THE CLASSIFICATION OF ROMANIAN HIGH-SCHOOLS

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Abstract: *The article tries to tackle the issue of high-schools classification from one city, district or from Romania. The classification criteria are presented. The National Database of Education is also presented and the application of criteria is illustrated. An algorithm for high-school multi-rang classification is proposed in order to build classes of high-schools performance.*

Key words: *classification criteria, NDBE, high-schools performance.*

1. High-school classification

Let us consider the multitude of high-schools from Romania, $L=\{L_1, L_2, ..., L_n\}$. According to the statistics, at this moment, there is a number of 1,397 schools, where 770,192 pupils are learning and 76,071 teachers are teaching[4].

High-schools are different, one from another, by a series of quantitative elements, such as:

- high-school age;
- number of pupils whom attend those high-schools;
- the pupils' profile at entrance;
- number of laboratories from every high-school;
- teachers' number.

Also, some differences are given by the qualitative elements, like:

- the quality of the learning process;
- the quality of pupil, meaning the marks obtained at the admission tests;

• the quality and the experience of the teachers;
• the number of graduating pupils, whom pass the admission tests for colleges;
• the number of pupils whom are participating and are obtaining awards to the Olympics

In order to set hierarchy, it is necessary to set a correspondence between high-school L_i and a number H_i by creating the pair (L_i, H_i), i=1, 2, ..., n. The H_i number is a score determined with an acknowledged procedure, based on data well measured, which contain performance elements, also accepted, due to the comparison of the obtained levels.

Setting high-schools hierarchy means to order the pairs (L_i, H_i), i=1, 2, ..., n, resulting the following sequence of pairs (L_1', H_1'), ...(L_n', H_n') with $H_i' > H_{i+1}'$, i=1,2,....,n-1.

High-schools classification has a dynamic character due to time variation of the elements, which are inflowing in H_1,...., H_n indicators' calculation.

The classification is well defined if for the L multitude elements there is only an inequality like $H_i' > H_{i+1}'$, and not equality $H_i' = H_{i+1}'$.

After creating and publishing the sorted list of high-schools and the calculation procedure of the classification coefficients, the moment of the next classification is presented, usually after 5 years, in order to give enough time for schools to improve their score, and to obtain a better rank and to pass into a superior class.

2. The classification criteria

In order to set the hierarchy, a series of criteria, both quantitative and qualitative is defined. Some of them are objective, others are subjective. The most important criteria, which are used for the multi-rang classification are chosen.

The age criterion takes into consideration the year when the high-school was opened. There will be the oldest school and the newest school from the country, presented in the table 1, which contain a selection of 10 high-schools, ranked by age, without being the oldest schools from country:

Table 1. A list of schools in oldness order, extracted from a sample

Nr. Crt.	High-school name	Locality	Establishing year
1.	National College	Timişoara	1773
2.	National College Iaşi	Iaşi	1828
3.	High-School „Ecaterina Teodoroiu"	Târgu-Jiu	1855
4.	National College „Gh Lazăr"	Bucureşti	1860
5.	National College „IL Caragiale"	Ploieşti	1864
6.	National College „Mihai Viteazu"	Ploieşti	1874
7.	National College „Traian"	D-Turnu Severin	1883
8.	National College „Tudor Vladimirescu"	Târgu-Jiu	1890
9.	National College „Emil Racoviţă"	Iaşi	1964
10.	National College of Informatics	Piatra-Neamţ	1968

After defining a template that includes the presentation elements for schools age, the list extends in order to include all the 1,397 high-schools, thus the classification becomes

complete. For high-schools created in the same year, the difference is given by the number of pupils.

The age criterion does not change the order, but has an important weight in the aggregate classification using multiple criteria of performance.

The criteria regarding the number of pupils that attend a school demonstrate the capacity of schools housing during the years of studies, and the capacity to attract pupils.

Based on this criterion the table 2 is built, which contains the top ten high-schools classified by the number of pupils, which pass the admission tests:

Table 2. The top ten school by the number of pupils

No.	High-school name	Locality	Number of pupils
1	Scholar-Group Industrial "DIMITRIE GUSTI"	București Sectorul 5	3405
2	Bilingual High-School "DECEBAL"	Bucuresti Sectorul 3	2361
3	Technical College for Telecommunication "GHE. AIRINEI"	Bucuresti Sectorul 6	2142
4	National College "SPIRU HARET"	Bucuresti Sectorul 2	2000
5	Technical College "ION CREANGA"	Targu Neamt	1836
6	Technical College "M.VITEAZUL"	Oradea	1819
7	Scholar-Group "Astra"	Pitesti	1801
8	Technical College "MIRON NICOLESCU"	Bucuresti Sectorul 4	1774
9	Scholar-Group "DIMITRIE LEONIDA"	Petrosani	1758
10	Scholar-Group Industrial "STEFAN PROCOPIU"	Vaslui	1754

Source: The data are for scholar year 2005-2006

The indicator being dynamic, the schools rank is different from one year to another, due to the variation of pupils graduating school and pupils admitted in the school.

