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Keywords: *Electrical Engineering Course; Academic Achievement; Western Amazon Education.*

1. Introduction

The States of Rondônia along with the States of Acre, Amazonas, Amapá, Pará, Roraima, and the Tocantins, represents 45% of the Brazilian territory and constitutes the greatest part of the Brazilian Amazon. The territorial extension and natural characteristics favored its recognition by the Military Government, with the intention of incorporating the region into the processes of country development, but not the people. Public policies portrayed the region as a part of Brazil whose demand for societal education was a secondary issue [1]. It was necessary to guarantee the basic schooling of local elites, while enabling access to higher education with other resources and in other States. It was this notion of "take up not to deliver" that brought the population closer to the offer of higher education through the Rondon Project, which was carried out through advanced units without local identification, as it represented an advantage for the institution that participated in the proposal [2]. In this case, the Federal University of Rio Grande does Sul as a space to be occupied, contributing to the start of higher education activities in the region. Thus, the

South of Brazil took a closer approach to development policies, which fulfilled the presence and offer of higher education, settling on May 2, 1971, with its priority areas defined by the military government of the time.

Thus, the development of public higher education in Rondônia occurred in the mid-1970s, but the proposal, as an activity of the State of Rondônia, took place in the 1980s [3]. The expansion process became fast and more expressive in 2005, especially as a participant in economic development, considering the growth data of private institutions with the expansion of the offer, students, and courses [4]. Also, in Rondônia, the expansion process is especially significant, since all the data accessed from Higher Education always overlap the national average.

The consequence is that UNIR, created through Federal Law 7011/1982 with the impulse of the creation of the State itself, incorporated courses in progress from the extensions of the other Universities. There are three remaining Bachelor's courses (Administration, Accounting Sciences, and Economic Sciences). The expansion was especially motivated from the Constitutional determination that established ten years for the Federal Higher Education Institutions (IFES) to internalize, a fact that materialized during the quadrennium 1986-1989, creating the campus of Vilhena and Ji-Paraná (1988), with the courses of Sciences. In 1989, the campuses of Guajará-Mirim, Cacoal, and Rolim de Moura were created, offering courses in Literature, Pedagogy and Accounting Sciences. Today, the UNIR headquarters is located in Porto Velho and has offices in the municipalities of Ariquemes, Cacoal, Guajará-Mirim, Ji-Paraná, Porto Velho, Presidente Médici, Rolim de Moura, and Vilhena. From this internalization, UNIR increased from 707 (seven hundred and seven) students in 1983, distributed in 9 (nine) undergraduate courses, to 8485 (eight thousand four hundred and eighty-five) enrolled in the undergraduate program in 66 (sixty-six) undergraduate courses and 768 professors in 2015, also began to expand with the offer of distance learning courses. According to [5], since 1992, it has been observed that, in a bit more than a decade, there a 318% approximate increase in the number of professors employed and an increase of approximately 347% in students enrolled, as can be seen, Figure 1.

