SCIENTIFIC PRODUCTION OF ENTROPY AND INFORMATION THEORY IN BRAZILIAN JOURNALS

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ABSTRACT

This article aims at giving an overview of the scientific production about Entropy and Information Theory in national periodical publications in Qualis/CAPES. This article is a descriptive research and a bibliometric study with a quantitative approach. Its sample is composed of 31 articles from periodic publications from different areas, such as: Accounting, Economy, Computer Sciences, Electrical and Hydraulic Engineering, Sciences, Mathematics, Physics and, also, articles that were published in an electronic library called Scientific Electronic Library Online (Scielo) from 2002 to 2009. Among the results, one was able to notice that the "B5" (Qualis Capes) classification has shown a higher number of articles, as well as that 2008 was the year with a higher number of publications.

Keywords: Entropy, Information Theory, Bibliometrics, Scientific Production, Shannon.

1. INTRODUCTION

Investigating the scientific production of a specific subject provides researchers with a thorough understanding of what is being discussed and worked with in the academic world. In this sense, Moura, Mattos and Silva (2002, p. 34) define scientific

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production as an "important vector for the consolidation of knowledge in learning areas."

There are, accordingly, various means for publishing scientific papers. Among them one can mention periodical publications. Ronchi, Ensslin, Gallon and Nascimento (2008) consider periodical publications one of the most utilized vehicles by researchers for disseminating scientific work, since they have a higher concept in the scientific community. Thus, this study seeks to investigate, in periodical publications, the scientific articles that address issues related to Entropy and Information Theory.

The concept of Entropy emerged from Physics and started expanding to many other areas. In this sense, Oliveira, Correia and Melo (2008, p.3) emphasize that "Entropy is an "objective" method of designating weights, i.e., it determines weights without having the decision maker issue preference between criteria." In agreement with the authors, Zeleny (1982) considers Information Entropy a good measure to be used by the decision maker.

Mattos and Veiga (2002, p.3) emphasize that "Entropy in Information Theory corresponds to *probabilistic uncertainty* associated with a probability distribution. Each distribution reflects a certain degree of uncertainty and different degrees of uncertainty are associated with different distributions." According to the author, the greatest uncertainty is reflected at the same time as the probability distribution is more widespread.

Considering the relevance of periodical publications and the scope of Entropy and Information Theory in different knowledge areas, the question that guides this research emerges: What are the main characteristics of scientific production related to Entropy and Information Theory in periodical publications classified by CAPES Qualis? For answering this question, we aim at giving an overview of the scientific production on Entropy and Information Theory in articles in periodical publications listed in Qualis/CAPES. To do so, the following specific objectives are presented: i) to know the concentration of periodical publications according to the Qualis/CAPES classification; ii) to identify the area of knowledge that has published the highest number of articles concerning Entropy and Information Theory; iii) to demonstrate the thematic categorization of the investigated articles iv) to measure the number of authors by scientific publications.

Seeking to achieve the objectives of this study, this research will address all the papers that have presented the term Entropy and Information Theory, in order to identify the periodical publications in which the articles are published and the areas that have published the most about this subject. From the identification of the scientific publications, this research will undertake a mapping of these articles, in order to identify the researchers' thoughts and use this information as a guide for reflection and suggestions for future research.

Thus, the relevance of this research consists in identifying the interdisciplinarity of the subject in scientific periodicals and its insertion in the area of Applied Social Sciences. This agrees with Mattos and Veiga (2002) when they mention that the principle of Entropy has recently been developed in different fields such as thermodynamics, probability, statistics, economics, finance and others.

This article is organized as follows: initially there is an introduction to the topic; in section two, there will be a brief contextualized explanation about Scientific Production, Information Theory and Entropy; the third section will discuss the research

methodology; in the fourth section, there will be an analysis of the results; and, finally, the fifth section will present the final remarks and suggestions for future research.

2 THEORETICAL BACKGROUND

In this section, we seek to explore the content related to: (i) scientific production, (ii) Entropy and (iii) Information Theory.

2.1 Production Scientific

In an attempt to highlight the facts that are correlated, scientific knowledge aims at explaining why and how phenomena occur. The product of scientific knowledge is the result of scientific production (Leite Filho, Junior & Siqueira, 2007). Thus, we have observed that in most of the different areas of knowledge, studies that analyze scientific production are quite often seen.

The researchers' attention regarding the nature of the knowledge generated in their field of study is considered to be essential, as well as the fundamentals that guide the research (Theóphilo, 2007). Accordingly, in Accounting, scientific production must continue in order to present, describe and discuss the quality of research in Accounting Sciences (Martins & Silva, 2006).

