test.The results are being used by the Tocantins Brazilian Government to plan education public policies.*

Keywords*— *Educational indicators; Brazilian InepTest; public policies.

I. INTRODUCTION

The contemporary society has the inexorable demand to an efficient education, which makes possible new ways to learn and to construct knowledge.One of the waysto improve education quality in Brazil,by the Education Ministry (MEC),is the implementation of external evaluations.For instance, theSystem of Evaluation of the Elementary School (Sistema de Avaliação da EducaçãoBásica – Saeb), created in 2007 by INEP, has the purposeto measure the quality of the student learning, by means ofan index of elementary school development (Índice de Desenvolvimento da EducaçãoBásica– IDEB).

The second section of this article presents the importance of the educational indicators and external evaluations, as essential to the Brazilian educational system.These evaluations and indices serve to observe and to monitor the results presented for diverse educational indicators.In this study, the indicators of "teacher effort", "teacher formation adequacy" and "teacher regularity" are analyzed. Pontes (2012) strengthens that these results serve to diagnosis the weak and strong points of the learning of the students.

In the third section, the process of Data Mining is depicted, according to Silva and Silva (2014),the data is transformed in a process of integration and preprocessing to be better structuralized, sanitized, selected and standardized.At the end, the results and the final considerations are presentedas an outline of this inquiry.

II. EDUCATIONAL INDICATORS – INEP

To know indepth the Brazilian educational system, MEC/INEP create the Saeb, in 1990. In 1995, the Saeb started to carry out evaluations by sampling each two years.The purpose was diagnosis the situation of the students learning in a varied of education stages, by stipulating reference matricesand scales of proficiency.

Following, the Saeb was constituted into two instruments: the National Evaluation of the Basic Teaching (Avaliação Nacional da EducaçãoBásica–Aneb) and the National Evaluation of the Pertaining to school Income (Avaliação Nacional do Rendimento Escolar–Anresc).TheAneb evaluates students of 5º and 9º years of Basic Teachingand third grade of High School, in disciplines of PortugueseLanguage and Mathematical, by sampling the Education Nets, in each unit of the Federation.In contrast, the Anresc, better known as "Brazil Test", evaluates the students of 5º and 9º years of Basic Teaching of the public net (county, state and federal), in urban and agricultural zones, in a census form.The Anresc evaluates schools with twenty or more students registered by year.

The Brazil Test evaluates the Portuguese language school performance (focus on reading), and Mathematics (emphasizes problem solving).INEP defined a curriculum cut through the construction of Reference Matrices, containing the set of contents and skills to be evaluated in

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each area of knowledge, for students in the 5th and 9th grade of Elementary School.

According to the MEC / INEP (2013, page 7), in the elaboration of the Reference Matrices of Portuguese Language and Mathematics of the Brazil Test:

Inepwas based on the National Curricular Parameters and a national consultation on the curricula proposed by the State Secretariats of Education and by some municipal networks. Network teachers were also consulted and the most used textbooks for the evaluated years were also examined.

In order to achieve student performance results, tests are developed using a numerical value, established by proficiency levels. The information about the conduct of the items (questions) used in the tests are previously constructed, and based on the Model of the Response of the Item (Teoria da Respostaao Item - TRI).

For a better understanding of this procedure, MEC / INEP (2017, p.17) clarifies that:

In the Brazil Test, the proficiency scale is constructed for each of the areas of knowledge evaluated and ranges from 0 to 500 points. It is divided into 25-point intervals, which are called proficiency levels. Each level comprises a set of skills that the students probably dominate it.

The levels of proficiency of Portuguese Language in the 2015 Brazil Test of the 5th year of Elementary Education starts with level 0 (performance lower than 125) and goes to level 9 (performance greater or equal to 325). In Mathematics, the level is also beginning at level 0 (performance less than 125), but goes up to level 10 (performance greater or equal to 325). At each level the skills expected to be developed by the students are described.