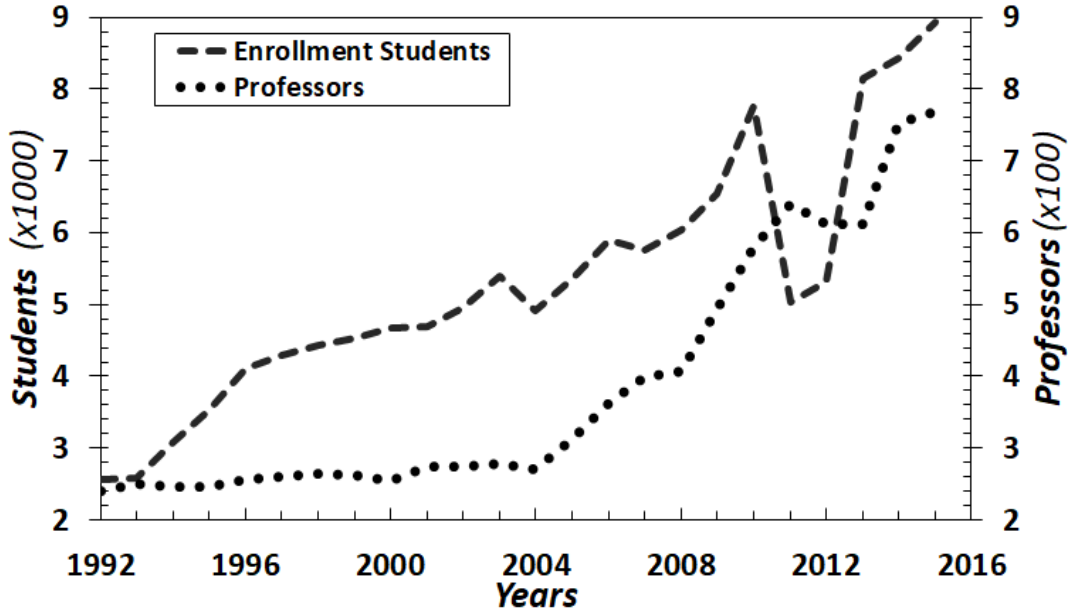

Figure 1. Enrollment Evolution and Hiring Professors [5].

1.1 Progress and Consolidation of UNIR

Despite starting with the training of bachelors to attend to the state bureaucracy, following the tradition of the professions in Brazil, the training of teachers for middle and high school became the most important point of the offer [6]. In the 1980s, undergraduate courses in Letters, Geography, History, Physical Education, Mathematics) and Pedagogy (Teaching and Technician Qualification in School Supervision).

In the mid-1990s, courses began in the area of Health, in the notice of the precariousness of the State in this area, the courses of Nursing (1988) and Psychology (1992) emerged. The implementation of the courses of Biological Sciences, Physics (Ji-Paraná), Spanish Language and Linguistics (1996), and Informatics (1997) occurred to meet the political-economic and geographical reality of this University and to the local and regional communities. Next, in 2002, the courses of Medicine, Chemistry, Communication (Vilhena), and Agronomic Engineering (Rolim de Moura). In 2006, the creation of the courses of Electrical Engineering and a full degree in Physics in Porto Velho, and Environmental Engineering in Ji-Paraná. In 2010, the course of Civil Engineering in Porto Velho was implemented, among other courses of the Restructuring and Expansion of Universities (REUNI) project, instituted by Decree No. 6096/2007.

The area of Engineering emerged as demand in the IFES in the 1980s when there was a proposal of the offer's regionalization, considering the sectors of production and economy. However, this project was not welcomed by the community [7]. During the Ecological Socioeconomic Zoning developed in Rondônia, the possibility of localized investments was also observed; this perception of the relation between the projects and the contribution of Higher Education was not considered either. This type of procedure delays the insertion of engineering in any community, and in this case, it did not allow the immediate progress of this area in the 1990s. In this way, the conditions of differentiation and diversification of the system arose from relations with pressures external and internal conditions [4].

UNIR has made strong investments in the qualification of its faculty, always seeking partnerships with high-level research development and scientific production institutions, such as USP, UNESP, UNICAMP, UFRJ, UFPA, and UFMS. With such partnerships, in addition to the hiring and release of professors for qualification, in less than a decade, it was possible to leap from less than ten doctors to 134 in 2006, in addition to having surpassed the number of 200 masters in the most diverse areas. Currently, the university has 300 doctors, 333 masters, 86 specialists and 15 graduates, which shows that the university prioritized the qualification of its faculty in recent years [5].

All these achievements accompany mobilizations focused on the creation of regional alternatives for the expansion and diversification of the offer. In this context, it includes the area of Engineering.

1.2 A Brief History of the Implementation of the Electrical Engineering Course

An implementation of the Electrical Engineering major at UNIR began in open discussions in 2002 by the Science Center, and Technology (NCT) at the Technical Committee event of Energy carried out in Manaus with the company Eletronorte, dealing with the possibility of implementing the undergraduate course in Electrical Engineering.

In 2003, a technical team established to carry out the Project for the Implementation of the Electrical Engineering Course. In the year of 2004, Eletronorte signaled the possibility of financing the course when

it officialized the decision to support five (05) courses in Electrical Engineering in the Amazon; considering that it was in the company's interest to invest in the qualification of labor, due to the need to renew the workforce by approximately 80% in the next ten years, in addition to the possibility of working together with the researchers of the area established in these new courses.

In 2006, the Superior Council of UNIR approved the implantation project and the pedagogical policy project of the course. The first entrance examination for the Electrical Engineering Course took place at the end of the same year.

