

APPLYING NEW SCIENTOMETRIC INDICATORS TO EVALUATE THE SCIENTIFIC PERFORMANCE OF CHEMISTRY GROUP FROM VALACHIA UNIVERSITY OF TARGOVISTE

SILVIU JIPA¹, LAURA MONICA GORGHIU¹, CRINELA DUMITRESCU¹,
CALIN OROS¹

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Abstract. *The paper describes different new indicators measuring research output by application to Chemistry Department of the Faculty of Sciences and Arts from Valahia University of Targoviste. We have also analyzed the Hirsch indices calculated with different relations proposed in literature. We have compared the data obtained in our study with the results of other studies done in other universities and circumstances.*

Keywords: *research, Scientometry, scientometric indices, Hirsch index.*

1. INTRODUCTION

The scientific research activity constitutes a maximum relevance-indicator for the evaluation of a university's level of quality. The excellence in the domain of scientific research is shown by both the increase in the number of research projects won in competitions and the number of papers published in ISI cited journals [1].

Several different citation-based indices are used to measure research performance. We consider that these indices correlate well with qualitative perception of quality. The analyzing of an individual department provides an overall picture of its quality. Scientometric studies are performed by scientific managers, scientometricians, experienced scientists and science journalists. An important number of scientometric studies have been carried out on scientist groups, disciplines, journals as well as universities and research institutes [2-6].

The aim of this paper is to describe some of the newly developed indicators which can be applied to characterize the scientific output of the Chemistry Department members in our university. The background of this piece of work has been laid out in the preceding paper.

2. EXPERIMENTAL

Based on Hirsch-index (h), different variants have appeared in the literature. Part of them is presented in the table 1 and has been applied to our Chemistry group to evaluate their scientific output.

Also, different relations of the Hirsch-index calculation, proposed by various authors, have been used as shown in table 2.

Table 1. New indices for evaluating the scientific output of the academic teaching staff

Index	References	Index	References
A-index	[7]	p-index	[10]
R-index	[8]	π -index	[11]
e-index	[9]		

¹ Valahia University of Targoviste, Faculty of Sciences and Arts, 130082, Targoviste, Romania.
E-mail: jipasilviu@yahoo.com.

Table 2. Relations of h-index calculations existing in literature

Relation of h-index calculation	References	Relation of h-index calculation	References
Redner's formula	[12]	Ye's formula	[14]
Glänzel-Schubert formula	[13]	Von Raan's formula	[15]

3. RESULTS AND DISCUSSIONS

The academic teaching staff's progress in the scientific research activity can be appreciated by the certain criteria such as publishing papers in ISI cited journals, their annual number per person, number of invention patents, frequency of citations [16] etc.

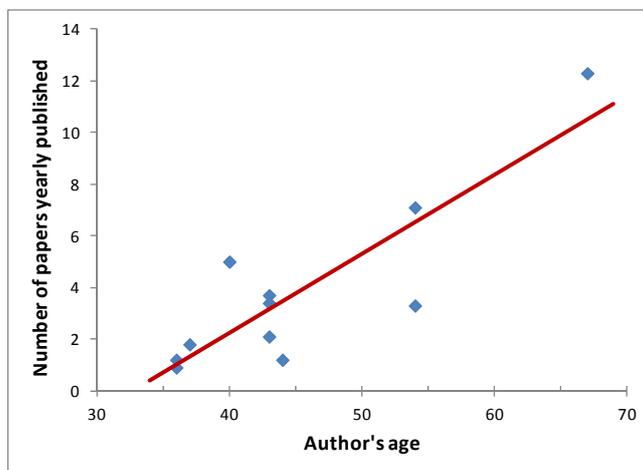
The 2002-2011 statistics issued by AdAstra allowed us to calculate the number of annually published papers by the members of Chemistry Department in the Faculty of Sciences and Arts of Valahia University of Targoviste (table 3).