From the analysis of student proficiency, the need to measure the student learning aroused. However, measuring learning is a complex task, since education is wide-ranging, involving a range of variables, from population to cultural, social and economic aspects. Thus, requiring an in-depth analysis of an enormous amount of information. In this case, educational indicators are important means in the search for this information.

When referring to the meaning of indicator, Pontes (2012, p. 13) points out that "it is a value calculated according to strict criteria and it represents a specific dimension of interest" (educational, in our case). In this sense, the indicator is a measurable resource, which allows us to analyze the extent to which the planned objectives and goals were achieved.

The next step was the creation of the IDEB in 2007, which is a good indicator to measure the quality of education, since it uses extremely important benchmarks in educational evaluation:

1) The calculation of student performance in external evaluations (Anresc and Aneb) of Portuguese Language and Mathematics;

2) The rate of students' income, identified by the School Census, in which the flow of students is perceived through the successive years spent in elementary school.

The IDEB calculation considers the multiplication of note 1) times note 2).

The Education Development Plan (PDE), defined by the MEC in 2007, establishes that, by 2022, Brazil will reach an Idebof 6.0, which is the same average grade point for countries of the Organization for Economic Cooperation and Development (OECD).

It was therefore essential for the Brazilian educational system to monitor the data presented by IDEB, in order to verify the real needs of the school, in the quest to raise the quality of teaching. Therefore, analyzing the data presented by the students' performance in the Brazil Test is fundamental for the investigation of the students' quality of teaching.

2.1 The Brazil Test in Tocantins

The state education system of Tocantins, as it happened throughout Brazil, began to monitor the students' performance in Brazil Test together with the IDEB results, to carry out the planning of pedagogical actions aimed at improving the quality of teaching. The State Plan of Education of Tocantins - PEE / TO, regulated by Law No. 2,977, of July 8, 2015, defines in Goal 23, "to guarantee the quality of elementary school in all stages, levels and modalities of teaching, with improved school flow and learning "(STATE EDUCATION PLAN, 2015, page 47).

This PEE / TO Goal is of fundamental importance to school management, since it provides data collection of school needs, for the control and monitoring of actions, in order to analyze whether school management consolidates the full, administrative and financial autonomy, and if the pedagogical dimensions are based on solid and effective planning, aimed at improving the quality of teaching.

The performance of the 5th grade students of the Tocantins state education system, in a total of 157 participating schools, had an average of 199.03 proficiency in Portuguese and an average of 209.93 proficiency in Mathematics.

As previously stated, Inep defined in dividing the performance of students in the Brazil Test based on proficiency levels. In the case of the Tocantins State network, schools were between levels 2 to 5. Level 5 (performance greater than or equal to 225 and less than 250), Level 4 (performance greater or equal to 200 and less than 225) , Level 3 (performance greater than or

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equal to 175 and less than 200), and Level 2 (performance greater than or equal to 150 and less than 175).

From this perspective, we can see that the performance of the students in the State school system is far from desirable, since in Portuguese, there are four levels to reach the ideal level, and in Mathematics, there are five levels missing.

Thus, in the accomplishment of this research work, the data analysis on the educational indicators of the Tocantins has the objective to find a relation between the attributes: effort of the teacher, regularity of the teacher, adequacy of the teacher formation, quantity of students in the school (whether urban or rural). These attributes were correlated to the average of proficiency in Portuguese Language and Mathematics of the Brazil Test, by school, of the 5th year of Elementary School, of the state teaching network of Tocantins, in 2015. The purpose is to provide knowledge about the performance of the students in the external evaluations, together with Seduc / TO and other educational bodies, in order to base the planning of educational public policies.

Thus, in the accomplishment of this research, the work for the analysis of data was directed on the educational pointers of the Tocantins with the objective to find a relation between the attributes:effort of the teacher, regularity of the teacher, adequacy of the formation of the teacher, amount of students registered for pertaining to school, in relation to the average of proficiency in Language Portuguese and Mathematical of the Brazil Test, for school, of 5º year of Basic Teaching, the state net of education of the Tocantins, in the year of 2015. The purpose is to give knowledge to the educational Tocantins systemand other agencies on the performance of the students in the external evaluations, with intention to substantiate the planning of educational public politics.