In 2007, the transversal action entitled "Information Center for Engineering Technology for Legal Amazonia – CITEAL" was elaborated, where Eletronorte made available today US$1.543 million for the implementation of Electrical Engineering courses in the North Region in the form of ordering at the Fin, an economist for Studies and Projects (FINEP). The project was launched and sent to the FINEP (Infrastructure Cross Order, Protocol No. 60, 07/18/2008) by UNIR which financial resources of US$1.543 million would be distributed among the IFES, but due to various problems and bureaucratic obstacles, it did not obtain success.

In mid-2012 began the teaching qualification of the Academic Department of Electrical Engineering (DAEE) using an Interinstitutional Doctorate (DINNER) promoted by the Graduate Program in Electrical Engineering (PPGEE) of the Federal University of Santa Maria (UFSM). It had a simple objective, but not least, to train and qualify the teaching staff as well as the partners in the scenario until 2016. In 2017, 7 PhDs in Electrical Engineering graduated from DINNER.

It is important to note that a doctoral program contributes considerably to the training of researchers, enabling the creation and installation of skilled work, to meet the regional peculiarities. Also, the implementation of DINNER, among other objectives, further strengthens the academic ties established among higher education institutions, opening new spaces for permanent actions.

Currently, the Electrical Engineering course is in full operation with five classes in progress and a new group scheduled for entry in the second semester of 2017.

1.3 Bachelor of Electrical Engineering at UNIR

The Northern Region was an isolated electrical system, and this was a characteristic in which the State of Rondônia was inserted, since it has a total 69 projects in operation, generating 8343.15 kW of power, 91.19% of this power being generated by Hydroelectric Power Plants (HPP). Among the main works are the Jirau Hydroelectric Power Plant with a generating capacity of 3750 MW, and the Santo Antonio Hydroelectric Power Plant with 3568 MW, located in the Madeira River, in Porto Velho, Rondônia [8].

According to the characteristics and specificities of the training in Electrical Engineering, which are foreseen in the National Curricular Guidelines (DCNs), the course demands a qualification of the professors, being the masters and doctorate levels in the following areas: 36% Basic Core (NB); 47% Vocational Core (NP) and Specific (NE); 10% Practical Activities; 3% Work Completion Course and 4% Supervised Internship.

1.4 Academic Electrical Engineering Department

The DAEE currently has 14 (fourteen) faculty professors members, with 5 (five) with doctorate degrees and 3 (three) with specialization, 6 (six) with a master's degree.

1.4.1 Technical Support Staff

The DAEE currently has 5 (five) technicians to support the didactic, research and extension activities, mainly in the area of electronics and electrotechnology.

1.4.2 Infrastructure

The DAEE has the support of the provisional infrastructure located at the Campus of Porto Velho, Building 1H, with four air-conditioned rooms to hold the following laboratories: Electrical Circuit Didactic Laboratory, Laboratory of Digital and Microprocessed Systems and Laboratory of Electrical Machines I and II. The laboratories are available to attend other courses, such as Computer Science and Civil Engineering, among others. The activities carried out in the laboratories are teaching, monitoring, development, and testing of projects, as well as any working meetings.

Currently, the specific building for the DAEE is in the completion stage and consists of three floors distributed in five classrooms, restrooms, academic center room, warehouses, canopy, auditorium, office, department core, fourteen offices for professors, three technical laboratories, eleven teaching laboratories, and one research laboratory.

2. Analysis of Academic Performance

According to the Pedagogical Course Project (PPC), the teaching process is in-person. This supports the purpose of attending to a solid technical and scientific training of the professional, where the student may absorb and develop new technologies, stimulate their critical and creative role in identifying and solving problems, consider their political, economic, social, environmental, and cultural aspects, with an ethical and humanistic vision in response to the demands of society.

During first periods of the course, the students experienced the subjects of basic contents, with some disciplines of specific contents and vocational content. In the second half of the course, it includes some disciplines of vocational content and basic content, and the specific contents of the Electrical Engineering course have an emphasis on Electrotechnology, although it is a generalist.

During the development of the Academic Performance Analysis (ADA), as the main objective, it sought the statistical outline of the academic profile of the Bachelor's Degree in Electrical Engineering, to subsidize administrative and pedagogical strategies to improve academic performance.