Table 3. Number of annually published ISI papers by Chemistry Department teaching staff

Code	Number of ISI papers published between 2002-2011	Number of annually published ISI papers
P1	111	12.3
P2	64	7.1
P3	30	3.3
C1	45	5.0
C2	34	3.7
C3	31	3.4
L1	49	2.1
L2	11	1.2
A1	11	1.2
A2	17	1.8
A3	8	0.9

P – Professor; C – Associate Professor; L – Lecturer; A – Teaching Assistant

Approximately 3.5 papers per researcher in 5 years is ranked well at national level. The European Union average is of one paper per researcher per year [17]. In relation to this standard we can consider that all the Department members fulfill this performance requirement and some of them even exceed it a lot. At the same time it can be inferred that the number of yearly published ISI papers goes up with the raise in the academic's age as shown by the data in Fig. 1.

**Fig. 1. Increase in the number of yearly published ISI papers with author's age.**

Analyzing the total number of ISI papers (P) and total number of citations (C) received by these papers, we have obtained the Hirsch-index (h) presented in table 4. There is a linear correlation in semi logarithmic dependence between these parameters as results from figures 2 (correlation coefficient: 0.93) and 3 (correlation coefficient: 0.99).

Table 4. Scientometric indicators to characterize the scientific output of UVT Chemistry Department members (Database: ISI Web of knowledge).

Code	Total number of ISI papers (P)	Total citation number (C)	Average citations per paper	Hirsch-index (h)
P1	157	648	4.13	11
P2	99	522	5.27	11
P3	55	330	6.00	10
C1	56	144	2.57	7
C2	43	91	2.11	6
C3	27	66	2.44	6
L1	21	30	1.42	4
L2	14	28	2.00	3
A1	17	32	1.88	3
A2	17	34	2.00	4
A3	9	27	3.00	3

P – Professor; C – Associate Professor; L – Lecturer; A - Teaching Assistant

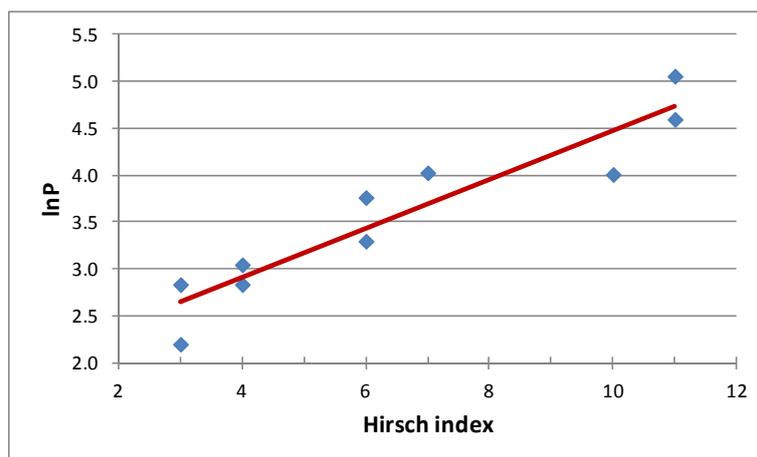


Fig. 2. lnP dependence on Hirsch-index (h).

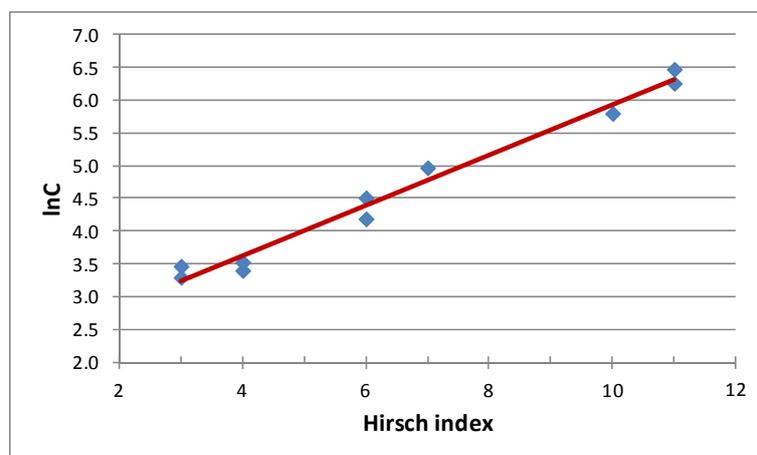


Fig. 3. lnC dependence on Hirsch-index (h).