2.1.1 Indicator of Teaching Effort

The Teaching Effort consists of the effort made by teachers of Brazilian elementary school in the exercise of their profession. By means of this indicator, INEP (2014) classifies the teacher of each school in levels, which ranges from 1 to 6.The higher the level, the greater the effort undertaken by the teacher. The items in the sequence below present the levels of the teacher effort indicator, according to the features of each teacher:

Level 1 - Teacher who, in general, has up to 25 students and acts in a single working shift, school and stage.

Level 2 - Teacher who usually has between 25 and 150 students and acts in a single working shift, school and stage.

Level 3 - Teacher who usually has between 25 and 300 students and acts in one or two working shifts in a single school and stage.

Level 4 - Teacher who usually has between 50 and 400 students and works in two working shifts, in one or two schools and in two stages.

Level 5 - Teacher who, in general, has more than 300 students and works in three working shifts, in two or three schools and in two stages or three stages.

Level 5 - Teacher who, in general, has more than 300 students and works in three working shifts, in two or three schools and in two stages or three stages.

Level 6 - Teacher who, in general, has more than 400 students and works in three working shifts, in two or three schools and in two stages or three stages. (INEP, 2014, p.6).

Thus, from the data available on the INEP website in relation to the Elementary School teacher, the teaching effort is also related to the following characteristics: number of teaching schools, number of work shifts, number of students attended and number of stages in which you teach.

2.1.2 Indicator of regularity of the teacher

According to INEP (2015), this indicator aims to evaluate the regularity of the teaching staff in elementary schools, based on the observation of the permanence of teachers in schools in the last five years. For the teacher of each school, a score was assigned in order to be valued: the total number of years in which the teacher worked in the school in the last 5 years, the teacher's actuation in the school in more recent years and the actuation in consecutive years.

The Teacher Regularity Indicator varies from 0 (zero) to 5 (five). Thus, the closer the index is to zero, the more irregular is the teacher's job linkage to the school and the closer to five, the more regular is the teacher's job linkage to the school. The indicator of regularity of each school is obtained from the average of the indicator of regularity of its teachers. (INEP, 2015).

2.1.3 Indicator of adaptation of the formation of the teacher

This indicator, according to INEP (2014), refers to the categories of adequacy of teacher formation in relation to the subject taught, according to the groups defined below:

Group 1 - Teachers with higher education degree in the same area of the course they teach, or a bachelor's degree in the same course with a pedagogical supplementing course completed.

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Group 2 - Teachers with a bachelor's degree in the corresponding course, but without a degree or pedagogical supplementing.
Group 3 - Teachers with a degree in a different area than the one that teaches, or with a bachelorsin the subjects of the common curricular base and pedagogical supplementingconcluded in an area different from the one that teaches.
Group 4 - Teachers with other higher education not considered in the previous categories.
Group 5 - Teachers who do not have a university degree. INEP (2014, p.5).

Thus, for each of the courses analyzed, INEP (2014) identified the teacher formation responsible for its development in the class, based on the data collected in the School Census.

III. RESULTS

The results of this research sought to analyze the hypotheses of relations between the attributes of educational indicators of teacher effort, teacher regularity, teacher formation adequacy, and the number of students enrolled, with proficiency levels in Portuguese Language and Mathematics in the Brazil Test, of the 5th year of Elementary School, of the State education network of Tocantins, in 2015.

In Figure 1, it is possible to observe a statistical significance, p <.05, analysis of variance test (ANOVA), between the number of students enrolled per school and the level of proficiency in the Brazil Test. In this manner, how much bigger it is the number of registered students, greater is the level of proficiency in the test. That is, of the 157 searched schools, 17 had note 5, with an average of 77 students; 64 schools - note 4, average of 55 students; 73 schools - note 3, average of 43 students and 3 schools - note 2, average of 22 students.The higher the number of students enrolled the higher the level and proficiency in the test, Figure 2.