The data presented were obtained from the Integrated University Management System (SINGU) through the Technology and Information Board (DTI), and treated to avoid inconsistencies and distortions. The data refers to the grades obtained by the students in all the disciplines studied and offered by the DAEE in the period from 2007/1 to 2016/2. The sample set of Basic Core (NB) scores is 37873 elements, with a mean of 63.18 and the standard deviation of 22.904. For Professional Core (NP), the sample set is 51400, with a mean of 68.91 and the standard deviation of 20.607.

2.1 Evolution of Academic Performance

In the course of the analysis, the databases emerged by taking note (nil), and other inconsistency problems, such as students who only enroll and do not attend the course, among others. The disciplines diverged into two segments, Basic Core (NB) and Professional Core (NP).

Along the analysis, two graphs demonstrated the evaluation, the first being, in descriptive statistics, a box or boxplot chart, a method for graphing the sets of notes through their quartiles. The box diagrams may have lines extending vertically from the whiskers, which indicate variability outside the upper and lower quartiles, and Outliers displayed as individual points. The box charts are not parametric, as they present varying student scores without making any assumptions about the underlying statistical distribution. The spacing between the different parts of the box indicate the degree of dispersion as well as the affinity in the data and show sporadic values.

In the analysis of the data, ranges for the degree of difficulty of the disciplines were taken into consideration, using the empirical domain and widely accepted in designing the scale from 0 to 100 within these parameters:

- The first track considers as a grade with “Difficult” degree, that is, when the first quartile is below the average of approval (60 points), that is, the desired threshold as a reasonable indicator of student achievement;
- The second track considers as a discipline with a Medium or Intermediate degree, i.e., when the value of the third quartile is between the average of approval (60 points) and less than 80 points;
- The third range is considered as an Easy discipline, i.e., when the value of the third quartile is greater than or equal to 80 points.

The second type of graph presented, the histogram deals with the precise representation of the distribution of student grades. It is an estimate of the probability distribution of a continuous variable (quantitative variable). In this evaluation, it explores the behavior of the grades by the frequency that they are assigned in order to quantify the knowledge acquired in the subjects, as well as it can subsidize the reflection on the models/methods of content evaluation in the subjects offered in the scope of the Bachelor's Degree in Electrical Engineering UNIR.

Analyzing the performance data of the academics regarding the degree of difficulty established from the curricular offer, it is possible to infer some answers to the following questions:

- Which subjects are easy, medium or difficult in NB? What about NP?
- What influences the difficulty level of the classes about NB and NP?
- It is possible to identify which contents are deficient?
- Is it possible to identify characteristics of the evaluative methodologies?

The following is the result of the data related to the evaluative period 2007/1 to 2016/2. Figure 2 presents the boxplot of this analysis, generally identifying the disciplines with their degrees of difficulty during NB, and Figure 3 presents the frequency of the grades obtained in that period.