Linear correlation have been also found between Hirsch-index (h) and the average citations per paper (CPP) as pointed out by Ruch and Ball [16b]. The straight line (1) in figure 4 shows the h vs CPP dependence which results when these values are extracted from the database of ISI Web of knowledge. The straight line (2) in this figure was obtained using a Hirsch-index calculated from:

$$N_{c,tot} = a \cdot h^2 \quad (1)$$

where $N_{c,tot}$ is the total number of citations, h is the Hirsch-index and a is a constant ranging between 3 and 5. CPP was calculated by the ratio:

$$CPP = \frac{N_{c,tot}}{N_p} \quad (2)$$

where N_p is the total number of papers. In this case it can be written that:

$$CPP \cdot N_p = N_{c,tot} \quad (3)$$

and:

$$CPP \cdot N_p = a \cdot h^2 \quad (4)$$

It results that:

$$h = \sqrt{\frac{CPP \cdot N_p}{a}} \quad (5)$$

In order to calculate the h -index we used the median value of the constant ($a = 4$).

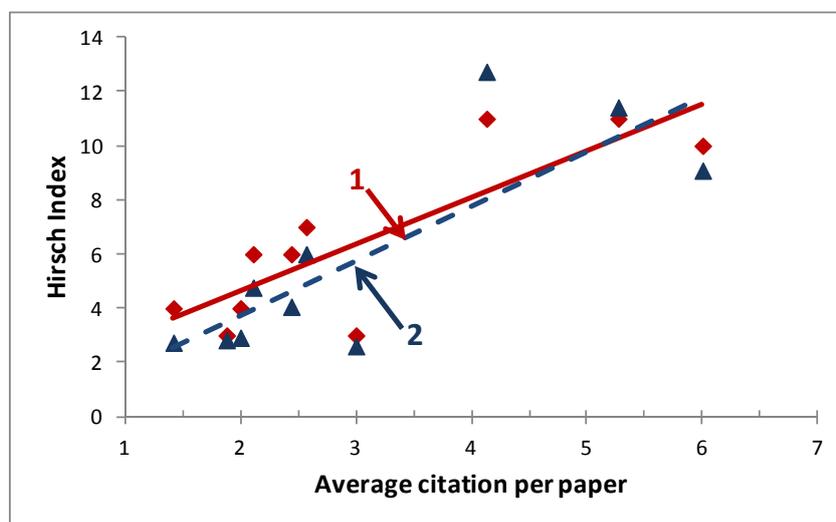


Fig. 4. Hirsch-index (h) dependence on average number of citations per paper (CPP): (1) h taken from ISI Web of Knowledge; (2) h calculated by Hirsch relation

In Fig. 4 we can observe a spreading of points for either straight line (correlation coefficient: 0.83 for line (1) and 0.82 for line (2) respectively). However these data do not correspond to the preliminary results obtained by Ruch and Ball [16b].

All of the five indices that were included in the present study were calculated using the following considerations:

The **A-index** is defined [7] as the average number of citations received by the papers included in the Hirsch core:

$$A = \frac{1}{h} \sum_{j=1}^h cit_j \quad (6)$$

where h is the Hirsch-index and cit_j is the number of citations.