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Nvl_PROVA_BR	3	19546.46327	6515.48776	7.02	0.0002

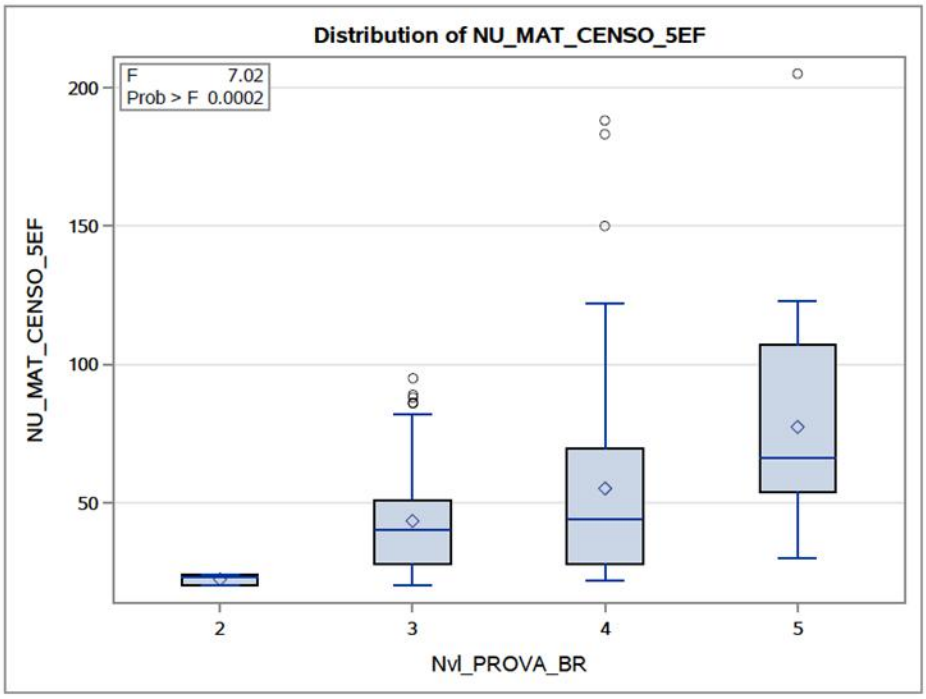

Fig.1. Anova test for the relation between the numbers of students enrolled per school and the proficiency levels of the Brazil Test.

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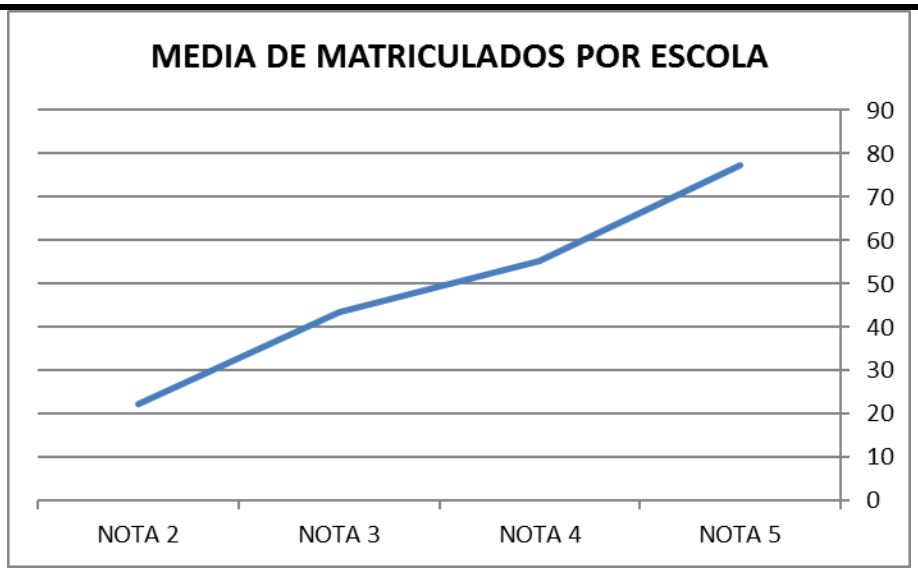

Fig.2. Relationship between the average numbers of students enrolled per school and the proficiency levels of the Brazil test.