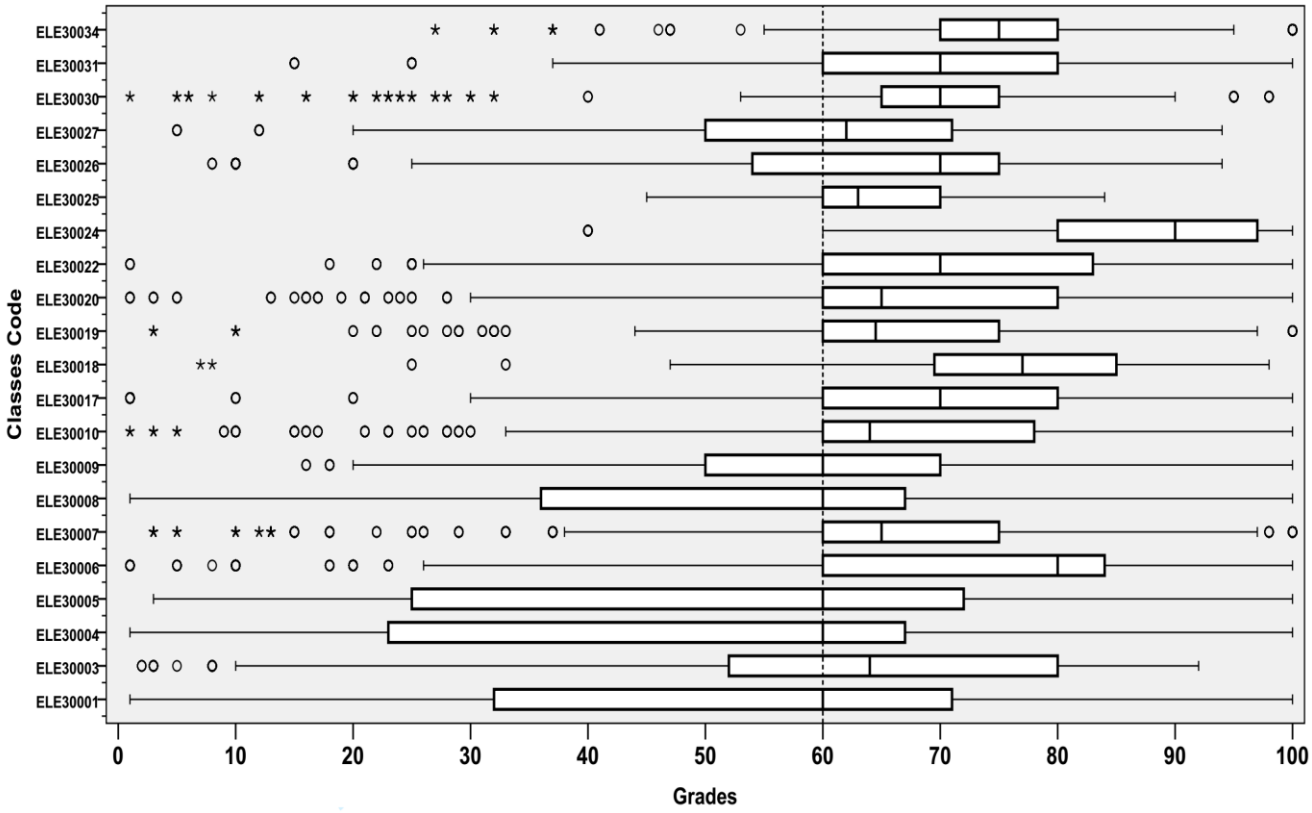

Figure 2. Performance analysis by the degree of difficulty of the NB of the Bachelor's Degree in Electrical Engineering from 2007/1 to 2016/2.

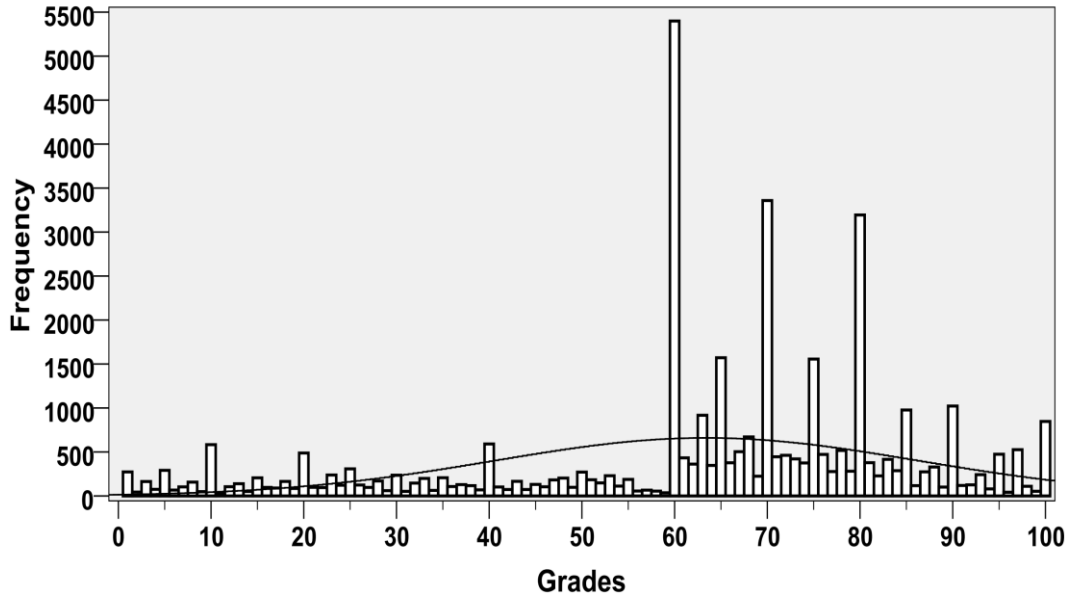

Figure 3. Performance analysis by a note of the NB of the bachelor's degree course in Electrical Engineering in the period from 2007/1 to 2016/2.