Rocha (2006) considers scientific production as a major means of assessing the quality of the faculties in institutions. In this sense, Nossa (1999) mentions that some of the ways of keeping up to date and encouraging scientific production are participating in conferences, symposia, courses and lectures. Thus, according to Araújo and Andere (2006), for professors, it is essential to have not only a title, but also the ability to build quality knowledge, to act as a motivator of the student's educational process, and to see scientific production as one of the sources of the construction process. According to Silva, Oliveira and Ribeiro Filho (2005), scientific production and its dissemination causes the bases of knowledge to be solidified and to be used as a support for further scientific development.

Bibliometrics is the tool which is used to measure scientific production. The scientific activities in the survey of studies are used in many different fields of knowledge, or else, careful research is done for certain topics in various publications of the area of studies (Pinto, Silva & Toledo Filho, 2009). Bibliometrics studies the quantitative aspects of the production, dissemination, and use of registered data (Macias-Chapula, 1998). Thus, through a review of the scientific production of a certain theme, it is possible to characterize this production by the theoretical approach that has been studied by several authors, the purposes and the methodological options of their research, the instruments for data collection, and the analysis procedures that are most used, among other important aspects (Brandão, 2006).

2.2 Information Theory

Fernandez and Azevedo (2006) consider information reproduction as a communication problem, that is, to reproduce information on one side of the communication, in an exact way, or very close to it, to the transmitted by the other side. Information Theory was born to help solve this problem. This theory was developed in 1948 by Claude E. Shannon, and it is not only related to the communication problems,

but it is also related to issues concerning various areas of knowledge, such as: Cryptography and Cryptanalysis, Probability Theory, Artificial Intelligence, Economics, etc. (Fernandez & Azevedo, 2006). In agreement with the authors, Gonçalves (2008, p.16) highlights that "Information Theory was developed by Shannon in the 40s bearing in mind the applications it would have in communication engineering." However, this theory had a major impact not only on engineering, but also on areas such as Statistics and Economics (Gonçalves, 2008). Thus, Trigo Jr. (2007) points out that Information Theory originated from studies on the statistics of electrical equipment for telecommunications.

Communication system, in general, can be drawn as shown in Picture 1.
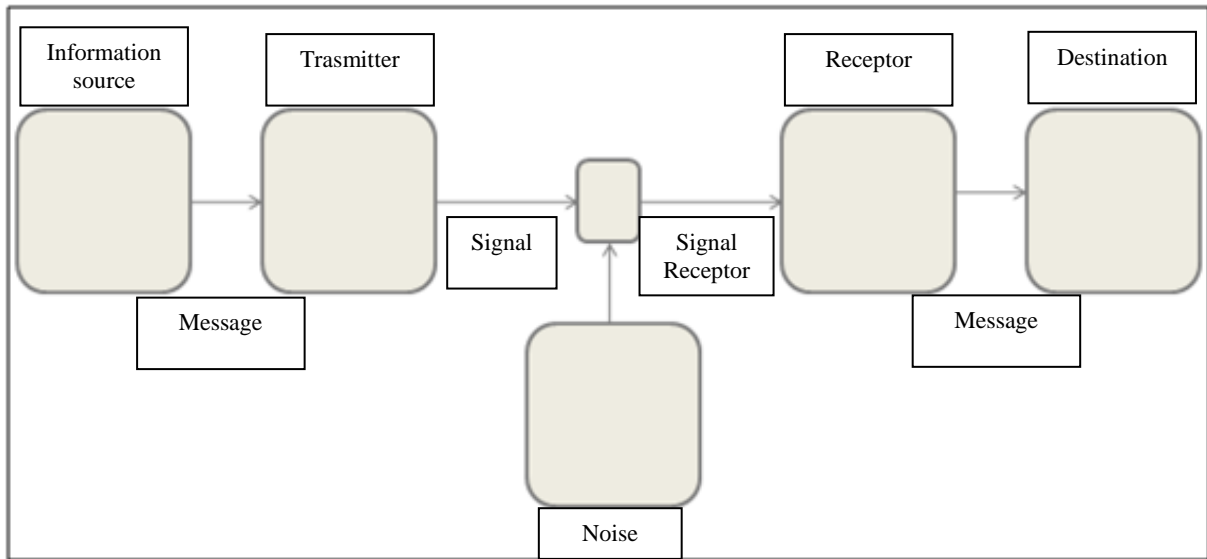
Picture 1. Communication system in general.

