

U-index: An analysis of the data associated to the ranking of Mexican universities with a similar approach to the h-index proposed by Hirsch

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1. Abstract

Inspired on the concepts of the h-index [1], to quantify an individual's scientific research output, the concept of U-index is introduced, as a complementary index to those indexes used in academic university rankings. It is a measure or indicator of performance in Mexican Higher Education Institutes (HEI). The main finding of this work is the fact that when using normalized data to compare the U-index, it changes depending on the criteria used to evaluate Higher Education Institutes. This leads to conclude that the U-index is not a universal parameter and it depends on the criteria used to evaluate the HEI. In this sense, the use of the U-index should be linked to the national education policy in order to have unbiased data to establish HEI rankings in Mexico. This will establish a criterion to promote the continuous improvement efforts in the education sector.

Key words: university rankings, h-index, productivity, undergraduate programs, Hirsch-index.

2. Resumen (Índice U: Un análisis de datos asociados a la clasificación de universidades mexicanas con un enfoque similar al índice h propuesto por Hirsch)

Considerando el índice h [1], para cuantificar los trabajos de la producción científica individual, es introducido el concepto de índice U, como un parámetro complementario a los índices usados en las tablas académicas para la clasificación de universidades, como un indicador de desempeño en las Instituciones de Educación Superior en México. El principal hallazgo de este trabajo es el hecho de usar datos normalizados para comparar el índice U entre Instituciones de Educación Superior; este parámetro cambia dependiendo del criterio usado para evaluar y comparar Instituciones de Educación Superior. Esto permite concluir que el índice U, no es un parámetro universal y depende del criterio usado para evaluar Instituciones de Educación Superior. En este sentido el uso del índice U deberá estar vinculado con la política nacional para la educación superior para establecer una tabla de posicionamiento de Instituciones de Educación Superior y así contar con datos objetivos que permitan promover los esfuerzos de mejora continua en el sector de educación en México.

Palabras clave: tablas de posiciones de universidades, índice h, productividad, undergraduate programas, índice de Hirsch.

3. Introduction

The league tables or rankings about HEIs have increased in the last two decades [2, 3, 4, 5, 6]. This is due to the international character of the higher education, because it is not enough to know the position of the university only in a local context. The concept of "World Class" has been created and many universities are waiting to be considered as "World Class Universities". The league tables are seen as analysis tools, related to the quality of universities. In an early stage, the rankings were seen as commercial mechanisms to help in the process of taking decision about what university select

to study. Nowadays, it seems there is a trend to consider those rankings as analysis tools. In fact, they are considered as an input of strategic planning in universities.

Definitively, the results of league tables have become an interesting factor for education policies, because they are feedback about the effectivity of educations systems [7]. In this sense is relevant to present new methods that allow compare institutions in unbiased way. This paper introduces the U-Index in the evaluation of performance of the universities. This parameter is practical and it is easy to calculate. Besides, it is a complement to those used in the existing ranking tables.

4. Development

4.1. Hirsch index

The h-index, also known as the Hirsch index, was introduced by Hirsh [1] as an indicator of lifetime achievement of a scientist. A list of publications of a scientist is considered. It is ranked according to the number of citations received. Accordingly, the h-index is defined as the highest rank, such that the first h publications received at least h citations. The h-index is not only useful for lifetime achievements, but also in the context of many -but not all- other source-item relationships [8, 9]. Consequently, the Hirsch index has been used for journals, citation topics, and library loans per category [10]. Considering this approach the U-Index is introduced in this paper. It is applied in the analysis of the classification of HEIs published in a Mexican newspaper in 2008.

4.2. *El Universal*: The Best Universities in Mexico

The Mexican newspaper *El Universal* published the guide named "The Best Universities" (*las mejores universidades*) [11]. This newspaper conducted this publication. It reports to society, Higher Education Institutes, students and parents useful, timely and objective information, which is related to the education offer on undergraduates programs in Mexico.

The Guide includes two ranking tables, independent one to each other. The first has the objective to analyze the Higher Education Institutes and the second one evaluates the involved programs.

The list of Higher Education Institutes (HEI) could change due to the fact that participation is voluntary. It is possible that some institutions that decide to participate this year, probably decide not to do so next time.

The study is performed based on data published on 2008 [11]. In this publication, 24 programs were evaluated:

Table 1. General Ranking (*El Universal* Marzo 2008, [11])

1	Universidad Nacional Autónoma de México (UNAM)	10.00
2	ITAM	9.48
3	Universidad Autónoma Metropolitana (UAM)	9.43
4	Universidad de las Américas (UDLA), Puebla	9.14
5	Instituto Tecnológico de Estudios Superiores de Monterrey (ITESM), Cd. de México y Sta. Fe	9.13
6	Universidad Anáhuac	9.06
7	ITESM, Edo. de México y Toluca	9.06
8	Universidad Autónoma de Nuevo León (UANL)	9.03
9	Universidad de Guadalajara (UG)	9.02
10	Universidad Autónoma del Estado de Morelos (UAEM)	8.92
11	ITESM, Guadalajara	8.91
12	Universidad Iberoamericana, Cd. de México	8.89
13	Instituto Politécnico Nacional	8.86
14	Universidad Nacional del Estado de México (UAEM)	8.78
15	Universidad Panamericana, Distrito Federal	8.78
16	Universidad Popular Autónoma del Estado de Puebla	8.58
17	Universidad La Salle	8.42
18	Universidad del Valle de México	8.38
19	Universidad Madero	8.36
20	Benemérita Universidad Autónoma de Puebla	8.35

Actuary, Business Administration, Architecture, Biology, Communication Science, Accounting, Law, Graphical Design, Economy, Philosophy, History, Civil Engineering, Electronic Engineering, Systems Engineering, Industrial Engineering, Mecatronics, Chemical Engineering, Mathematics, Medicine, Odontology, Pedagogy, Psychology and International Relations. Table 1 shows the results of the ranking published by the newspaper in the 2008.