Figure 4 presents the analysis boxplot identifying in general form the disciplines with their degrees of difficulty during NP, as well as Figure 5, shows the frequency of the grades obtained in that period.

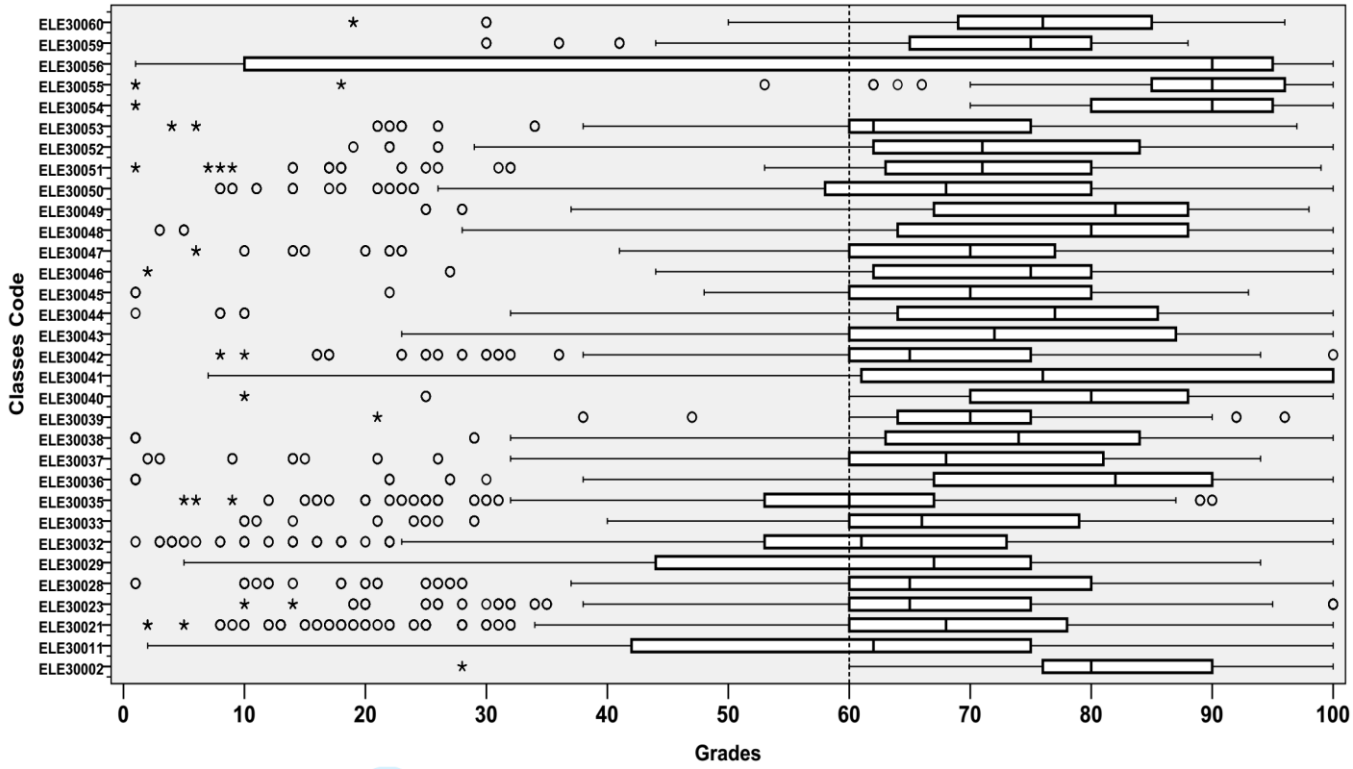

Figure 4. Performance analysis by the degree of difficulty of the NP of the baccalaureate course in Electrical Engineering in the period from 2007/1 to 2016/2.

