

THE HIRSCH INDEX – A MULTIPLE USE SCIENTOMETRIC INDICATOR

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Abstract. *The paper presents an overview on Hirsch-index applications that can be found in the literature. Different possibilities of using the Hirsch-index for the assessment of the scientific output of a country, university, research institute, medicine, specialists or academic journals are presented. On the other hand we have examined the Valahia University of Targoviste (UVT) researchers' scientific productivity and we found a lack of correlation with the scientific research activity attributed to the institution.*

Keywords: *research, Scientometrics, Hirsch index, influence score.*

1. INTRODUCTION

Scientific research within higher education is considered to be one of the supportive bases of the socio-economic development in Romania. The growth of the researchers' innovation skills, the good use of the professors' and students' creativity by the transfer of knowledge, products and technologies oriented toward the economic environment represent essential factors for the country's sustainable development. Owing to the assumption of specific responsibilities for society, universities are called upon to carry out research programmes oriented toward new directions and priorities in science, to maintain internal and external research relationships, to promote excellence at both national level and, most of all, at international level [1].

Scientometrics can be defined as the measurement of scientific and technical research activity. Many scientometrics indicators have been used to describe the research performance of scientists. The Hirsch index combines two important parameters: the number of papers and the number of citations [2]. In other words, a Hirsch index of 12 shows that a researcher has at least 12 ISI papers, each of them with a minimum of 12 citations in the ISI system. This index does not reduce with time, it can only grow with the rise in the number of citations. Details on the Hirsch index are to be found both in the papers previously published by the current group of authors [3-6] and in other publications [7, 8]. Today, the Hirsch index is used to make a quantitative comparison of the publishing activity of certain authors from a field and to establish some classifications or hierarchies. Even the Nobel Foundation admit that, when making their annual lists of the Nobel Prize candidates, they take into consideration this index, starting from $h=50$ [9] (Table 1).

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Table 1. American chemists, Nobel Prize laureates [10].

Item no.	Name	Hirsch index	Field
1	Corey, E. J.	140	Organic Chemistry
2	Heeger, A. J.	134	Organic Chemistry
3	Huber, R.	127	Biochemistry
4	Wüthrich, K.	122	Biochemistry
5	Lehn, J. M.	117	Organic Chemistry
6	Hoffmann, R.	116	Theoretic Chemistry
7	Noyori, R.	105	Organic Chemistry
8	Sharpless, K. B.	104	Organic Chemistry
9	Grubbs, R. H.	103	Organic Chemistry
10	Grtl, G	100	Physical Chemistry

This paper presents some results on the research performance of the Chemistry Group in Valahia University as well as the scientometric applications of the Hirsch-index.

2. MATERIALS AND METHODS

We have examined the AdAstra centralized data on the Romanian universities' scientific papers, published annually between 2002-2011, in correlation with the classification of universities.

Another point which has been considered relates to the scientific productivity of the Chemistry department academics within the specified timespan.

We have also analyzed the scientific journals in which the Chemistry Group's papers were published in correlation with the Hirsch-indices of these journals.

The Hirsch indices of the Chemistry Department members have been considered in relation to the number of citations for the published papers.

We have also discussed the types of possible evaluations based on the Hirsch index, such as: the scientific output of a country, a university, a scientific research institute, a medical institution, the specialists' scientific performance, academic journals and so on.