Source: adapted from Shannon, CE (1949). *The mathematical theory of communication. Bell System Tech. Journal*, 27.

According to Picture 1, these are the parts of a communication system in the information source: the transmitter and the receiver of the message and the destination. So, we can describe them as follows (Shannon, 1949):

Information source - place where the message to be transmitted is produced. It can be of different types, i.e., a sequence of letters and numbers as the ones used in the telegraph, a continuous function of time as the ones used via radio and television, telephone, etc.

Transmitter - It operates in the message to produce a signal that is suitable for the transmission through a channel to the reception point so that the message is less susceptible to noise in the channel it is important to encode it.

Channel - whereby the signal is transmitted, from the transmitter to the receiver. The channel may be a pair of wires, a coaxial cable, a light beam, etc. As noted in Picture 1, during transmission, the signal may be disturbed by noise.

Receiver - It normally acts on the received signal by performing the inverse operation that was performed by the transmitter, i.e., it reconstructs the message signal.

Destination - Person or machine to whom or which the message is designated.

For Epstein (1986), "Information Theory concerns only the structures of the codes as vehicles that enable the transmission of variety." Thus, Minei (1999) highlights that Information Theory is interested in the information content of the message, and not only in the message, so that the amount of information can be related to a numerical quantity. Contributing to the author, Trigo Jr. (2007) considers that Information Theory aims at providing quantitative measures of the ability of different systems to generate, transmit and store information.

Information Theory has two basic concepts: "(i) Entropy - a measure of uncertainty or randomness of random individuals or combined variables; and (ii) mutual information - stochastic dependence between random variables" (Gonçalves, 2008, p.16).

2.3 Entropy

In 1865 Clausius launched the first two Laws of Thermodynamics. The first Law stated that the total energy of the universe is constant, and the second Law stated that the total Entropy of the universe is increasing toward a maximum value (Coveney & Highfield, 1990). In agreement with the authors, Epstein (1986) notes that "the physical entropy measures the degree of disorder in a system, and its quantification was proposed by Clausius around 1864, in terms of a transformation that always accompanies a conversion between thermal and mechanical energy." The meaning of Entropy can also be related to the disorder of a system (Covolan, 2003). The concept of Entropy and information was related for the first time by Shannon. The notion of Entropy is related to the degree of disorganization in the existing source. The greater the disorganization is (Entropy, uncertainty), the greater the potential of information in the source. (Shannon, 1949)

Entropy Law can be defined as the most economical law of the physical laws. It is urgent to include the issue of Entropy in the economic thought, given the current environmental crisis and the pursuit of sustainable developments. The material base that serves as a support, as well as the ability of the environment to absorb high Entropy resulting from the economic process, is what threatens the sustainability of the economic process (Georgescu-Roegen, 1971).

According to Gonçalves (2008), uncertainty can be characterized by the amount of information that the occurrence of an event provides; uncertainty would then be translated based on the probability of an event. In this sense, there is no additional information on an event whose occurrence is certain, i.e., the certainty of the occurrence contains all the information. For the author, "one can state that the determination of the amount of information produced by the occurrence of an event is determined by the amount of surprise that this occurrence brings with it (Gonçalves, 2008 p.16)." Information is provided by the observation of an occurrence of an event from the sample space of a random variable. In this sense, common events contain less information than rare events. We can cite as an example of Entropy that one learns very little from hearing: - "the sun rose in the morning", and one learns much more from hearing: - "Sao Paulo was hit by a hurricane this morning" (Castro & Castro, 2001)

Thus, for Bertalanffy (2002) Entropy is a measure of disorder. The author also defines Entropy as the probability logarithm, i.e., a way to mathematically measure information when making decisions. Zeleny (1982) considers Information Entropy as a good measure to be used by the decision maker when choosing from several options that

have the same probability. In agreement with the author, Soares (2001, p. 93) highlights that "Entropy is a measure of the available choice in sequences controlled by probability." Gonçalves (2008, p.17) points out that "Shannon Entropy is, therefore, a weighed measure of information Q (pi)."

To calculate Entropy, one must consider the weight of the significance of the attribute (λi), considering the i-*ith* attribute as a measure of relative importance in a given decision situation, which is directly related to the amount of intrinsic information generated by a set of possible alternatives for each i-ith attribute, and in parallel to the subjectivity associated with the importance, the culture, the psychology and the environment in which the decision-maker lives and are reflected (Zeleny, 1982).