Consideration to the analysis of data. In some cases, the results are classified by campus, then an average value is reported in order to have a general perspective of the HEI evaluated. In those cases, where just one program is evaluated, this data is not consider as a part of the analysis, as the h-index could not be calculated with a single value.

Computing U-index

Based on the concept the h-index [2] to compare scientific production, the U-index is introduced; it is computed practically in the same way followed as in the case of h-index. However, the difference is found in the fact that U-index is estimated with normalized data. In order to complete this analysis two yardsticks are used to compare data. These criteria are described in the following sections.

Criteria 1 - U-index (U-C1)

The analysis is based on the data reported in the newspaper *El Universal* (*The Best Universities-Mejores Universidades*

2008). For each HEI_{j-th} a ranking table is developed. Firstly, for each HEI_{j-th} the corresponding rating scores P_i obtained from [6] are recorded. They are classified in a decreasing format. A consecutive number C_p is assigned to each program, i.e. the best evaluated program has number 1 and so on. The normalized data sheet is constructed using the normalized score of the program NP_p defined as:

$$NP_i = \frac{P_i}{10}$$

where $i = 1,2,3,\dots,n$

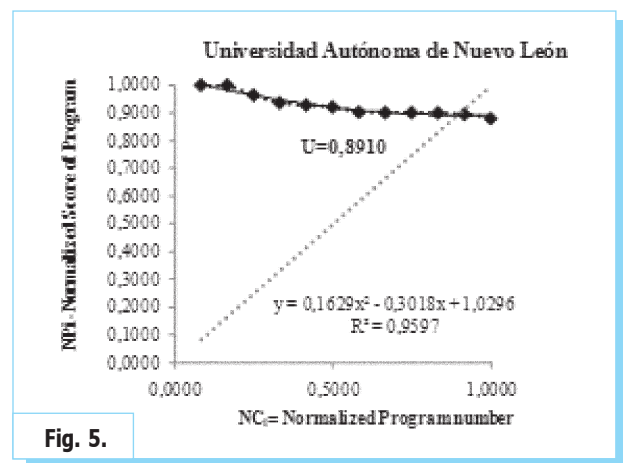
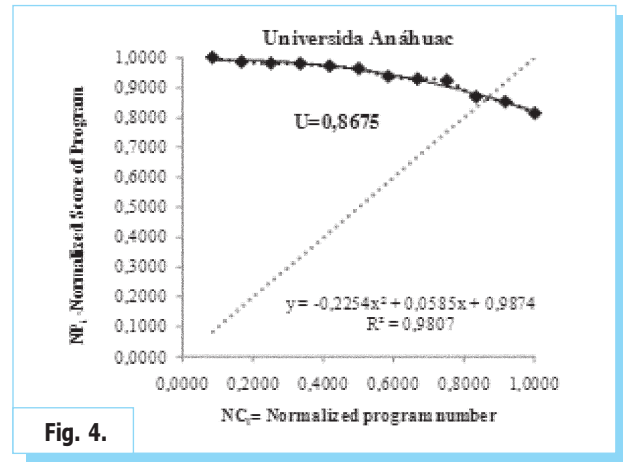
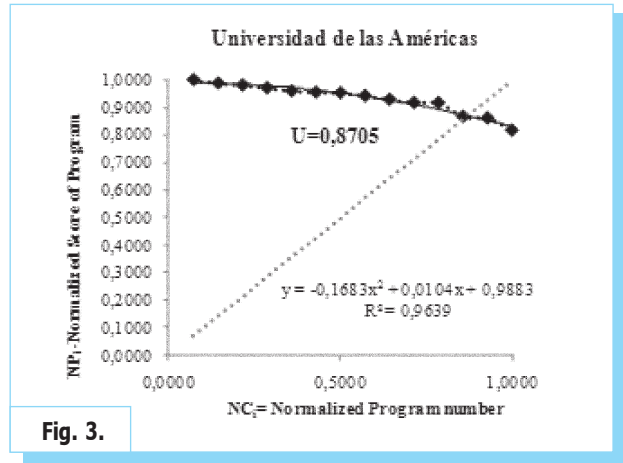
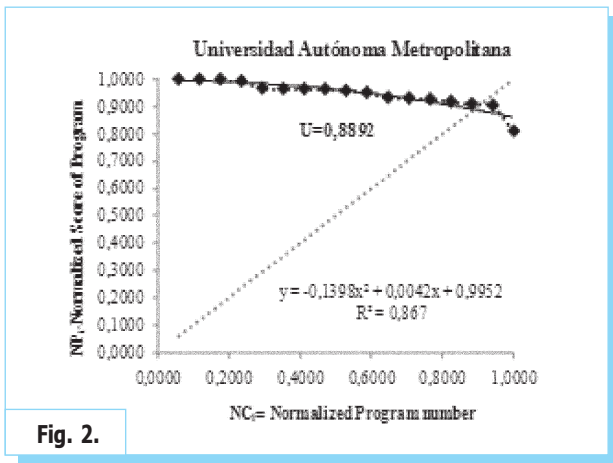
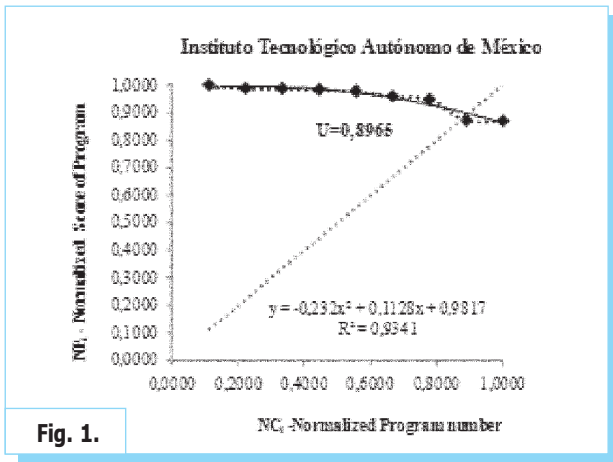
and the normalized program-numbers NC_p are defined as