The **R-index** is defined [8] as the square root of the sum of citations in the Hirsch core:

$$R = \sqrt{\sum_{j=1}^h cit_j} = \sqrt{h \cdot A} \quad (7)$$

The **e-index** has been proposed [9] to compare the scientific output of a group of scientists having an identical h-index. The index is defined as the square root of the excess citation over those used for calculating the h-index. That is:

$$e = \sqrt{\sum_{j=1}^h cit_j - h^2} \quad (8)$$

where $\sum cit_j$ is the total citations received by the h paper for a scientist if his h-index is h .

The **p-index** is defined as a balance between mean citation rate (C/P) and total citations (C) [10]:

$$p = \left(\frac{C^2}{P} \right)^{1/3} \quad (9)$$

where C is the number of citations and P is the number of papers.

The **π -index** is equal to the 100th of the number of citations $C(P_\pi)$ to the top square root (P_π) of the total papers (P) ranked by a decreasing number of citations [11]:

$$\pi = 0,01C(P_\pi) \quad (10)$$

where P_π is the highest number of citations in the set of the analyzed papers and it is defined as:

$$P_\pi = \sqrt{P} \quad (11)$$

Table 5 presents the values of the analyzed indices.

Table 5. The analyzed indices

Code	Index				
	A	R	e	p	π
P1	32.81	18.99	12.44	13.81	81.19
P2	23.90	16.21	11.57	13.94	51.93
P3	13.50	11.61	9.64	12.50	24.47
C1	10.42	8.54	4.47	7.16	10.77
C2	7.33	6.63	3.31	5.76	5.96
C3	5.33	5.65	2.00	5.43	3.42

P – Professor; *C* – Associate Professor

Comparing the indices it is observed that $A > R$. Similar results have been reported by Zhang [9]. When compare e-index, p-index and π -index it is observed that the decreasing order is: $\pi > p > e$.

Therefore it results that these indices follow the same decreasing line as the Hirsch-index (h) when we analyze the members of the group mentioned.

The increase in time of the number of citations can be tracked using any of these indicators. This can be exemplified by the p-index increase over 133 days in the case of P1 as shown in Fig. 5.

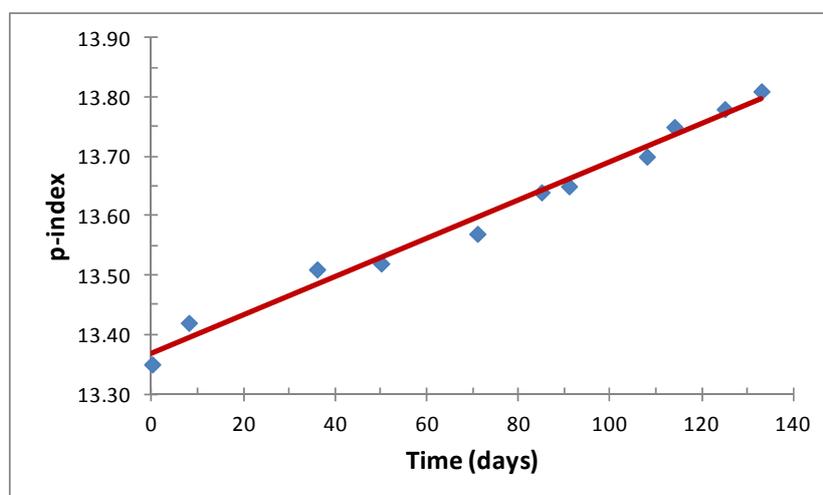


Fig. 5. p-index raise in time as a result of the increase in the number of citations (case P1).

A number of authors have proposed relations for Hirsch-index (h) calculation as follows:

- a) Van Raan [15] studied the empirical correlation of the Hirsch-index with the total number of citations and total number of papers. The study was done on a group of 147 Dutch Chemistry researchers and the following relation was found:

$$h = 0,42 \cdot C^{0,45} \quad (12)$$

where h is the Hirsch-index and C is the total number of citations.