The Anova test for the teacher regularity indicator, which evaluates the permanence of the teachers in their schools during the last five years, there was no evidence of a correlation with the levels of proficiency in the Brazil Test, Figure 2, Table 1. The results show that this index of teacher regularity does not influence the student's grade in the tests of Portuguese and mathematics.

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Nvl_PROVA_BR	3	0.79111218	0.26370406	1.11	0.3468

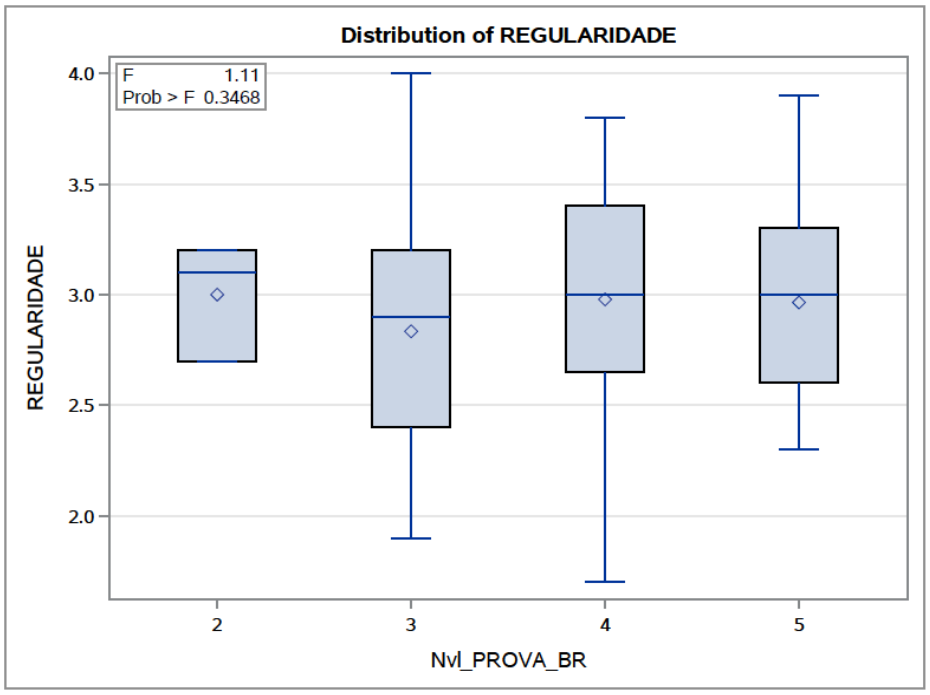

Fig.3. Anova test for the relation between the teacher regularity index and the proficiency levels of the Brazil Test.

Table 1. Average of teacher regularity and proficiency levels of the Brazil Test.

Nvl_PROVA_BR	AVERAGE OF REGULARITY	TOTAL SCHOOLS
NOTE 5	2,96	**17**
NOTE 4	2,98	**64**
NOTE 3	2,84	**73**
NOTE 2	2,99	**3**

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There is also no correlation between the proficiency levels of the Brazil Test and the teacher formation adequacy indicator in relation to the school course (Table 2), both at the highest levels of adequacy, 4 and 5 (Figure 4), and at the lower levels. Recalling that the data analyzed refers to students up to the fifth year of elementary school. The behavior of this indicator suggest the need to evaluate students of higher grades, in future work. The more advanced the course is in the school grades, the greater the need for more specific and deep knowledge of the subjects to be approached in the course by the teacher.

Table 2. Levels of adequacy of teacher formation to the proficiency levels of the Brazil Test.