3. RESULTS AND DISCUSSION

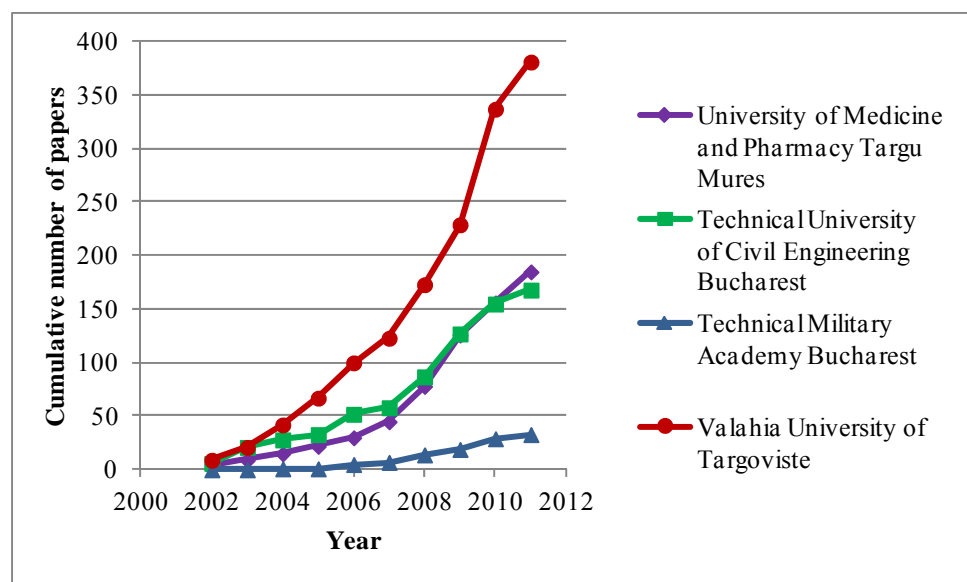
Valahia University of Targoviste ranks 18 among the 49 universities in the AdAstra classification of universities with research activity in our country during 2002 – 2011 [11]. However, UVT belongs to the group of universities whose main focus is education [12] (see Table 2 and Fig. 1).

Professor PhD Andrei Marga points out the following aspects related to this problem [13-15]: "The criteria used for classification of universities have never been clarified, in advance, and, obviously, they are not the European ones, if we read the documents. They are sooner a mixture of local traditions and interested evaluation, "played by the ear".

Table 2. Number of ISI papers for some universities and their category [11, 12].

Year	University of Medicine and Pharmacy Targu Mures	Technical University of Civil Engineering Bucharest	Technical Military Academy Bucharest	Valahia University of Targoviste
2002	5	6	0	9
2003	4	15	0	12
2004	6	7	1	21
2005	7	5	0	25
2006	8	19	4	33
2007	15	6	2	23
2008	33	29	7	50
2009	48	40	5	56
2010	30	28	10	108
2011	29	13	4	44
TOTAL	185	168	33	381
<i>Category</i>	<i>Universities of education and scientific research</i>			<i>Education focused university</i>

The reference to the European University Association (EUA) is improper, because the association does not deal with classifications. EUA gives advice, evaluates and informs on methodologies, but does not make classifications (hierarchies). Classifications (hierarchies) belong to specialized institutions, such as ENQA (European Association for Quality Assurance in Higher Education) who, obviously, did not take part in this ranking”.

**Fig. 1. Dependence of cumulative number of papers on time for different universities.**

On June 19th 2012, Liviu Pop, the ad-interim Minister of Education, filed a petition under Penal Code against the way in which the classification of universities had been made: “The classification was made by the Minister’s order but it was not performed in compliance with the Law of Education” [15b].

The number of papers published by the above mentioned universities between 2002-2011 results in a productivity that is shown in Table 3.

Table 3. Scientific productivity of the above-mentioned universities.

University	Scientific productivity (papers/year)
Valahia University of Targoviste	42.3
University of Medicine and Pharmacy Targu Mures	20.5
Technical University of Civil Engineering Bucharest	18.6
Technical Military Academy Bucharest	3.6

We can notice that the scientific productivity expressed by the number of papers published in a given time span is not correlated with the scientific research which is attributed to the institution. In the case of UVT, most of the papers were published in academic journal whose Hirsch indices and influence scores are listed in Table 4. The value of the indices point to the scientific status of the journals and the papers published in them. This standing has triggered a significant number of citations for the published papers that resulted in the Hirsch indices presented in Table 5. On the other hand, the Hirsch-index exhibited a high correlation with the journal influence score as can be seen in Fig. 2.

Table 4. The Hirsch indices of the journals in which most of the UVT Chemistry Group papers were published.

