Social Network Analysis (SNA) and the Training Process of the Employees of the Federal Institute of Santa Catarina

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Abstract— *In Brazil, law 8112/90 regulates the training of government officials; therefore, these employees are constantly subjected to processes aimed at improving their training and thus at improving the quality of public service. Social network analysis (SNA) has been widely employed in studies in various fields such as social science, psychology, health, business organization, electronic communications, and epidemiology. The objective of this work is the characterization of the capability indicators of the Federal Institute of Santa Catarina (IFSC) through SNA. In this study, teacher and technician employee data were used in qualification processes such as workplace and postgraduate programs. This information was provided as input to SNA with Degree and PageRank algorithms applied. In terms of quantity, the Florianópolis campus led with the largest number of qualifying employees; linguistics was found to be the most outstanding graduate program. In the administrative technical group, Florianópolis was the largest unit in terms of qualification; education was the most sought-after course. Finally, in the teacher's group, the Florianópolis campus had the largest number of qualifying teachers, and the most prominent courses were linguistics and computer science. Thus, the use of SNA can help managers offer postgraduate courses with higher demand indices.*

Keywords— *social network analysis, professional training, teachers.*

I. INTRODUCTION

The starting point of public policy concerning the establishment of professional education at the federal level is Decree No. 7566 of September 23, 1909. Artisan Apprentice Schools were established, with 19 units spread throughout the states of Alagoas, Bahia, Rio de Janeiro, Ceará, Espirito Santo, Goiás, Maranhão, Mato Grosso, Paraiba, Paraná, Piaui, Pernambuco, Rio Grande do Norte, Sao Paulo and Sergipe; courses in woodworking, mechanics, and arts were offered (SOARES, 1981).

The first restructuring took place between 1937 and 1942, with the creation of 21 Industrial Schools in the municipalities of Aracaju, Belém, Campos, Belo Horizonte, Cuiabá, Curitiba, Florianópolis, Fortaleza, Goiânia, João Pessoa, Maceió, Manaus, Natal, Niterói, Pelotas, Salvador, São Luiz, São Paulo, Recife, Teresina and Vitória. The curriculum already had an industrial profile, with courses lasting four years, offered in mechanics, electricity, crafts, and construction. During this same period, the S system of professional qualification was founded as a result of the public-private partnership (SOARES, 1981).

The Federal Network for Professional Education, Science and Technology was sanctioned by Bill No. 11892 of December 29, 2008; the Network is composed of the Federal Institutes of Education, Science and Technology - Federal Institutes (38); Federal Technological University of Paraná - UTFPR; Celso Suckow da Fonseca Federal Technological Education Centers - CEFET-RJ and CEFET-MG (2); Technical Schools Linked to Federal Universities (26); and Pedro II College (1) (Figure 1) (BRAZIL, 2008).

The Federal Institute of Education, Science and Technology of Santa Catarina (IFSC) is part of the Federal Network of Professional, Scientific, and Technological Education. The IFSC is composed of twenty-two campuses (Figure 2) (BRAZIL, 2008).

Fig. 1: Map of the Federal Network of Professional, Scientific, and Technological Education

Fig. 2: Campus distribution in the state of Santa Catarina.

1.1. Training of Federal Public Servants

Law 8112/1990 establishes the Legal Regime of Civil Employees of the Union of municipalities, including those in a special regime, and of federal public foundations. Articles 81 and 87 in particular ensures that employees are removed from their day-to-day activities to perform their training duties according to their level of qualification:

> "*Art. 87. After each five-year term, the employee may, in the interests of Administration, withdraw from the effective position, with the respective remuneration, for up to three months, to participate in a professional training course*" and / or

> "*Art. 96a. The employee may, in the interest of the Administration, and provided that the participation cannot occur simultaneously with the exercise of the position or by means of time compensation, may withdraw from the exercise of the effective position, with the respective remuneration, to participate in a postgraduate*

program stricto sensu in a higher education institution in the country."

Institutions of basic and technical education are constantly producing qualitative and quantitative educational data. However, such information is published by each institution and is publicly available; in very few instances has this information been subjected to statistical and social networks analysis techniques for purposes of obtaining a wider view of the data used for decision-making.

1.2. Theoretical Reference
1.2.1. The Training

There is an understanding within institutions of basic and higher education that teacher training has contributed to improved learning. Duarte (2004) explains that teacher qualifications have not only impacted student learning but have also improved the quality metrics of public and private educational institutions.