According to the author, there are two components in the λ_i weight composition: a) The concept of priori stable relativity, assigning w_i importance, reflecting the individual, cultural, genetic, psychological, social and environmental culture; b) Unstable relativity, concept in the dependent-context of the informational λ_i importance, based on a particular set of possible alternatives of a given decision-making situation. These weights are sensitive to any change in both X (values of the decision matrix) and D (normalized values of the decision matrix) sets, and in fluctuations in amounts of intrinsic information generated by them. In this sense, Entropy is calculated by:

$$e(d_i) = -\alpha \sum_{k=1}^{m} \frac{d_i^k}{D_i} Ln\left(\frac{d_i^k}{D_i}\right)$$

Zeleny (1982) considers entropy to be a simple, yet powerful, measure, because of the amount of information supplied by a given information source.

3 RESEARCH METHODOLOGY

This is a descriptive research, conducted as a bibliometric study, with a quantitative approach. According to Cervo and Bervian (2002, p 66), "Descriptive research observes, registers, analyzes and correlates facts or phenomena (variables) without manipulating them." This research is classified as descriptive, because it draws an overview of the scientific production in different areas which address contents related to Entropy and Information Theory.

Regarding the bibliometric study, Cardoso *et al*. (2005 cited in Leite Filho & Siqueira, 2007, p.3) emphasize that "one of the ways of assessing the scientific production in a given area of knowledge is its bibliometric analysis, whose subject is to study publications."

Regarding the quantitative approach Silveira, Moser, Cristelli, Jesus Rodrigues & Maccari (2004, p. 107), note that "generally, quantitative research is based on analyzing differentiated and numerical characteristics, usually some dimensions, between two or more groups, seeking to prove the existence of relationships between variables."

This research is a bibliographical study, since it performs the analysis of scientific articles in periodical publications in the following areas: Accounting, Economics, Computer Sciences, Hydraulic Engineering, Electrical Engineering, Sciences, Mathematics, Probability and Physics, in a period between 2002 and 2009, listed in Qualis/CAPES, classified as A1, A2, B1, B2, B3, B4, B5 and C. The scientific

articles published in the electronic library *Scientific Electronic Library Online* (SciELO) during this period of time were also a criterion for data collection.

It should be highlighted that this research was limited to national publications in the period of analysis. The criterion used for selecting the articles was based on the occurrence of the terminology "Entropy" and "Information Theory" in the titles, abstracts and keywords of the articles. Thus, 31 articles were found between 2002 and 2009. Table 1 shows the sample of the scientific articles that were collected.

Table 1: Number of articles comprising the sample by periodical publications' titles:

PERIODICAL PUBLICATIONS' TITLES	CLASSIFICATION IN QUALIS / CAPES	AMOUNT OF ARTICLES
Revista Brasileira de Entomologia (Brazilian Entomology Magazine)	B1	1
Iheringia. Série Zoologia (Impresso) (Iheringia. Zoology Series) (Printed)	B1	1
Boletim de Geografia (Geography Bulletin)	B5	1
C&T. Revista Militar de Ciência e Tecnologia (C&T. Science and Technology Military Magazine)	B5	1
Caderno Brasileiro de Ensino de Física (Brazilian Physics Teaching Book)	B1/B5	1
Cadernos de Ciência & Tecnologia (Science and Technology Book)	B4	1
Ciência e Tecnologia de Alimentos (Food Science and Technology)	B4	2
Ciências Agrárias e Engenharias (Agricultural Sciences and Engineering)	B5	1
Estudos Econômicos (USP. Impresso) (Economical Studies) (USP. Printed)	B2	1
Pesquisa Operacional (Operational Research)	B3	1
Revista Brasileira de Estudos de População (Impresso) (Brazilian Population Studies Magazine) (Printed)	B4	1
RECITEC. Revista de ciência e tecnologia (RECITEC. Science and Technology Magazine)	B5	1
Revista Brasileira de Anestesiologia (Brazilian Anesthesiology Magazine)	B1	2
Revista Brasileira de Ciências Farmacêuticas (Brazilian Phramaceutical Sciences Magazine)	B4/B5	1
Revista Brasileira de Engenharia Agrícola e Ambiental (Brazilian Agricultural and Environmental Engineering	B3	2

|		
Magazine)		
Revista Brasileira de Ensino de Física (Online) (Brazilian Physics Teaching Magazine) (Online)	B5	7
Revista Brasileira de Finanças (Brazilian Finances Magazine)	B5/B3/B5	1
Revista Brasileira de Recursos Hídricos (Brazilian Water Resources Magazine)	B3/B5	1
Revista Controle & Automação (Automation & Control Magazine)	B1	1
Revista de Administração (Business Magazine)	B3/B4	1
Revista de Economia Política (Political Economics Magazine)	B2	1
Revista Tecnológica (UEM) (Technological Magazine) (UEM)	B5	1
TOTAL NUMBER OF PERIODICAL PUBLICATIONS		**31**

Source: research data

4 RESEARCH ANALYSIS

Seeking to meet the specific objectives of this research, the following is a description of the articles: the classification of the periodical publication according to CAPES (Coordination of Improvement of Higher Education Personnel); knowledge area that has published the highest number of articles on the subject discussed by this paper; thematic categorization of the articles which were investigated; and, finally, thenumber of authors who published the analyzed articles.