Item no.	Journal	Hirsch index	Influence score	Country
1	Polymer	133	3.19878	Netherlands
2	Polymer Degradation and Stability	65	2.03670	Netherlands
3	Polymer International	54	1.79817	United States
4	Macromolecular Materials and Engineering	43	1.69419	United Kingdom
5	Polymer Testing	42	1.66972	Netherlands
6	Polymer Bulletin	39	1.00000	Germany
7	Journal of Macromol. Sci. Pure and Appl. Chem.	30	0.55352	United States
8	E-Polymers	6	0.57798	France
corr. coef. = 0.94				
9	Carbon	118	2.93374	Netherlands
10	Materials Chemistry and Physics	66	1.28848	Switzerland
11	Radiation Measurements	51	1.17274	Netherlands
12	Radiation Physics and Chemistry	43	1.03011	Netherlands
13	Journal of Optoelectronics and Advanced Materials	23	0.33626	Romania
14	Revista de Chimie	12	0.09274	Romania
corr. coef. = 0.99				

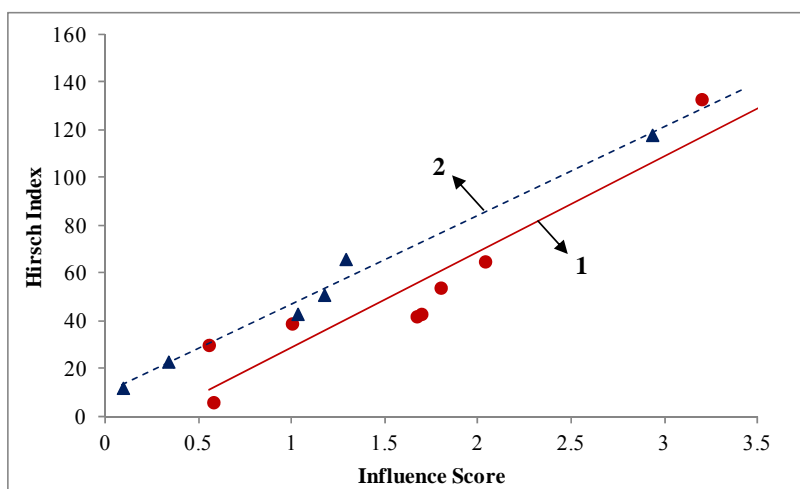
**Fig. 2. The relationship between the journal influence scores and the Hirsch indices: (1) polymer topics; (2) general topics.**

Table 5. The scientometric indicators for the UVT Chemistry Group members (database: ISI Web of Knowledge).

Code	Total number of papers	Total number of citations	Average citations per year	Hirsch-index
P1	168	727	21.38	12
P2	101	558	19.93	12
P3	55	354	18.63	10
C1	56	161	14.64	7
C2	66	91	3.33	6
C3	40	66	1.50	6

These data show that an index of 6-12 is honorable at the European level and good at a national level [16]. The Hirsch index can be used for a lot of applications, such as the ranking of countries according to their scientific output [17, 18], classification of universities [20, 21], of scientific research institutes [22-24], development of some research areas [25-27], developed of medicine [24, 28, 29], the performance of some specialists [30, 31], ranking of academic journals [32] and so on. Table 6 shows the first ranks in the classification of countries by their scientific output while Table 7 presents a similar classification for ex-communist countries.

Table 6. Country ranking by scientific output (2011) [17].

Item no.	Country	Hirsch-index
1	United States of America	1139
2	United Kingdom	689
3	Germany	607
4	France	554
5	Canada	536

Table 7. Ex-communist country ranking by scientific output in 2008 [18].

Item no.	Country	Hirsch-index	Item no.	Country	Hirsch-index
1	Russian Federation	285	6	Slovenia	127
2	Poland	258	7	Bulgaria	121
3	Hungary	224	8	Ukraine	121
4	Czech Republic	206	9	Croatia	118
5	Slovakia	131	10	Romania	117

According to International Journal of Scientometrics, Informetrics and Bibliometrics, there is, at present, a total number of 17,036 universities in the world [19]. Tables 8 and 9 show the ranking of Anglo-American universities [20] respectively Indian ones [21] according to the Hirsch index.

Table 8. Ranking of Anglo-American universities (2006) by the Hirsch index [20].