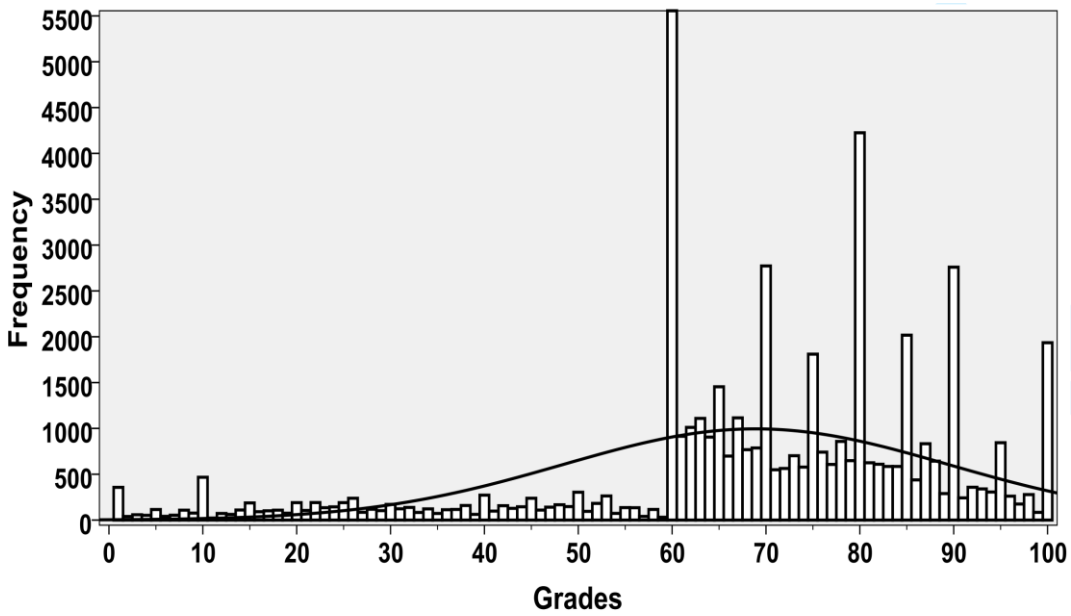

Figure 5. Performance analysis by a note of the NP of the bachelor's degree course in Electrical Engineering from 2007/1 to 2016/2.

3. Results and Discussions

In the analysis, it is possible to note some considerations about the performance of the students of the Bachelor's Degree in Electrical Engineering. One can identify the easy, medium/intermediate, and difficult

disciplines.

Tables 1 and 2 emphasize, according to the graphs, the results on this topic and represent the NB disciplines evaluated between 2007 and 2016.

In this distribution, it states that the entrance disciplines in the area of mathematics and physics are considered more difficult, suggesting that there is a deficit of knowledge regarding elementary mathematics. This deficit directly influences the other basic subjects, since they use basic knowledge to subsidize the concepts presented in the higher-level subjects.

Table 1. The Basic Core Difficult Disciplines

Code	Discipline
ELE30001	Differential and Integral Calculus I
ELE30003	General and Experimental Chemistry
ELE30004	General and Experimental Physics I
ELE30005	Analytical and Vectorial Geometry
ELE30008	Linear Algebra
ELE30009	Statistics and Probability
ELE30026	Mechanics of Solids
ELE30027	Differecial Equations and Modeling
ELE30030	Transport Phenomenon

Table 2. The Basic Core Medium Disciplines

Code	Discipline
ELE30006	Environmental Sciences
ELE30007	Differential and Integral Calculus II
ELE30010	General and Experimental Physics II
ELE30017	Portuguese I
ELE30019	Differential and Integral Calculus III
ELE30020	General and Experimental Physics III
ELE30022	Scientific Methodology
ELE30025	General and Experimental Chemistry
ELE30031	Notions of Economy
ELE30034	Technical Drawing

After the NB (First Period), when disciplines are completed and approved, it perceives that the students maintained an intermediate performance in the disciplines offered in the following periods. The discipline of NB, Notions of Law - ELE30024, was the only one considered easy.

Regarding NP, initial contact with specific contents of the electrical engineering course provides some degree of difficulty. Again, we infer that in the first period, low knowledge of mathematical tools as well as theoretical concepts undermines student academic performance.

After the completion and approval of NP disciplines (First to the Third Period), students are observed to have maintained an intermediate performance in the subjects offered in the following periods, as shown in Table 3.

Subjects ELE30054 and ELE30055, Supervised Internship I and II, respectively, are considered NP, since evaluations are performed by supervisors in the labor market, and the students do not depend exclusively on the technical or theoretical component for understanding and solving a situation, besides being in an environment of professional practice.