It is important to highlight the comprehensiveness of Entropy and Information Theory in various knowledge areas, i.e., its origin in the area of physics and its gradual application in other areas, as one will be able to notice throughout this topic.

4.1 Classification of journals according to CAPES (Coordination for the Improvement of Higher Education Personnel)

Picture 2 shows the articles prevalence percentage according to the classification of Qualis/CAPES.
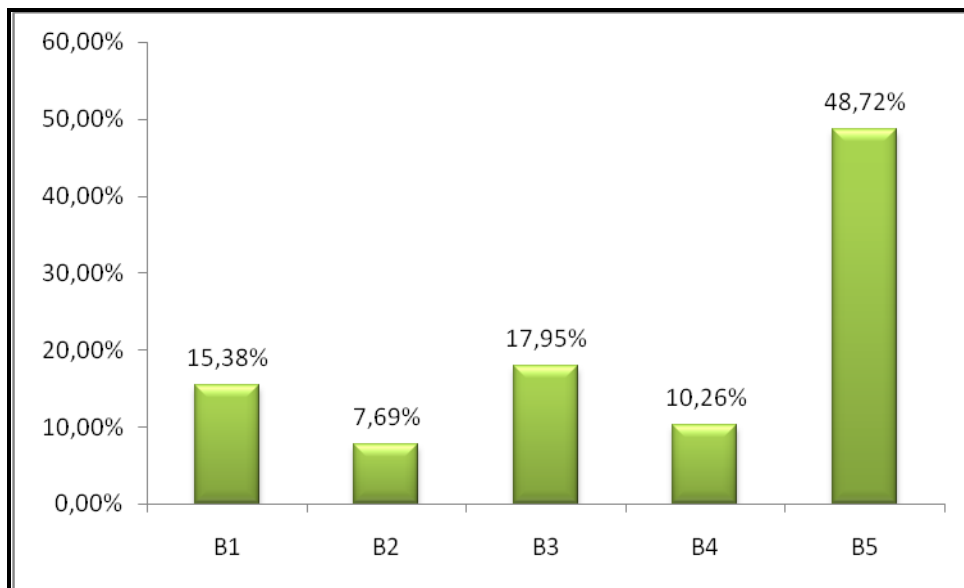
Picture 2. Classification of the periodical publication according to CAPES

Picture 2 shows the predominance of periodical publications classified as B5 (48.72%), followed by the B3 classification (17.95%), B1 (15.38%), B4 (10.26%) and B2 (7.69%). It is important to highlight that the Brazilian Physics Teaching Magazine concentrated the highest number of publications, presenting 7 (seven) articles. The Food Science and Technology Magazine presented 3 items, which put it in the second place, and the Brazilian Anesthesiology, the Agricultural and Environmental Engineering and the Political Economics magazines presented only two articles each.

Picture 3 presents the percentage of scientific articles published per year in the period between 2002 and 2009.