The admission results criterion is very used and shows the degree of knowledge of the future pupils, aspects of the quality regarding the teaching process, teachers, showing the differences between the pupils who passed the high-school admission tests and those who passed the college admission tests.

The top ten schools by the best results criterion are given in table 3, and the list of the same schools using the worst result criterion is given in table 4:

Table 3. The top ten schools by the grade average

Nr. Crt	High-school name	Locality	First grade point average in 2006
1	National College "SFANTUL SAVA"	BUCURESTI	10.00
2	National College of informatics "TUDOR VIANU"	BUCURESTI	9.99
3	National College "UNIREA" FOCSANI	VRANCEA	9.98
4	College "COSTACHE NEGRUZZI"	IASI	9.97
5	National College "MIHAI VITEAZUL"	BUCURESTI	9.96
6	National College "ION LUCA CARAGIALE"	PRAHOVA	9.95
7	National College "O.GOGA" SIBIU	SIBIU	9.94
8	National College "VASILE ALECSANDRI"	GALATI	9.93
9	TEORETICAL HIGH-SCHOOL 'OVIDIUS'	CONSTANTA	9.92
10	National College "EMIL RACOVITA"	CLUJ	9.91

Table 4. The top ten schools based by the least grade average

No.	High-school name	Locality	Last grade point average in 2006
1	National College "SFANTUL SAVA"	BUCURESTI	9.33
2	National College of informatics "TUDOR VIANU"	BUCURESTI	9.5
3	National College "UNIREA" FOCSANI	VRANCEA	9.12
4	College "COSTACHE NEGRUZZI"	IASI	8.94
5	National College "MIHAI VITEAZUL"	BUCURESTI	9.52
6	National College "ION LUCA CARAGIALE"	PRAHOVA	9.14
7	National College "O.GOGA" SIBIU	SIBIU	8.63
8	National College "VASILE ALECSANDRI"	GALATI	9.18
9	TEORETICAL HIGH-SCHOOL 'OVIDIUS'	CONSTANTA	9.39
10	National College "EMIL RACOVITA"	CLUJ	9.04

GPA is also a dynamic indicator, being affected by the pupils results obtained at the admission tests.

Using this criterion, the schools are classified as difficult to access in, which offer a high qualification level, or easy to access in, which offer a lower qualification level, this indicator regarding the way how pupils and parents perceive the school, as a serious, good one or as an ordinary school.

The GPA's for the last three years, the average GPA, the calculated ranks and the average rank for years 2004, 2005 and 2006 are given in table 5, the list of the best schools after the last three years GPA:

Table 5. The list of the best high-schools using the GPA's from 2004, 2005, 2006

No.	High-school name	Locality	2004 GPA	2004 rank	2005 GPA	2005 rank	2006 GPA	2006 rank	Average GPA	Average rank
1	National College "MIHAI VITEAZUL"	BUCURESTI	9.47	2	9.42	1	9.52	1	9.47	1.33
2	National College of Informatics "TUDOR VIANU"	BUCURESTI	9.57	1	9.29	3	9.5	2	9.45	2.00
3	National College "SFANTUL SAVA"	BUCURESTI	9.46	3	9.21	4	9.33	4	9.33	3.67
4	National College "GHEORGHE LAZAR"	BUCURESTI	9.31	8	9.14	5	9.26	5	9.24	6.00
5	Theoretical High-School 'TRAIAN' CONSTANTA	CONSTANTA	9.15	16	8.96	15	9.19	6	9.10	12.33

6	National College "VASILE ALECSANDRI"	GALATI	9.2	15	9.04	9	9.18	7	9.14	10.33
7	National College "UNIREA" FOCSANI	VRANCEA	9.21	13	9	13	9.12	9	9.11	11.67
8	National College of Informatics 'GRIGORE MOISIL' BRASOV	BRASOV	9.32	7	9	12	9.08	12	9.13	10.33
9	National College "GHEORGHE SINCAI"	BUCURESTI	9.24	11	8.94	16	9.07	13	9.08	13.33
10	National College 'ANDREI SAGUNA'	BRASOV	9.2	14	8.98	14	9.05	16	9.08	14.67
11	National College "AL.I.CUZA" FOCSANI	VRANCEA	9.13	20	9.04	8	9.04	17	9.07	15.00
12	National College "B. P. HASDEU"	BUZAU	9.22	12	8.77	24	9.04	18	9.01	18.00
13	National College "EMIL RACOVITA"	CLUJ	9.31	9	9.11	7	9.04	19	9.15	11.67
14	National College "M.KOGALNICEANU" GALATI	GALATI	9.13	18	8.91	19	9.03	20	9.02	19.00
15	Bilingual National College "GEORGE COSBUC"	BUCURESTI	9.02	28	8.81	22	9	21	8.94	23.67
16	National College "CANTEMIR VODA"	BUCURESTI	9.26	10	8.93	17	8.99	22	9.06	16.33
17	College "COSTACHE NEGRUZZI"	IASI	9.13	19	9.04	10	8.94	25	9.04	18.00

The average rank is obtained as an average of 2004, 2005 and 2006 ranks. Using this criterion, schools are sorted ascending, resulting in an hierarchy depending on average GPA from years 2004, 2005 and 2006.