$$NC_i = \frac{C_i}{n}$$

where $i = 1,2,3,\dots,n$

and n is the total number of the programs.

A schematic curve is constructed considering that NP_p is a function of NC_i . To calculate U-index, the best fit is selected and the intersection point between the curve and the line $y=x$ gives the value U-index. Figures 1 to 17 show the computing method used for each of the HEI's analyzed in this paper.



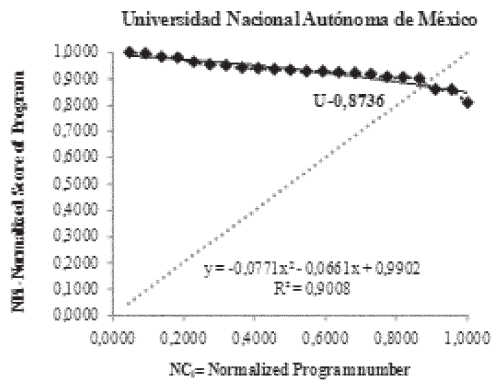


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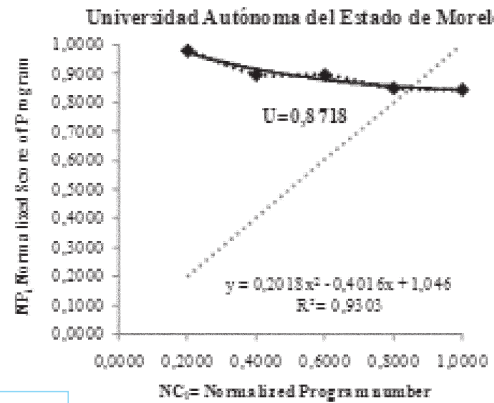


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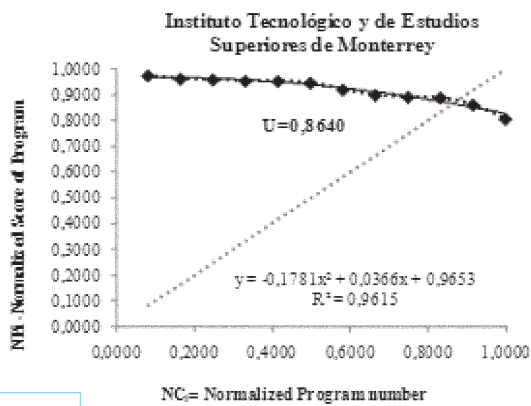


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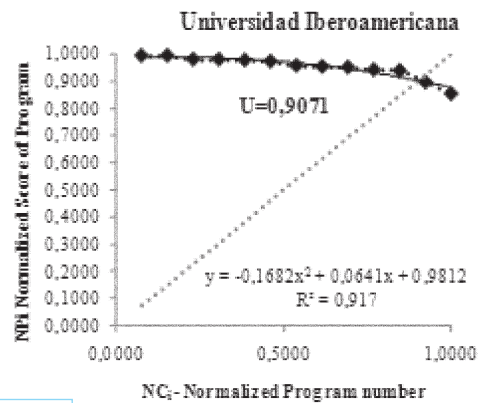


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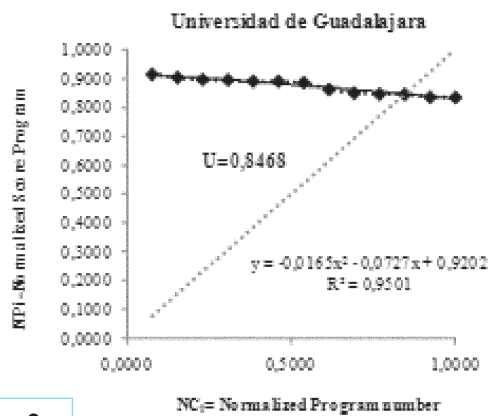