1.2.2. Graph Network

According to Freitas (2018), a graph (figure 3) is defined as "a set of vertices and a set of edges that connect pairs of vertices". Each vertex is represented by a circle and the edges by lines.
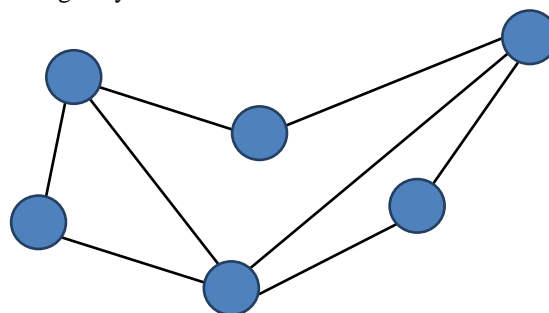

Fig. 3: Example of simplified graph network.

1.2.3. Social Network Analysis

For Serrat (2017), social network analysis (SNA) is a method with increasing application in the social sciences and has been applied in areas as diverse as psychology, health, business organization, and electronic communications. Aragão *et al*. (2018) have used the method of SNA through graphs to represent the movement of animals present in the state of Pará. (Arora, 2019, Alamsyah, 2019, Jacomy et. al., 2014; Hongyi et. al., 2019; Saheb, 2019; Zhao, 2019).

1.2.4. Objective

The objective of this work is the characterization of the training indicators of the IFSC through SNA.

II. MATERIALS AND METHODS

For the development of this work, quantitative data from the Administrative Technicians (28) and Teachers (140) were used in the *stricto sensu* qualification process,

distributed in groups by location and registered postgraduate program.

This data was then entered in a spreadsheet. The field "ORIGIN" describes the student capacity of the institution, the field "DESTINATION" indicates the postgraduate course taken by the employee, and finally the field "SIZE" describes the number of campus employees taking a certain postgraduate course.

Edge: Responsible for expressing the relationship between student capacity (origin), graduate program (destination), and number of people (size) (Table 1).

Table 1 - Example of relationship between employees (source), graduate program (destination) and the number of employees.

ORIGIN	DESTINATION	SIZE
College	Course	Quantity
CANOINHAS	Computer Science	1
CANOINHAS	Linguistics	1
CANOINHAS	Public Health	1

Workplace information, number of employees, and graduate programs were submitted to social network analysis (with Degree and PageRank both used) for characterization.

III. RESULTS AND DISCUSSION

The quantitative information analyzed by the Degree algorithm demonstrated (Figure 4) that the Florianópolis campus is the unit with the highest number of qualified employees, followed by Joinville, São José, and Jaraguá do Sul.

In the PageRank analysis (Figure 5) of all people in qualification, the highlight is students attending the postgraduate program in linguistics, followed by computer science, mathematics, and visual arts.
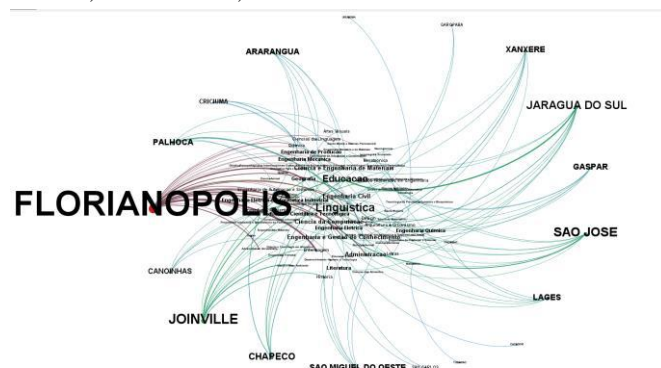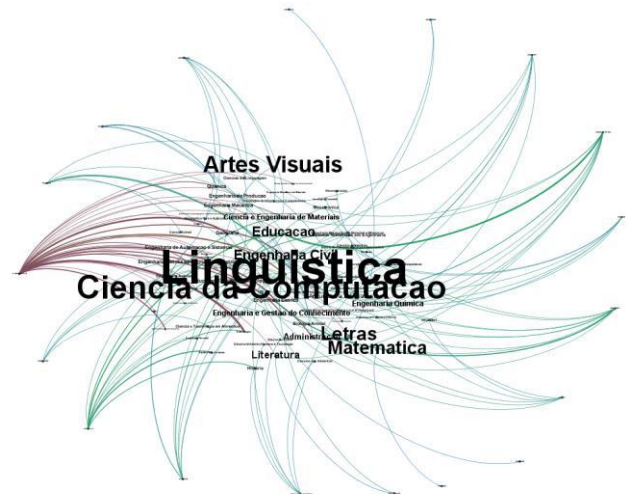

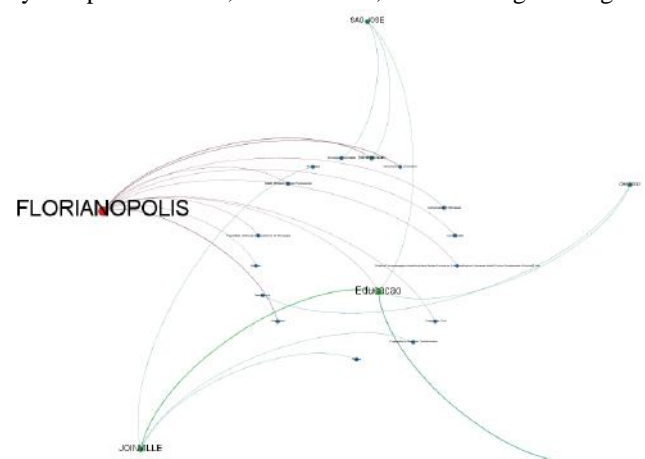*Fig. 4: Social Network Analysis of all employees by Degree algorithm*

Fig. 5: Social Network Analysis of all employees by PageRank algorithm.