Percentage of Scientific Articles Published per year
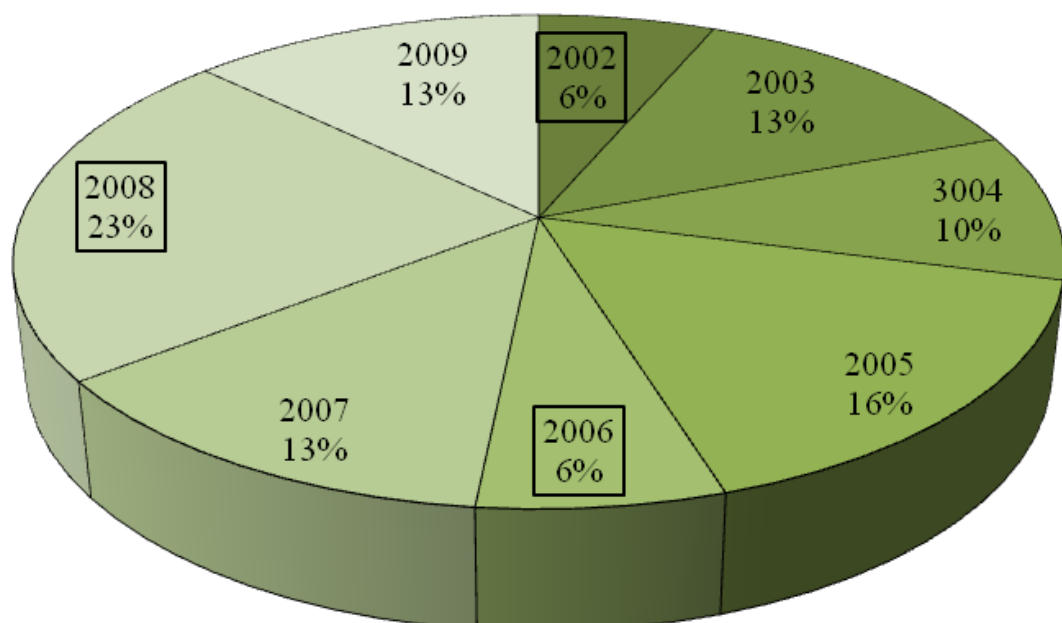
Picture 3. Percentage (%) of articles published per year.

Picture 3 shows the percentage of scientific articles published per year in the period between 2003 and 2009. In this sense, one can see the predominance of publications in 2008 (23% - 7 articles), followed by the year of 2005 (16%). The years in which there was the lowest number of publications were 2002 and 2006 (only 6%). Among these publications, there are articles in the areas of Hydraulic Engineering, Mathematics/Probability and Agricultural Sciences I.

4.2 Scientific articles on Entropy and Information Theory in periodical publications related to different areas of knowledge

The search for articles on the referred topic was held in different areas of knowledge, since it is an interdisciplinary topic which was originated in Physics and then disseminated in other areas of knowledge. According to Georgescu-Roegen (1971), it is important to include Entropy in economical thinking. So, in other areas we could also observe the application of Entropy. Thus, Picture 4 presents the number of articles, from 2002 to 2009, in several periodical publications related to different areas of knowledge in which any connection with that theme was found.
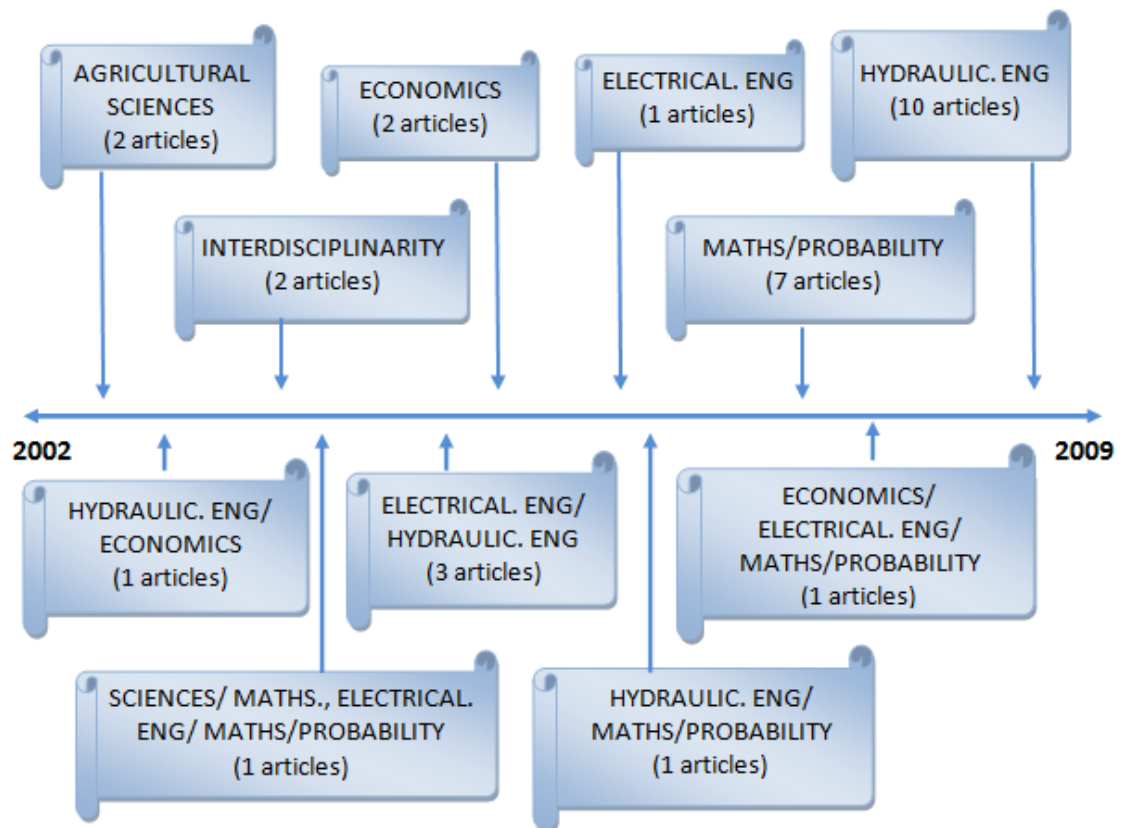
Picture 4. Articles in periodical publications related to their respective areas of knowledge - 1 article