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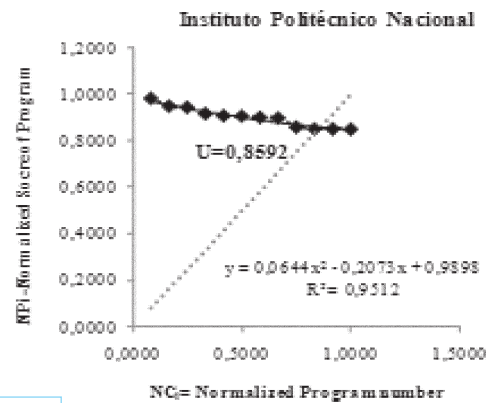


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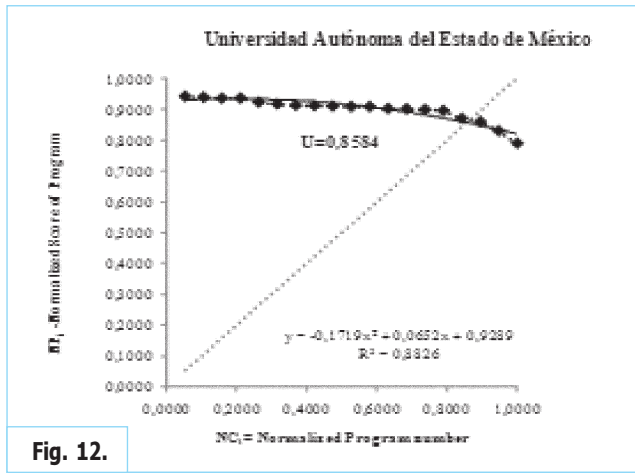


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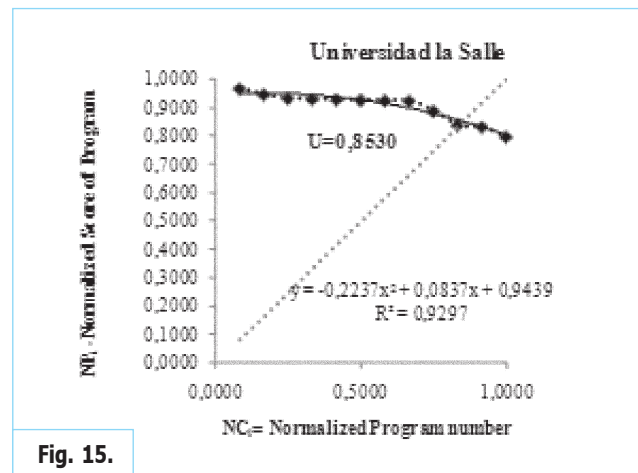


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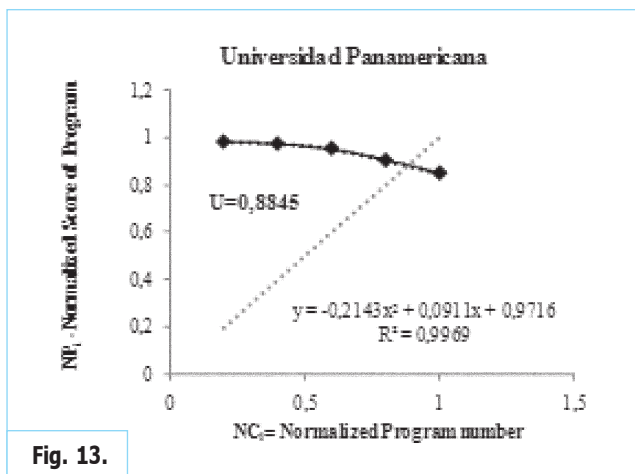


Fig. 13.

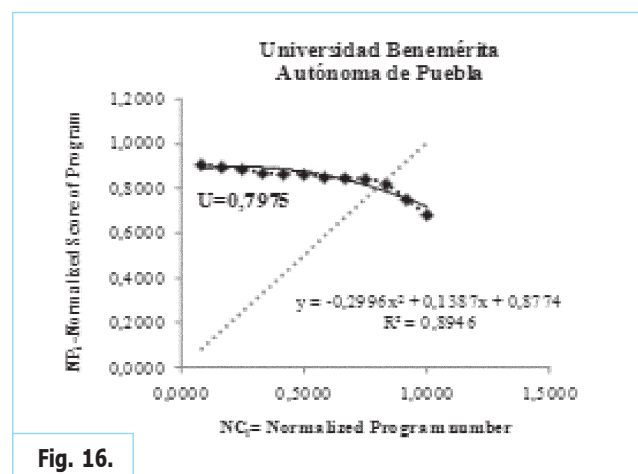


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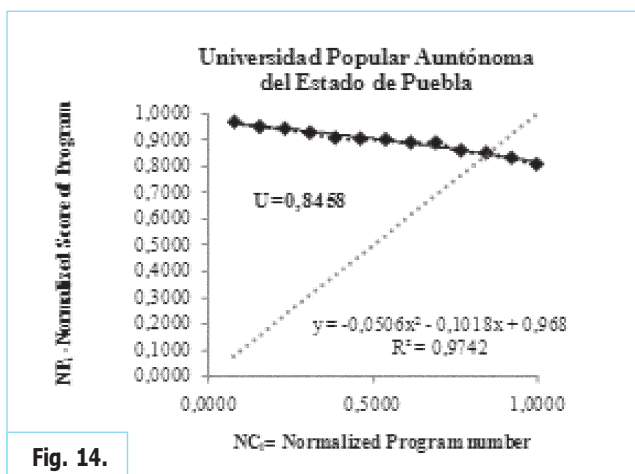


Fig. 14.

