

BRAZIL'S INSERTION INTO NUCLEAR ENERGY RESEARCH: BIBLIOMETRIC ANALYSIS OF DISSERTATIONS DEVELOPED AT THE INSTITUTO DE PESQUISAS NUCLEARES – SÃO PAULO.

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1 Introduction

This study carries out the steps of the nuclear energy area, focusing on research developed at the INSTITUTO DE PESQUISAS NUCLEARES de São Paulo (IPEN – São Paulo Nuclear Research Institute). IPEN was created in 1956 by the “Conselho Nacional de Pesquisas” (CNPq – National Research Council) and the Universidade de São Paulo (USP – São Paulo University), missioned to produce scientific knowledge, to develop technologies, to generate products and services as well as to qualify human resources in nuclear energy and allied sciences, for peaceful purposes. Within such effort, IPEN's Master and Doctoral Programs were created in 1976.

The academic production is recorded in a Dissertations Database, elaborated within the Institution Library following international standards for metadata attribution. Data are structured in order to allow thematic mapping of developed research, its relationship with advisers' research lines and their adherence to the Programs research areas.

The data systematic study, performed, by means of advanced bibliometric methods, will enable to identify the profile of research carried out within the institution, along this period, and correlated between the country nuclear research policies, expressed on national scientific and technological plans. The results, jointly with journal and event articles studies, may enable the institution to have a framework of its research backgrounds and an overview of its academic performance. Based on bibliometric methods, theme rankings, and research areas were elaborated.

This study is part of a wider research project, cooperatively developed among Information Science researchers of USP and PUC–Campinas, focusing on social and cognitive institutionalization of scientific research.

3 Methodology

The study was carried out by bibliometric analysis of bibliographic data. Bibliometric analysis has innumerable areas of application and one of them is the *mapping science* which is concerning with the monitoring of scientific activity and science evolution. The research output (in this case, dissertations) is subject to clustering and scaling analysis in order to determine the structure and to monitor its changes (Braam, Moed and Van Raan, 1991)

Bibliometric maps studies are policy support tools. Constructed on the basis of publication data, they provide a historical overview of science fields in order to validate their activities or explore

future developments. Science maps should be used as additional information for policy decision and discussions (Noyons, 1990)

The availability of reliable data is the most important condition for a valid bibliometric study. The selection of a database should be recognised as a valid information source. In this study the selection of the data source was done aiming to know the performance of the Master and Doctoral Program. So, the literature issues, dissertations produced by this Program, along the thirty years period, holding in an internal database, were considered adequate.

The research corpus is composed of data extracted from an internal institutional database operated by the library and holding about 1,200 dissertations and thesis produced by this scientific community, since the Program was created (1976-2005).

The database structure is based in the INIS reference series publications, such as the Thesaurus and the Subject Categories and Scope Descriptions. The INIS/ETDE subject manual and the thesaurus are the most current tools used for the subject description of the nuclear literature all over the world.

Prior to bibliometric analysis, data were exhaustively checked as to identify inconsistencies in all database fields. Record consistency was reached regarding both bibliographic data and key-words and general subject category, using the INIS controlled vocabulary, aiming to obtain significant, standardized data for the study objectives. Each register is constituted by the following elements: author, title, year of presentation, institution, academic degree, advisor, subject category and indexing terms

In the present study the following elements were used: year of presentation, subject category and indexing terms. It was constructed a dataset for the subject analysis considering a period of thirty years. In order to follow the evolution of the themes, the total dataset was stratified in a five year period issues. In this way it was possible to identify fields that play a crucial role in leading research in nuclear energy area and allied sciences, as well as emerging fields and trends in the scientific growing of the institution.

To assure research accuracy a set of specialized software was used to allow data reformulation, transforming bibliographic records into bibliometric ones, counting and representing them in a matrix and/or frequency distribution form, feasible to statistical analysis for automatic generation of thematic clusters: ***Infotrans; VantagePoint; Dataview*** and ***Excel Program***

4 Results

By ranking the themes according to their size (based in number of dissertations) in a graphical display it was possible to obtain an overview of the scientific profile of the Academic Program. It strengths the main characteristic of the nuclear area, their interdisciplinary features, as the nuclear techniques could be applied in different knowledge areas, as materials science, physics, chemistry environment and so on. From the 45 subject categories currently used by the INIS/ETDE

databases, it could be observed that all the dissertations of this Institution are spreading in 33 of them.