Item no.	University	Hirsch-index
1	Harvard University	140
2	Massachusetts Institute of Technology	127
3	Princeton University	117
4	University of California – Berkeley	116
5	University of Cambridge	115

Table 9. Ranking of Indian universities (1999 - 2008) by the Hirsch index [21].

Item no.	University	Hirsch-index
1	University of HYDERABAD	49
2	University of DELHI	45
3	PANJAB University	44
4	JADAVPUR University	43
5	BANARAS HINDU University	42

In a ranking based on the Hirsch index, Romania has only 5 scientific research institutes whose h-index is in two digits, although this indicator can be also in three digits [22]. In accordance with the data supplied by the Institute of Scientific Information and Thomson-Reuters, Table 10 shows the top scientific research institutes in Romania [23].

Table 10. The top scientific research institutes in Romania [23].

Item no.	Name of Institute	Hirsch-index
1	“Victor Babeş” National Institute, Bucharest	13
2	“I. G. Murgulescu” Institute of Physical Chemistry, Bucharest	13
3	“Fundeni” Clinical Institute, Bucharest	11
4	The Institute of Oncology “Prof. dr. Ion Chiricuță” Cluj Napoca	11
5	The Institute of Biochemistry of Romanian Academy	10

Table 11 shows the most prolific Indian medical research institutes (1999-2008) from a publishing perspective using the Hirsch index [24].

Table 11. Top scientific medical research institutes in India (1999-2008) [24].

Item no.	Name of Institute	Hirsch-index
1	Centre of Celular and Molecular Biology, Hyderabad	27
2	Indian Institute of Science, Bangalore	25
3	National Institute of Cholera and Enteric Diseases, Kolkata	25
4	Tuberculosis Research Centre, Chennai	24
5	Indian Institute of Chemical Biology, Kolkata	23

Considering the science profile of our faculty, it would be useful to present the top rankings in the fields of mathematics, physics and chemistry that were made by using the Hirsch indices. Tables 12-14 show these data [25-27].

Table 12. Academic top authors in Mathematics [25].

Item no.	Name	Affiliation	Field	Hirsch index
1	Pierre-Louis Lions	Paris Dauphine University	math. analysis, geometry a.s.o.	47
2	Michael Atiyah	University of Edinburgh	math. analysis, geometry, algebra	45
3	Gene H. Golub	Stanford University	math. analysis, scientific computing	44
4	Barry Simon	California Institute of Technology	math. analysis	43
5	Louis Nirenberg	New York University	math. analysis, algebra	41

Table 13. Top Physicists according to the Hirsch index [26].

Item no.	Name	Affiliation	Hirsch index
1	Edward Witten	Princeton Institute for Advanced Study	110
2	Marvin Cohen	University of California Berkeley	94
3	Philip Anderson	Princeton University (Nobel Prize Laureate)	91
4	Manuel Cordona	Max Plank Institute	86
5	Pierre-Gilles de Gennes	ESPCI Paris (Nobel Prize Laureate)	79

Table 14. Top Chemists according to the Hirsch index [27].

Item no.	Name	Field	Hirsch index
1	Whitesides, G. M.	Organic Chemistry	169
2	Karplus, M.	Theoretical Chemistry	144
3	Corey, E. J. (Nobel Prize Laureate)	Organic Chemistry	140
4	Heeger, A. J. (Nobel Prize Laureate)	Organic Chemistry	134
5	Grätzel, M.	Physical Chemistry	128

The Hirsch index is also used to evaluate the medical field, for instance: the evaluation of some countries' medical development (Table 15), hospital ranking (Table 16), classification of domains (Table 17), college ranking (Table 18), ranking of foundations (Table 19) and so on.

Table 15. Top countries with advanced medicine according to the Hirsch index (1996-2008) [28].

Item no.	Country	Hirsch-index
1	United States of America	686
2	United Kingdom	436
3	Canada	375
4	Germany	364
5	France	356
56	Romania	51

Table 16. Top European Hospitals (2002 – 2006) by the Hirsch index [29].