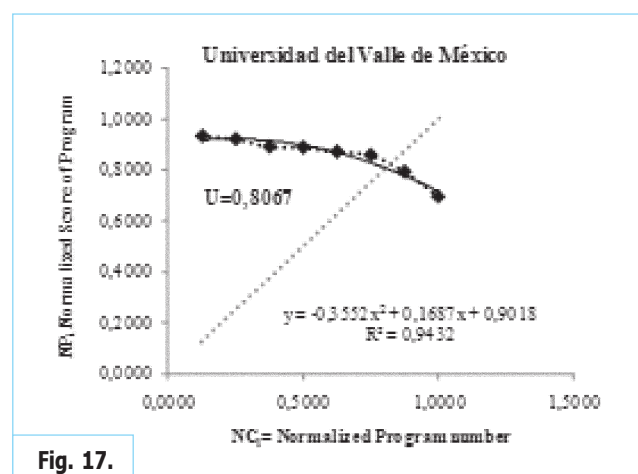


Fig. 17.

Table 2. Comparative analysis of ranking tables (C1-criteria).

HEI (criterion 1)	C1-U-index	Table Rank
Universidad Iberoamericana, Cd. de México	(1) 0.9071	8.89 (10)
Instituto Tecnológico Autónomo de México (ITAM)	(2) 0.8965	9.48 (2)
Universidad Autónoma de Nuevo León (UANL)	(3) 0.8910	9.03 (7)
Universidad Autónoma Metropolitana (UAM)	(4) 0.8892	9.43 (3)
Universidad Panamericana, Distrito Federal	(5) 0.8845	8.78 (13)
Universidad Nacional Autónoma de México (UNAM)	(6) 0.8736	10.00 (1)
Universidad Autónoma del Estado de Morelos (UAEM)	(7) 0.8718	8.92 (9)
Universidad de las Américas (UDLA), Puebla	(8) 0.8705	9.14 (4)
Universidad Anáhuac	(9) 0.8675	9.06 (5)
Instituto Tecnológico de Estudios Superiores de Monterrey	(10) 0.8640	9.06 (6)
Instituto Politécnico Nacional	(11) 0.8592	8.86 (11)
Universidad Nacional del Estado de México (UAEM)	(12) 0.8584	8.78 (12)
Universidad La Salle	(13) 0.8530	8.42 (15)
Universidad de Guadalajara (UG)	(14) 0.8468	9.02 (8)
Universidad Popular Autónoma del Estado de Puebla	(15) 0.8458	8.58 (14)
Universidad del Valle de México	(16) 0.8067	8.42 (16)
Benemérita Universidad Autónoma de Puebla	(17) 0.7975	8.35 (17)

Table 2, shows the ranking table obtained using U-index for HEIs. Note that the positions of a HEI change compared to the rank table of [5].

Criteria 2 - U-index (U-C2)

The U-index C2 is constructed using the same methodology as for the criterion 1, the only difference is the way that the normalized data are considered.

The analysis is based on the data reported in the newspaper *El Universal* [11].

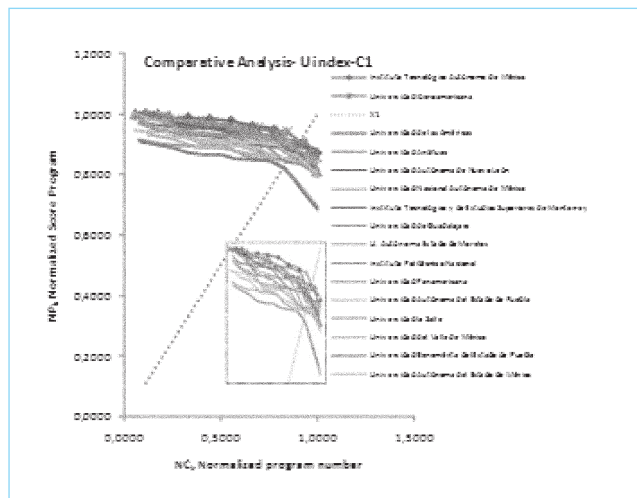


Fig. 18. Comparative Analysis U-index (C1).

For each program, a HEI_{j-th} ranking table is developed. Initially, for each HEI_{j-th} the corresponding rating scores P_i obtained from [5] are recorded. They are classified in a decreasing format. A consecutive number C_i is assigned to each HEI. The best evaluated university in this program has number 1 and so on.

The normalized data sheet is constructed using the normalized score university-program NU_j defined as:

$$NU_j = \frac{U_j}{\text{Max}_{1 \leq j \leq m} [U_j]}$$

where

$j = 1, 2, 3, \dots, m$ (m is the total number of HEI).

A new rank table is constructed and the NU_j values are ordering in a decreasing format.

To each program is assigned a consecutive number C_i which represents a consecutive number, i.e. the best evaluated program has number 1 and so on.

$$NC_i = \frac{C_i}{n}$$

n is the total number of the programs

The U-index is calculated in the same way as the h-index. A schematic curve is constructed considering that NU_j is a function of NC_i . To calculate U-index, the best fit is selected and the intersection point between the curve and the line $y=x$ gives the value U-index. Figures 19 to 34 show the computing method used for each of the HEIs analyzed in this paper.