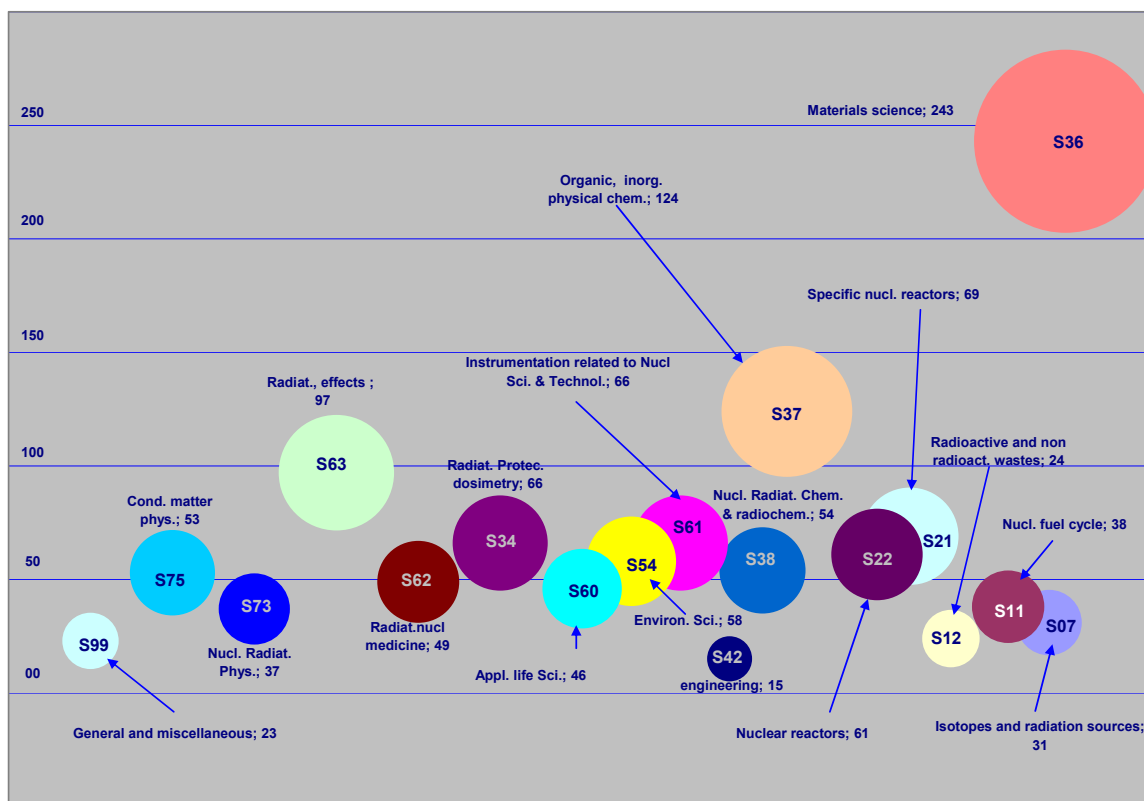


Fig. 1 – Ranking of themes

Fig 1 shows the current ranking of the major themes. The size of the bubbles represents the number of bibliographic issues. Three areas could be considered, today, the *Research Front* of the Program: Materials Science (243 dissertations), Organic and Inorganic Chemistry (124 dissertations) and Radiation thermal and pollutant effects in biological materials and living organisms (97dissertations).

Another areas such as: studies in specific and general nuclear reactors, instrumentation related to nuclear science and technology (dosimeters, chambers, detectors) and radiation protection, present a balanced performance.