	IN PERCENTAGE					
Nvl_PROVA_BR	**ADEQUACAO_1**	**ADEQUACAO_2**	**ADEQUACAO_3**	**ADEQUACAO_4**	**ADEQUACAO_5**	**TOTAL SCHOOLS**
NOTE 5	87,48	0,45	5,81	2,82	3,45	**17**
NOTE 4	85,89	0,00	3,50	5,31	5,31	**64**
NOTE 3	88,57	0,00	2,43	5,75	3,26	**73**
NOTE 2	86,67	0,00	0,00	0,00	13,33	**3**

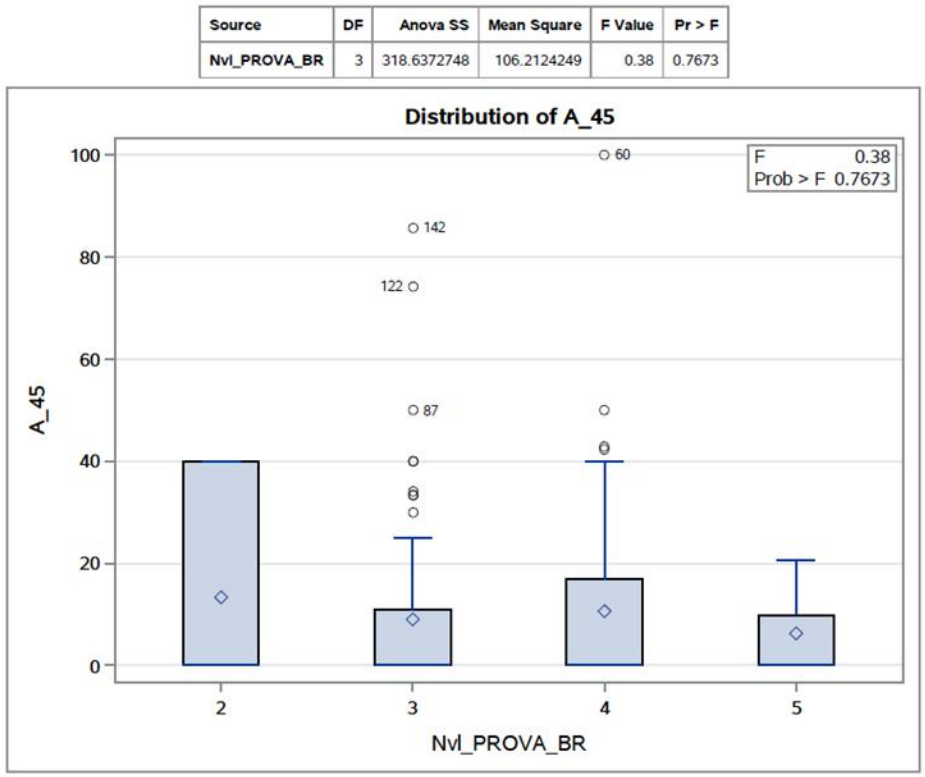

Fig.4. Anova test for levels 4 and 5 of teacher formation adequacy in relation to proficiency levels of Brazil Test.

For the teacher effort indicator, which affects the number of students attended by the teacher in a single working shift at school, statistically significant evidences were obtained for the proficiency levels of students in the Brazil Test. Both at the lower levels of effort, 1 and 2, and at higher levels, 3, 4, 5 and 6, $p < .05(.009)$, Figures 5 and 6. The results show that the lower the teacher effort the higher the average of Portuguese and Mathematics scores in the Brazil Test. And, the higher the teaching effort, the lower the average of Portuguese and Math scores. The level of proficiency 2 (two) of the Brazil Test was withdrawn from this evaluation, because the sample had only three schools in this category.

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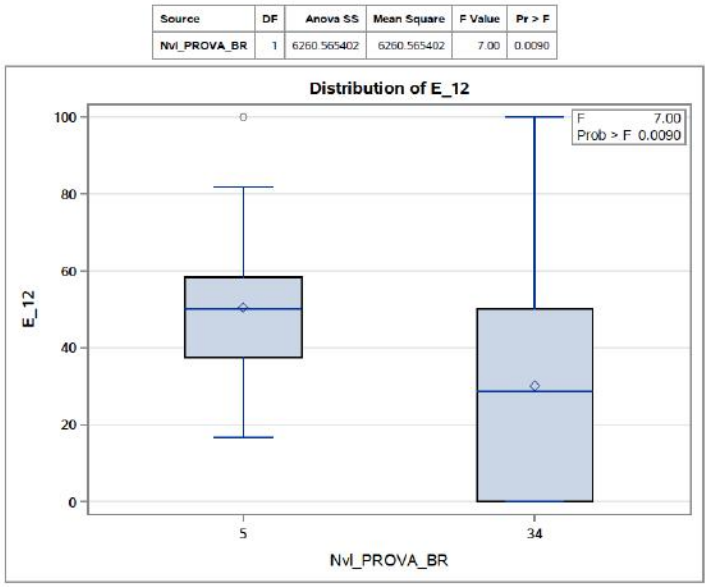