- b) Redner [12] proposed the following relation for the theoretical calculation of the Hirsch-index (h):

$$h = \sqrt{\frac{N_p}{4}} \cdot \chi^{2/3} \quad (13)$$

where N_p is the total number of papers and χ is the average of citations per paper.

- c) Glänzel-Schubert [13] established the following relation for the Hirsch-index (h) calculation:

$$h = c \cdot P^{1/3} \cdot \left(\frac{C}{P}\right)^{2/3} \quad (14)$$

where P is the number of papers, C is the number of citations and c is a constant. On journal analysis $c = 0.9$ and for the rest of the cases $c = 1$ [14].

- d) Fred Y. Ye [14] proposes the following relation for the calculation of the Hirsch-index (h):

$$h \approx e^{\log C} \quad (15)$$

where C is the number of citations.

The application of these calculation relations to the Chemistry Department academics has resulted in the Hirsch-index values written in table 6.

There are three databases in which a person has been cited: Web of Science, Scopus and Google Scholar. Google Scholar consulting is free of charge but the other two databases require a fee for being consulted.

Table 6. Hirsch-indices for the Chemistry Department members calculated on different relations

Code	Hirsch-index calculated with relation:			
	Van Raan [15]	Redner [12]	Glänzel-Schubert [13]	Ye [14]
P1	8	9	14	17
P2	7	9	14	15
P3	6	8	12	12
C1	4	5	7	9
C2	3	4	6	7
C3	3	3	5	6

P – Professor; C – Associate Professor

None of three databases are comprehensive, which means that the more databases are consulted the more comprehensive the result will be. The h-index as calculated in the Web of Science is the most accurate measurement [17b].

A Hirsch-index value of 10-12 is sufficient in the USA to obtain the position of Professor; however, higher scores (15-20) are required for access to American Scientific Societies [18].

A study done on Chemistry Departments in Greek universities regarding the Hirsch-index average value [5] reveals achieved scores ranging between $h = 9.0$ (Athens University) and $h = 16.6$ (University of Crete) compared to the value of $h = 44.5$ for Harvard University (USA).

Henry Schaefer and Amy Peterson from the University of Georgia (USA) compiled the list of American chemists in the decreasing order of the Hirsch-index [19, 20] (using ISI Web of Science). At the top of the list there are Whitesides, G. M. ($h = 163$) and Karplus, M. ($h = 143$), both from Harvard University and the last of the list (the 597th) is Schinke, R. ($h = 50$). The presence of a Nobel Prize laureate on a common place position of the list can be explained by the understanding that the Prize is awarded for a certain achievement while the Hirsch-index marks a person's entire career [19]. Romanian performances are still far from the ones mentioned above, even the academic ones. A Romanian scientist (a biologist), Noble Prize laureate who had a high Hirsch-index was George Palade ($h = 105$) [21].

Scientometrics is ignored by two categories of people: the ones with a modest CV for obvious reasons and the ones with a good CV but who are too proud to accept hierarchies [22]. Sometimes ignorance is induced. For instance, the official low ranking of both Romanian and East-European ISI journals with an influence score of ≤ 0.5 [23] is not a rightful line of action. From a strategic point of view we must preserve what is good of Romanian ISI journals and, then in parallel, consult foreign journals.

4. CONCLUSIONS

The paper is intended to identify the scientific research performance in the Chemistry Department of the Faculty of Sciences and Arts from Valahia University of Targoviste.

There have been analyzed five scientometric indices complementary to the Hirsch-index such as A, R, e, p and π indices and a comparison of the obtained results has been presented.

There have been analyzed the Hirsch-indices calculated with different relations proposed by Redner, Glänzel-Schubert, Ye and Van Raan, the result being compared with the values obtained from the application of the Hirsch method, using ISI Web of Knowledge.

The obtained data presented in the current study have been compared with the results of other studies done in the chemistry field but also in other universities and/or circumstances.

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