Item no.	Name of Hospital	Country	Hirsch index	Item no.	Name of Hospital	Country	Hirsch index
1	Imperial	UK	106	6	Helsinki	Finland	87
2	UCL	UK	102	7	Cambridge	UK	85
3	Oxford	UK	95	8	King College	UK	84
4	Karolinska	Sweden	93	9	Paris VI	France	83
5	Charite (Freie-Humboldt)	Germany	87	10	Louvain	Belgium	82

Table 17. Ranking of some Indian medical units according to the Hirsch indices obtained for each pathology [24].

Item no.	Pathology	Hirsch index	Item no.	Pathology	Hirsch index
1	Cardio-vascular disease	60	6	AIDS	39
2	Diabetes	57	7	Hepatitis	36
3	Cancer	56	8	Malaria	33
4	Tuberculosis	47	9	Pneumonia	28
5	Diarrheal disease	41	10	Respiratory infection	27

Table 18. Ranking of Indian Medical Colleges using the Hirsch index (1999-2008) [24].

Item no.	Medical College	Hirsch-index
1	All India Institute of Medical Sciences, New Delhi	52
2	Postgraduate Institute of Medical Education and Research, Chandigarh	51
3	Christian Medical College, Vellore	34
4	Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow	34
5	Maulana Azad Medical College, Delhi	20

Table 19. Ranking of Indian Medical Foundations using the Hirsch index (1999-2008) [24].

Item no.	Foundation	Hirsch-index
1	Madras Diabetes Research Foundation, Chennai	25
2	Vision Research Foundation, Chennai	18
3	Medical Research Foundation, Chennai	18
4	Schizophrenia Research Foundation, Chennai	13
5	Aravind Medical Research Foundation Tamil Nadu	11

The Hirsch index is also used to evaluate the scientific performance of certain specialists. Table 20 shows the selection of specialists from the field of Computer Sciences [30].

Table 20. Specialists in the field of Computer Sciences [30].

Item no.	Name	Affiliation	Hirsch index
1	Herbert A. Simon (Nobel Prize Laureate)	Carnegie Mellon University	135
2	Anil K. Jain	Michigan State University	129
3	Terrence Joseph Sejnowski	University of California, San Diego	114
4	Scott Shenker	University of Berkeley	107
5	Ian Foster	University of Chicago	102

In addition, the Hirsch index can be also used for the inter-comparison of some very well-known scientists as shown in Table 21.

Table 21. The Hirsch index for some scientists [31].

Item no.	Name	Presentation	Hirsch index
1	Albert Einstein	Author of the Theory of Relativity. Nobel Prize. Over 300 papers.	92
2	Paul Erdos	Prolific mathematician: combinatorics, graph theory a.s.o.	76
3	Claude Elwood Shannon	Mathematician and electronic engineer. Father of Information Theory.	44
4	Jorge Hirsch	Professor at the University of San Diego, California	31

Evaluation of academic journals represents another application of the Hirsch index. In table 22 we illustrate this use by example of the most prestigious journals.

Table 22. Scientific journal rankings [31].

Item no.	Journal	Country	Hirsch index
1	Nature	UK	698
2	Science	USA	678
3	Chemical Reviews	USA	356
4	Journal of Biological Chemistry	USA	350
5	Physical Review Letters	USA	349

A large number of examples show the use of the Hirsch index in the area of humanities and social sciences [33-37]. Therefore, this index turns out to be of a wide applicability, thus contradicting some fantasizing explanations in this respect.

In a society that is constantly trying to accommodate itself to the global requirements, the academic community should be the first to comply with those high standards. At present, high standards mean both good quality education and researchers who are refined, competitive and with Hirsch values that reflect a substantially qualitative jump. Grigore Moisil stated: "We are expected to perform productive science and scientific production. It would be better if we managed to do scientific science and productive production".

4. CONCLUSIONS

This paper constitutes the authors' plea for the wider acceptance of the Hirsch index as an indicator that characterizes a community's scientific research activity, given the fact that there is still resistance to change.

We have examined the UVT researchers' scientific productivity and found a lack of correlation with the scientific research activity attributed to the institution.

We have exemplified the possibilities of using the Hirsch index to characterize the scientific output of a country, university, scientific research institute, field of research, medicine, specialists, academic journals and so on.

The current paper is part of a cycle of few papers on the evaluation of the UVT Chemistry Group from the perspective of scientific research and corresponding publications.

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