Source: adapted from Espejo, M. M. dos S. B. (2008). Perfil dos Atributos do Sistema Orçamentário Sob a Perspectiva Contingencial: uma abordagem multivariada. Doctoral Accounting Theses – Faculdade de Economia, Administração e Contabilidade da Universidade de São Paulo, SP, Brasil. Available at: http://www.teses.usp.br/teses/disponiveis/12/12136/tde-30062008-141909/

Scientific production about entropy and information theory in Brazilian journals

Picture 4 shows areas regarding periodic publications which are related to Entropy and Information Theory. During this search, the following articles were found, and they are related to seven specific areas: Agricultural Sciences I (2 articles), Economics (2 articles), Interdisciplinarity (2 articles), Electrical Engineering (1 article) Mathematics/Probability (7 articles), and Hydraulic Engineering (10 articles). At the same time, some articles from common areas were also found in some periodical publications such as: Hydraulic Engineering and Economics (1 article); Science/Mathematics, Electrical Engineering and Mathematics/Probability (1 article); Electrical Engineering and Hydraulic Engineering (3 articles); Hydraulic Engineering and Mathematics/Probability (1 article); Economics, Electrical Engineering, Mathematics/Probability (Article 1). The area that presented the highest number of publications was Hydraulic Engineering (10 articles), in second place Mathematics/Probability (7 articles), Electrical Engineering and Hydraulic Engineer (3 articles each), Agricultural Sciences I, Economics and Interdisciplinarity (2 articles each), and the other two presented 1 article each, totalizing 31 articles that were investigated. Given the results of this research, Fernandez & Azevedo's (2006) considerations that highlight the theme's dissemination in several areas of knowledge are confirmed. It can be deduced, from this context, the predominance of articles in Engineering and, in second place, Mathematics, i.e., according to (Gonçalves, 2008) these were the areas where Information Theory had a major impact on.

4.3 Thematic Categorization of the Investigated Articles

This subsection will reveal the thematic categories resulting from the study area of the analyzed articles, as well as the nature of the application of Information Entropy, which are covered in Table 2.

Table 2: Categorization of the articles

CATEGORIZATION	NATURE OF THE ARTICLE		TOTAL	PERCENTAGE (%)
	PRACTICAL	THEORETICAL		
Computational Sciences	1	1	2	6.45%
Economics	0	1	1	3.23%
Education	1	0	1	3.23%
Finances	1	1	2	6.45%
Physics	3	9	12	38.71%
Animals	2	0	2	6.45%
Medicine	2	1	3	9.68%
Psychology	0	1	1	3.23%
Environment	6	1	7	22.58%
TOTAL	16	15	31	100.00%

Source: research data

Table 2 shows the classification of the articles in ten categories, namely: a) Physics Category - addresses some kind of practical experience which emphasizes a large area of Physics - this category comprises 12 articles representing 38.71% of the articles analyzed, where 9 articles are theoretical, and 3 are practical applications. It is important to note that Physics is the area from which Information Theory originated; b) Environmental Category - this category is composed of articles related to the application of Entropy by means of experiments with plants, rivers, soil and sustainability policies – presenting seven articles which represent 22.58% of the articles that were studied, c) Medical Category - discusses studies that measure entropy related to medicines and anesthesia - this category consists of three articles that represent 9.68% of the analyzed articles; d) Computational Category with 6.45%; e) Financial Category, which also represents 6.45%, f) Animals Category, which is related to articles that use entropy to calculate the distribution of death and survival of the species - it represents 6.45% of the analyzed articles; and, finally, the categories that represent only 3.23% - Economical and Educational Categories, which address a practical proposal to teach high school students the Second Law of Thermodynamics, and the Psychological Category – which refers to the analysis of the transition of people into adulthood.