As for the results of the Degree algorithmic analysis of only administrative technical employees (Figure 6), it appears that Florianópolis is the unit with the largest number of qualified employees, followed by Joinville and São José.

The results of the PageRank algorithm (Figure 7) for the master's and doctoral programs show Education as the most sought after, followed by Mechatronics, Administration, Technology and Society.

In the teaching group, when performing Degree algorithmic analysis (Figure 8), we can notice a large number of Florianópolis campus students in attendance, followed by Jaraguá do Sul, Joinville, and São José.

Finally, PageRank's algorithmic analysis (Figure 9) found strong demand for the course in linguistics, followed by computer science, mathematics, and civil engineering.

Fig. 6: Social Network Analysis of all employees Administrative Technicians by Degree Algorithm
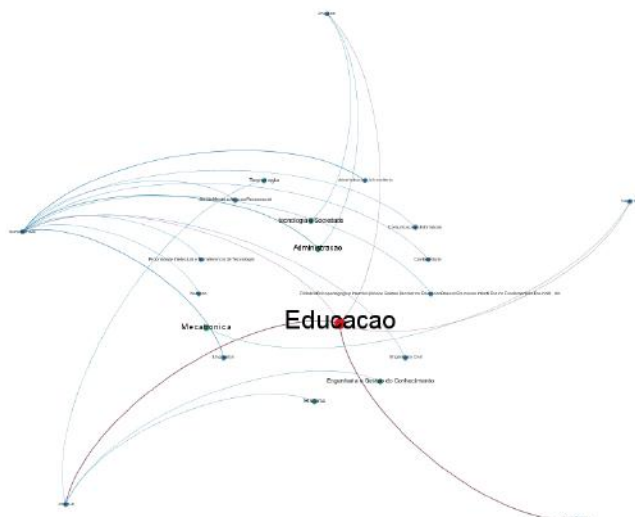
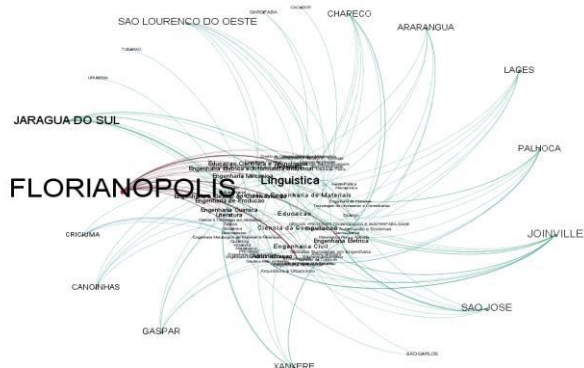*Fig. 7: Social Network Analysis of all students Administrative technicians by PageRank algorithm.*

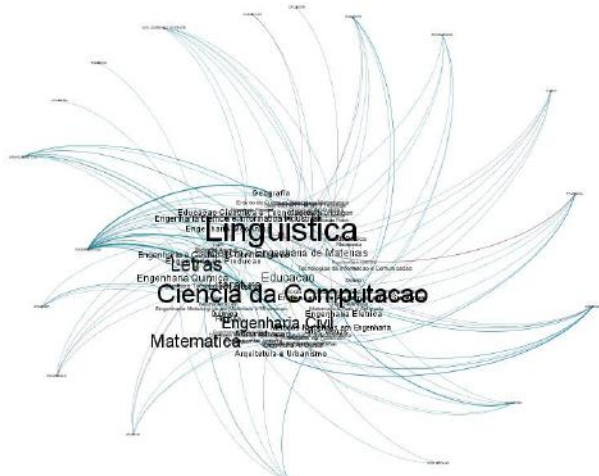*Fig. 8: Social Network Analysis of all Teachers by Degree algorithm.*

Fig. 9: Social Network Analysis of all Teachers by PageRank algorithm.

IV. CONCLUSION

The present study showed that the use of SNA, as applied to qualifying employees at the Federal Institute of Santa Catarina, allowed a complete and accurate visualization of qualifying employees in relation to postgraduate programs (in *stricto sensu*). Thus, the use of SNA can assist managers in offering postgraduate courses with higher demand indices. Also, such networks can be improved as additional data from Federal Education Institutions becomes available.

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