Fig.5. Anova test for levels 1 and 2 of the indicator of teaching effort in relation to the level 5 and levels 3 and 4 of proficiency of the Brazil Test.

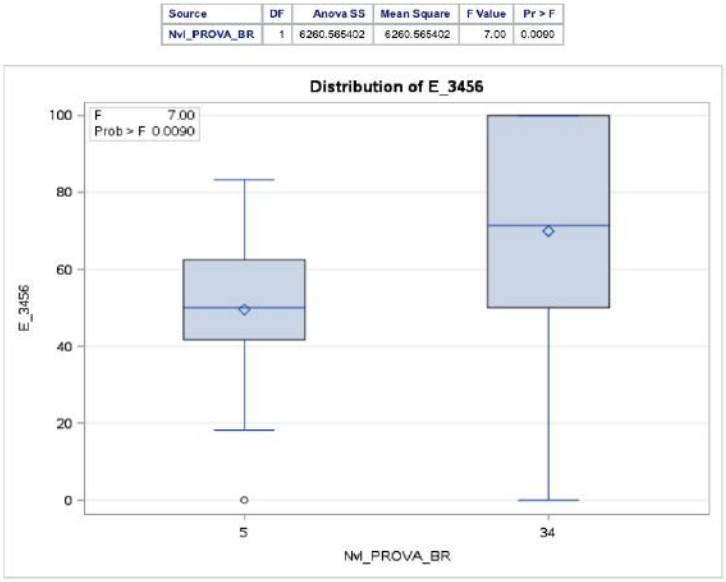

Fig.6. Anova test for levels 3, 4, 5 and 6 of the indicator of teaching effort in relation to the level 5 and levels 3 and 4 of proficiency of the Brazil Test.

IV. FINAL CONSIDERATIONS

This article analyzed data extracted from the Basic Education Development Index (IDEB) of the schools of the Education Network of the State of Tocantins, in the 5th year of Elementary School, in 2015. In this analysis, the indicator of teacher effort, the indicator of teaching regularity, and the indicator of teacher formation adequacy were correlated with IDEB grade.The work was an attempt to find out what are the factors that are present in schools that allows a higher grade.

By means of the use of tools of statistics with categorization of numerical data, projection of tables, as well as the use of algorithms that use several existing techniques in the computational environment, it was possible to arrive at some conclusions on the raised data:

- The higher the number of students enrolled the higher the level and proficiency in the test;
- The Anova test for the teacher regularity indicator, which evaluates the permanence of the teachers in their schools during the last five years, there was no evidence of a correlation with the levels of proficiency in the Brazil Test;

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- There is also no correlation between the proficiency levels of the Brazil Test and the teacher formation adequacy indicator, both at the highest levels of adequacy, 4 and 5, and at the lower levels;
- For the teacher effort indicator, which affects the number of students attended by the teacher in a single working shift at school, statistically significant evidences were obtained for the proficiency levels of students in the Brazil Test. Both at the lower levels of effort, 1 and 2, and at higher levels, 3, 4, 5 and 6, p <.05(.009),

Finally, it is important to note that the analysis consisted only of 2015 year.The classes analyzed were of the fifth year of the public network of Tocantins State. Maybe, the results here can be different in other States and years, due to political, socioeconomic and cultural changes, among other aspects. For a greater reasoning, itis being developed by the authors of this article a broader analysis, involving other results of the IDEB and other levels of education.

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