4.4 Number of authors in scientific publications

Table 3 presents information regarding the amount of authors/educational background of those who participated in the development of the selected articles.

Table 3: Number of authors that participated in the selected articles

Number of Authors	TITLE/FORMATION	NUMBER OF PUBLICATIONS	(%)
1 author	Doctor of Physics, Doctor of Economics, Doctor of Demography	1	22,58%
2 authors	Doctor of Physics, Taller de Ensenanza de la Física, Doctor of Ecole Nationale, Graduated in Physical Education - Licenciateship, Doctor of Education to Science	10	32.26%
3 authors	Doctor of Mechanical Engineering, Master of Science in Mechanical Engineering, Master of Electrical Engineering, Doctor of Physics, Doctor of Nuclear Physics, Doctor of Surgery, Professor of Anaesthesiology and Intensive Care, Doctor of Business, Master of Economics, Doctor of Environmental Sciences, Doctor of Geotechnics, Master of Geography	6	19.35%
4 authors	Scholarship student of the Institutional Program of Scientific Initiation Scholarships, Doctor of Food Engineering, Doctor of Food Technology, Degree in Chemistry – Licentiateship, Master of Molecular Sciences	2	6,45%

More than 4 authors	Doctor of Chemistry, Doctor of Pharmaceuticals Sciences, Degree in History, Master of Pharmaceutical Sciences, Biosciences, Master of Geosciences, Doctor of Food Engineering, Doctor of Metallurgical Engineering, Specialist in Automation and Control of Industrial Processes, Degree in Physics, Master of Physics	6	19.35%
TOTAL		31	100.00 %

Resource: research data

Table 3 presents the number of authors of the articles under examination. There have been found articles that were developed by 1 to 6 authors. In this sense, it can be highlighted that 32% of the analyzed articles were written by two authors, 22.58% of the articles were written by only one author. In 19.35% of cases, there was the participation of three authors, 12.90% of the articles were written by five authors and, finally, 19.35% of the analyzed articles were written by more than four authors. One can infer from the 31 articles that were analyzed that there was the total participation of 84 authors, and that only one author, called Rogean Rodrigues Nunes, who is from the University of Fortaleza, related to the Interdisciplinary area, presented two publications in 2004. The other authors had only one publication each. In this context, the number of articles written by two authors prevailed, i.e., 32% of the articles. This result is consistent with the findings of Leite Filho, Paulo Junior and Siqueira (2007) that have found, in their studies, the result of 46% of the published articles on the researched topic, written by two authors each.

5 FINAL REMARKS

This study aimed at giving an overview of the scientific production on Entropy and Information Theory in articles in periodical publications listed in Qualis/CAPES. For this purpose, the sample was composed of 31 scientific articles that present in their titles, abstracts and keywords the terminology Entropy and Information Theory. In this context, the question that guided this research is revised: *What are the main characteristics of the scientific production related to Entropy and Information Theory in periodical publications classified by Qualis CAPES?*

In response to this inquiry, the predominance of scientific papers in periodical publications classified as "B5" (48.72%) was established among the various knowledge areas that were addressed. The predominance of scientific papers published in 2008 was also observed, i.e., there were seven of them among the various analyzed periodical publications.

Regarding the number of articles in periodical publications listed by area of expertise, one is able to observe that the area of periodical publications with the highest number of published papers was the area of Hydraulic Engineering, followed by the areas of Mathematics/Probability, Electrical Engineering and Hydraulic Engineering, Agricultural Sciences I, Economics and Interdisciplinarity, and, finally some other areas.

Regarding the categorization of the articles that were investigated, it was observed that the highlighted area was the category of Physics, since there was a higher number of a certain publication in this category, followed by the Environmental, Medical, Computational, Financial, Animal and, finally, Economical, Educational and Psychological categories.

Finally, regarding the number of authors by scientific publication, there were observed articles written by one, two, three, four or more than four authors. However, the number of articles published by two authors was predominant. In this context, one could also observe that one author alone was responsible for publishing two articles related to the topic. All the other authors have published only one scientific paper each. There was the participation of 84 authors in preparing the articles that were investigated.

As limitations for this research, one can mention the search in national periodical publications and the analysis period from 2002 to 2009. It can be suggested as future research: i) to replicate this study at conferences related to the areas of: Accounting, Economics, Computational Sciences, Hydraulic Engineering, Electrical Engineering, Science, Mathematics, Probability and Physics; ii) to conduct this research at an international level, iii) to conduct this research some years from now aiming at monitoring scientific developments regarding the research issue.

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