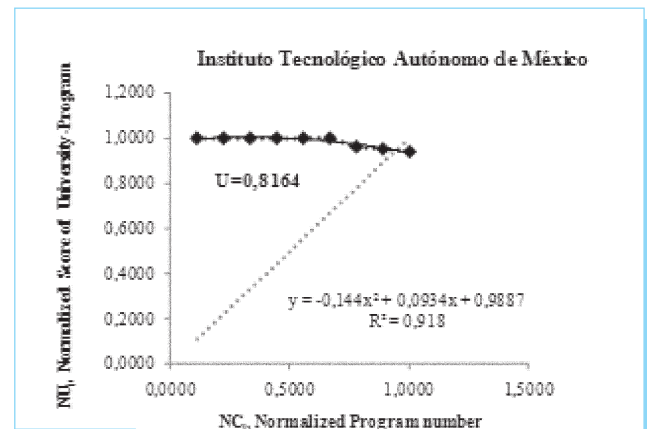


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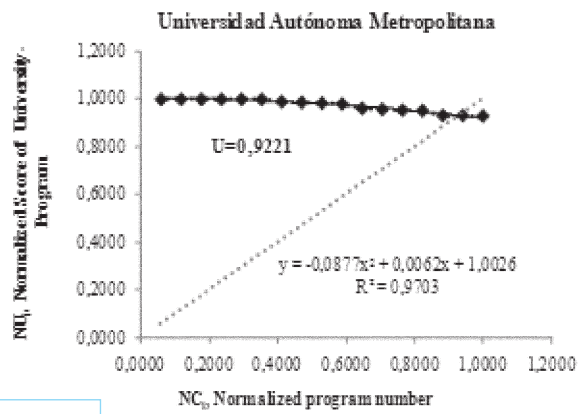


Fig. 20.

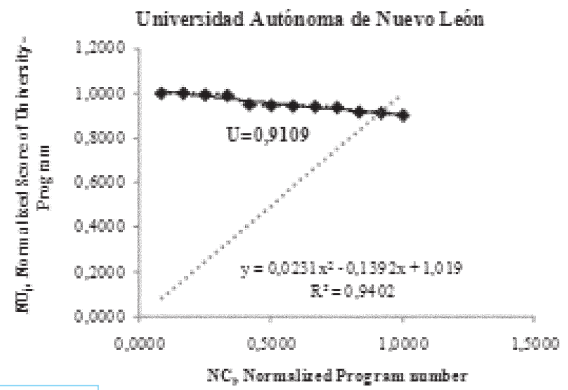


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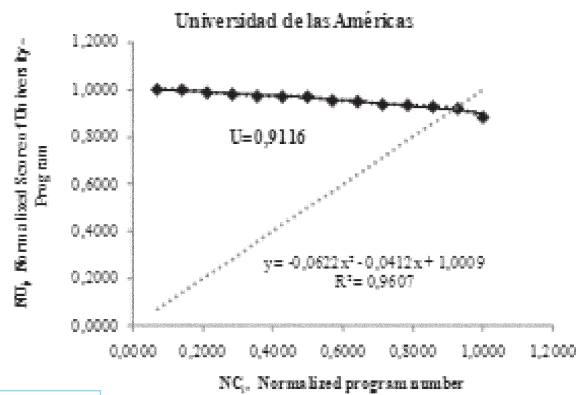


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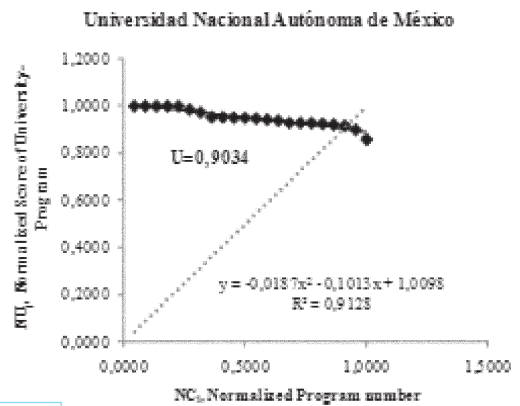


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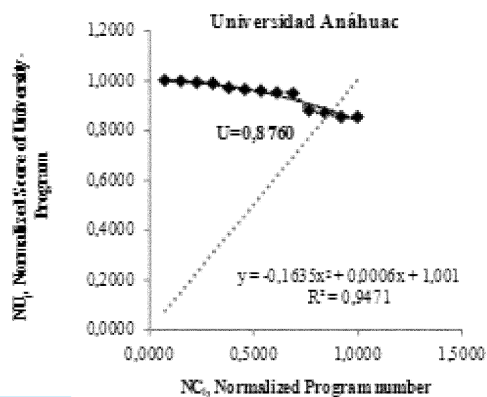


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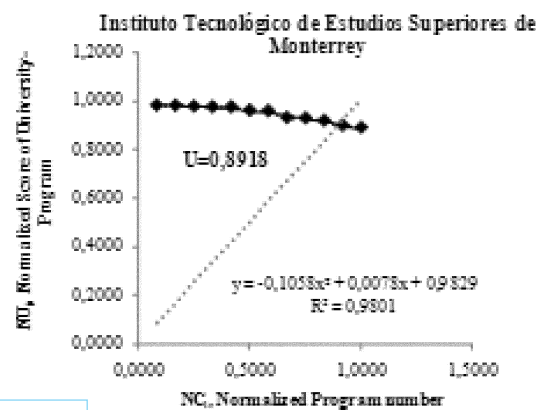


Fig. 25.