Table 3. The Professional Core Medium Disciplines

Code	Discipline
ELE30002	Introduction to Engineering
ELE30021	Electric Circuits I
ELE30023	Complex Variables
ELE30028	Electronics I (Theory and Lab)
ELE30029	Numerical Calculation
ELE30033	Electronics II (Theory and Lab)
ELE30036	Industrial Organization
ELE30037	Mathematical Methods Applied to Engineering
ELE30038	Polyphasic Circuits
ELE30039	Electrical and Magnetic Materials
ELE30040	Control I
ELE30041	Energy Conversion
ELE30042	Electromagnetism
ELE30043	Digital Systems I
ELE30044	Communication Theory
ELE30045	Applied Electromagnetism
ELE30046	Control II
ELE30047	Electric Machines
ELE30048	Data Transmission System
ELE30049	Energy Conversion Lab
ELE30051	Generation, Transmission, and Distribution of Electricity
ELE30052	Power System Analysis
ELE30053	Embedded Systems
ELE30059	Analysis of Electricity Distribution Systems
ELE30060	Protection of Electrical Power Systems

Table 4. The Professional Core Difficult Disciplines

Code	Discipline
ELE30011	Basic Electricity (Theory and Lab)
ELE30032	Electric Circuits II (Theory and Lab)
ELE30035	Electromagnetism I
ELE30050	Electrical Installations
ELE30056	Final Work of Course

Evidently, about the frequency of the assigned grades, there is a high concentration of grade 60, the average for approval. This information may suggest that the evaluation methodology used by the professors does not adequately stratify the expected knowledge of the student during the course offer, and it is still possible to suggest that the professors round up the grades for approval.

4. Conclusions

The creation and implementation of the Bachelor's Degree in Electrical Engineering brought opportunities for the establishment of skilled work of the local community, public and private companies operating in the energy sector. The institutional support provided the qualification of the faculty, which can consolidate research group and raise funds to improve infrastructure, as well as support the implementation of a graduate program.

The evolutionary analyzes of students' academic performance from 2007/1 to 2016/2 showed that there is a lack of solid knowledge in the basic tools in the areas of mathematics and physics.

To observe deficient contents, it is important to note the international responses to the area standard and its prerequisites. In this case, the database of the Program for International Student Assessment (PISA) was used. Thus, it was possible to verify a correspondence with the results of PISA in this international exam, Brazilian students have indicators in science (401 points, compared to the average of 493 points) [9], in reading (407 points, compared to the average of 493 points) [10] and mathematics (377 points, compared to the average of 490 points) [11], below the average of the countries of the Organization for Economic Co-operation and Development (OECD). Since 2006, the Brazilian average in science has remained stable, with an approximate increase of 10 points in the grades (390 points in 2006 to 401 points in 2015), which does not represent a statistically significant change. The results obtained by PISA are similar to the historical evolution observed among the OECD countries, as there was a slight decline from 498 points in 2006 to 493 points in 2015. In reading, Brazilians increased the score from 396 points in 2000 to 407 points by 2015 but also does not represent a statistically significant change. In the area of mathematics, there was a significant increase of 21 points in the average of students between 2003 and 2015. At the same time, there was a decrease of 11 points if we compare the average of 2012 with the average of 2015 [9-12].

The data does not allow the identification of deficient contents, but with greater inference, the gaps and areas that hamper student performance. The characteristics of the methodologies differ greatly about the nature of the curricular component, its objective in the project of vocational training and the conditions of

the offer. In fact, a safe description is given of where and what aspects of the engineer's training need to be articulated between the previous contents and the requirements of the professional training. It is important to realize that these articulations of mathematics and physics content are paramount to the intellectual maturity of the student for better understanding and the applications in the specific disciplines of the bachelor's degree in electrical engineering.

Finally, based on this information, it is also necessary to reassess basic and secondary education by observing and improving the teaching of science, reading, and exact subjects to guarantee better use at the beginning of the activities at the higher level and improving the student's performance. Also, a leveling program should establish with the higher-level students to reduce the effect of such retention and avoidance. As a suggestion, intensive pre-calculus and pre-physical courses should emerge, a practice that some universities already use, and these can take place about two weeks before the beginning of the semester for those incoming students who feel somewhat insecure in these areas.

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