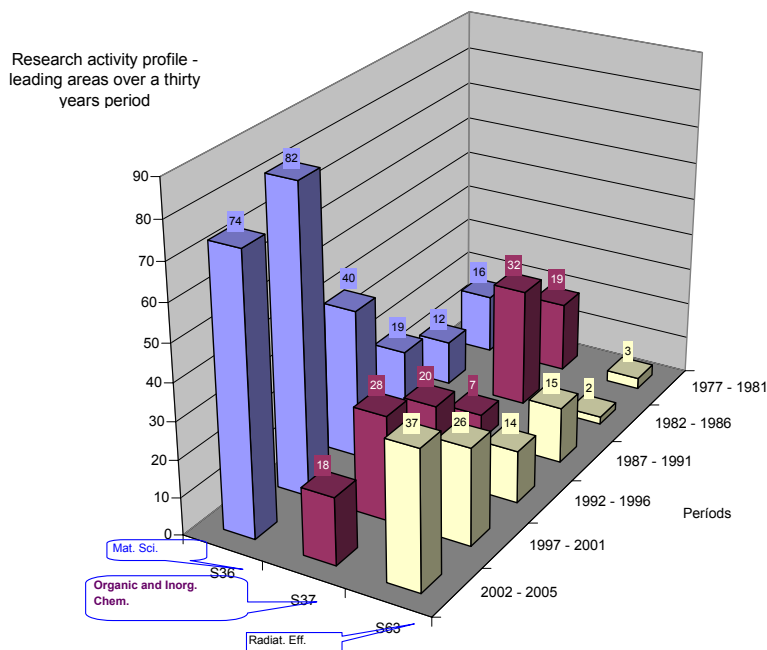


Fig 2 – Development of research areas

Fig 2 shows the development of the three leading areas along the studied period. By a retrospective analysis it could be observed that Materials Science (S36) maintains a linear performance along the period, followed by the Organic and Inorganic Chemistry (S37) which maintain an intermittent ranking position. Concerning the Radiation Effects area (S63) it is remarkable its development along the period

Maps of science represent the static situation of a field in a particular period of time, using the publication data in a time span. As the scientific production of the Institution increases, maps should be updated to check the field dynamics.

One important topic in bibliometric studies is validation. Only visual representation of the research fields is not enough, in order to be a supportive tool to address scientific policy. In this sense, science maps should be recognized and validated by the experts.

In the discussion of the results with experts, they were considered quite coherent, concerning the research activities profile of the institution and their development along the period. All the leading research areas represent today, according to the experts, the core research themes and this tendency should continue. Concerning the multidisciplinary of the area, it was considered unavoidable and a natural interrelationship among the areas, considering the fact that nuclear techniques could be applied in many different knowledge areas, as well as reactors fabrication, function and maintenance require the use of a wide-ranging spectrum of materials and processes, establishing, a propitious environment for the developing of the allied sciences. Specifically in this Institution and in this strategic area – nuclear energy - socioeconomic and political problems are frequent and highly influence the development of different areas. Also according the expert opinion

and concerning the remarkable development of the *Materials Science* (S36) area, one aspect should be mentioned, the group commitment for searching funds and opportunities for supporting the research projects.

5. Concluding remarks

This study is part of a broader one, concerning the institutionalization of the science in the country, using bibliometric methods and turning it visible through the science maps. One of the main points of this study is the idea that issues, like dissertations, produced by Academic Programs represent, any way, the scientific production of the country. Another remarkable point in this study was to demonstrate the usefulness of this methodology which showed to be adequate for the objective of this study.

The experience showed that for reliable outcomes, in such kind of study, data to be explored should be quite standardized. As a matter of fact, after the analysis of different databases, it was observed, there is a great volume of work to be done in order to obtain standard bibliographic data useful for bibliometric studies and cartographical presentation.

Finally, one observation of great importance should be done. Evaluative bibliographic studies demand bringing together multidisciplinary expertises. This was experienced along this cooperative study with researchers that work in different areas: planning and management of bibliographic databases, knowledge management, bibliometrics and nuclear energy.

Acknowledgements: The authors wish to thank the persons who collaborated with the data collection and processing: Priscila Nozaki (undergraduate student of Information Science – USP) and Claudinei Pracidelli (library technical assistant of IPEN).

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