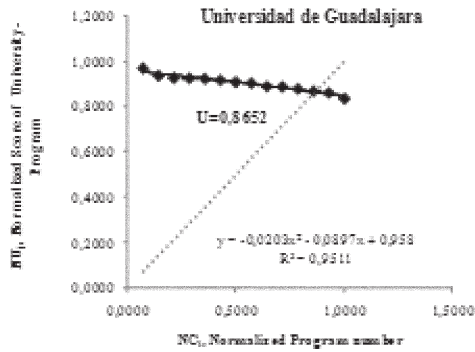


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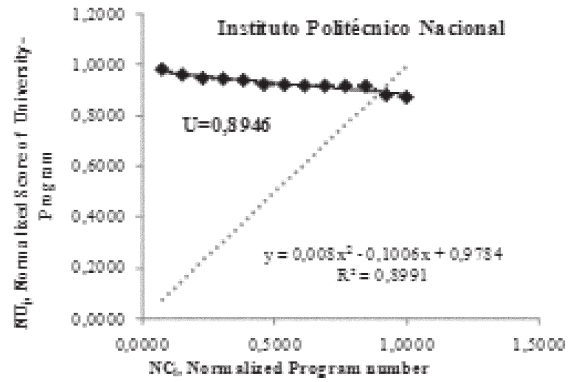


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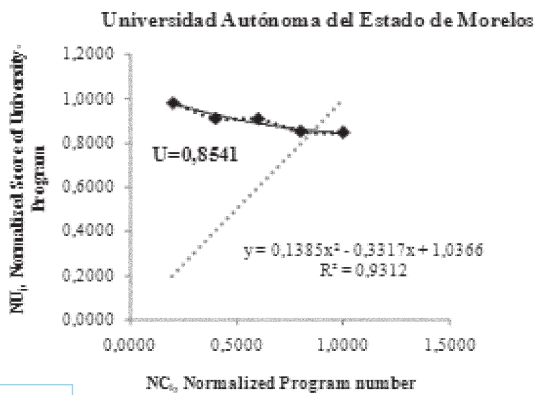


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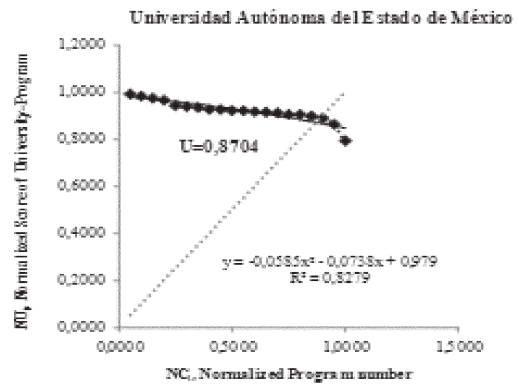


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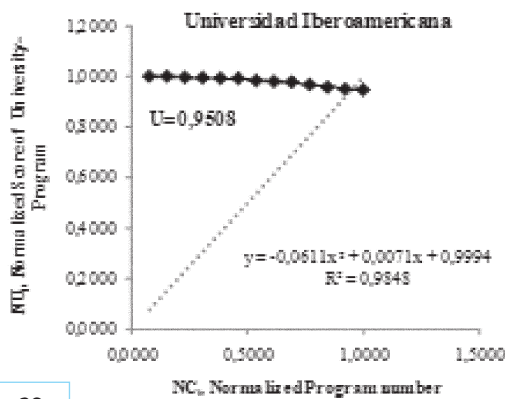


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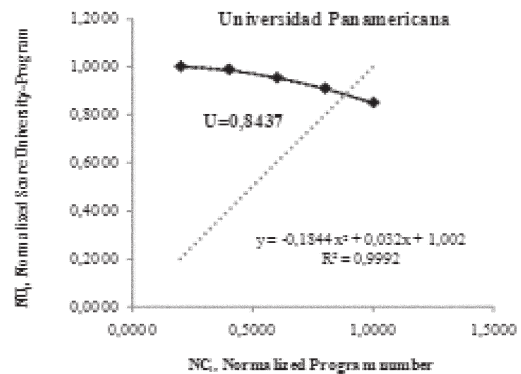


Fig. 31.

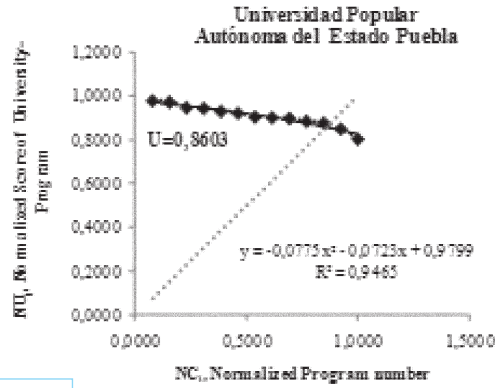


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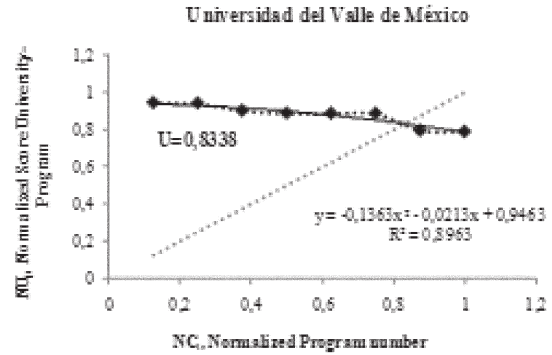


Fig. 35.

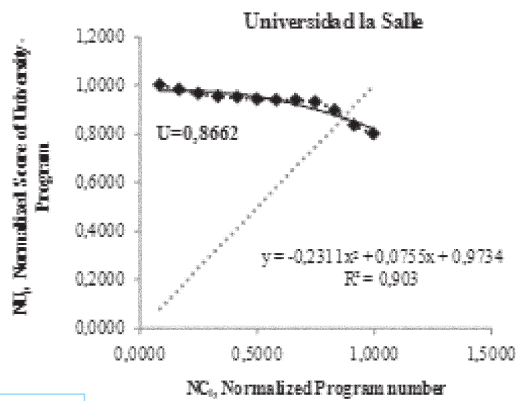


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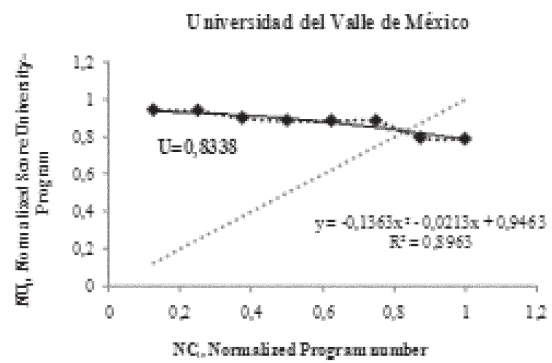


Fig. 36. Comparative Analysis U-index (C2).

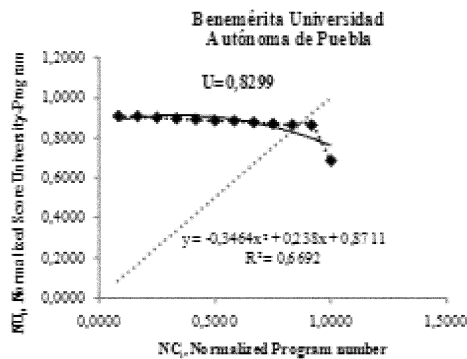


Fig. 34.

Table 3 shows the ranking table obtained using U-index for the HEIs evaluated. Note that the classification changes when it is compared with the rank table of the criteria (C1).

5. Conclusions

This paper presents an introduction of the U-index [13] for the university ranking based on the approach of the h-index [1]. The main result of this work is the fact that using normalized data to compare HEIs the ranks of the HEI change depending on the criteria used. In this sense, the U-index is sensitive to the criteria used. The U-index, is not a universal parameter. In this sense the use of the U-index should be linked to the national

Table 3. Comparative analysis of ranking tables (C2-criteria).

HEI (criterion 2)	C1-U-index	C1-U-index	Table Rank
Universidad Iberoamericana	(1) 0.9071	(1) 0.9071	8.89 (10)
UAM	(2) 0.8965	(2) 0.8965	9.48 (2)
UDLA	(3) 0.8910	(3) 0.8910	9.03 (7)
UANL	(4) 0.8892	(4) 0.8892	9.43 (3)
UNAM	(5) 0.8845	(5) 0.8845	8.78 (13)
IPN	(6) 0.8736	(6) 0.8736	10.00 (1)
ITESM	(7) 0.8718	(7) 0.8718	8.92 (9)
Universidad Anáhuac	(8) 0.8705	(8) 0.8705	9.14 (4)
UAEMéxico	(9) 0.8675	(9) 0.8675	9.06 (5)
Universidad La Salle	(10) 0.8640	(10) 0.8640	9.06 (6)
UG	(11) 0.8592	(11) 0.8592	8.86 (11)
UPAEP	(12) 0.8584	(12) 0.8584	8.78 (12)
UAEMorelos	(13) 0.8530	(13) 0.8530	8.42 (15)
Universidad Panamericana	(14) 0.8468	(14) 0.8468	9.02 (8)
Universidad del Valle	(15) 0.8458	(15) 0.8458	8.58 (14)
BUAP	(16) 0.8067	(16) 0.8067	8.42 (16)
ITAM	(17) 0.7975	(17) 0.7975	8.35 (17)

education policy in order to have unbiased data. The position of a university in a ranking can vary in accordance with the evaluation criterion, and the position could change if some parameters are modified [12].

Only two criterion are used, in a first stage the parameter is based in the highest score by program and in the second stage the parameter is based in the highest score by HEI in both cases the same source of data is used, due this it could be of interest for future research to consider other normalization methods such as $NP_i = (P_{max} - P_i) / (P_{max} - P_{min})$ where P_{max} and P_{min} are the maximum and minimum scores for each institution to compare results.

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5th International Conference on Advanced Computational Engineering and Experimenting

Abstract Submission Deadline:
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AREAS:

- Material modelling and constitutive relationships
- Homogenisation and localisation
- Plasticity
- Impact and crash
- Damage and fracture
- Transport phenomena
- Fluid-structure interaction
- Nanomechanics
- Dynamics
- Biomechanics

3, 4, 5 & 6 July 2011, Algarve, Portugal.

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