The criterion of number of medals obtained at the Olympics consists of the sum of all medals obtained at national or international Olympics, on different types of medals: gold, silver, bronze for a period of time, for example last five years. In order to

make calculation, each medal has a number of points, like: 93 points for a gold medal, 2 points for a silver medal and 1 point for a bronze medal. The points are given taking in account the exchange quotation for the precious metals and the chemical composition for the bronze.

After the classification is performed, the table 6 is obtained:

Table 6. High-school hierarchy by the medals obtained at the international Olympics:

No.	High-school name	Locality	Number of gold medals	Number of silver medals	Number of bronze medals	Total score
1	National College „Petru Rareş"	Piatra Neamţ	2	-	1	187
2	National College „Traian"	Drobeta Turnu-Severin	2	-	-	186
3	National College „I.L. Caragiale"	Ploieşti	1	2	-	97
4	High-School „Grigore Moisil"	Bucureşti	1	2	-	97
5	High-School „Gheorghe Şincai"	Baia Mare	1	1	-	95
6	National College „Sf. Sava"	Bucureşti	1	-	1	94
7	Theoretical High-School „Gh. Ţiţeica"	Dr. Turnu-Severin	1	-	-	93
8	High-School „Ştefan Obregia"	Dolj	1	-	-	93
9	International High-School of Informatics	Bucureşti	1	-	-	93
10	National College of informatics „T. Vianu"	Bucureşti	-	3	3	9
11	National College „Mihai Viteazu"	Bucureşti	-	2	1	5
12	National College	Iaşi	-	2	-	4
13	High-School „Ady Endre"	Bihor	-	1	-	2
14	National College „Unirea"	Vrancea	-	-	2	2
15	National College „Emil Racoviţă"	Bucureşti	-	-	1	2

The classification was performed using the high-schools reports[5].

Number of academicians' criterion who learned in a high-school, sorts descending the schools. It requires the identification of the academicians list from the establishment of The Romanian Academy till now and the schools they used to attend.

The graduates' criterion who became students in the first five universities from USA.

The graduates' criterion that became students and obtained GPA over 9 at university admission tests.

The criterion of the GPA obtained by the teachers at university graduating and at tests for occupying the vacancy job as a teacher.

These averages are usefully, but their representation is affected by the non-homogenous character of the terms entering in the calculation formula.

The criteria list is very big and an import decision is to extract those criteria which classify the schools in a realistic measure of their value. In order to satisfy this condition we have to take into consideration those criteria which sort schools on a base of valuable information which imply working with pupils and which express best the educative potential for those schools.

3. National Database of Education (NDBE)

For an efficient administration of data used for obtaining the procedures for admission in high-schools, for passing the baccalaureate, for teachers' designation and for the social programs supported by the Ministry of Education and Research, it was necessary to create a large database.

National database of education has become operative in 2006, and the data contained are generated complex analyses regarding the structure of Romanian teaching system and the evolution of pre-university school.

Information contained regards:
* network school: structure, school list, high-schools, etc;
* description of learning units;
* number of classes;
* number of pupils from each class;
* number of teachers;
* fixed assets;

The high-school database admission contains:
* identification data for each pupil;
* transcripts for each pupil, the results at national tests, GPA for V-VIII classes;
* option list;
* the sorting result;

Database for the baccalaureate exam contains:
* identification data;
* marks from IX-XII classes;
* baccalaureate marks;

In order to be included in the classification process, databases content must correspond from the quality point of view.

The character of a large database implies a series of security tasks for data administration. An important operation is database loading. This operation is done automatically, or by human operators. The automatic loading implies the existence of an application which gets data from a source; for example, the system used to record dialogues from digital telephony centrals in a telephone company.

Manual loading, through operators, also supposes an application to be used by the operators, a graphical interface for example.

An important step in loading data is the data validation. For cutting back errors, validation must be well done and using more methods, such as:

- validation regarding data type: numerical, character, data type, Boolean type, etc. This is the primary level of validation; all data should correspond to the associated type in database in order to load the data.
- validation applied to data following templates. For example personal numerical code has a certain format: first digit indicates if that person is a male or a female, and has 1 or 0 value, next six digits indicate date of birth, and the next six are generated using an algorithm. If in database is introduced a personal numerical code, this must be validated according to the steps presented earlier.
- validation in the context of the problem. That means that for example between two data must exist a relation, linear or non-linear, or the absence of a data implies the absence of another data. These validations are called *business* validation.
- validation using control keys, is necessary due to the large volume of data unprocessed

Because NDE influences directly persons whom data are stored into and a series of quality criteria must be respected:

Completeness regards all schools. In each school, completeness means entering all pupils, and for each pupil means entering data in all fields.

Precision of the data means that data introduced in database must reflect reality. What it is written in the primary documents and recognized as being correct by the parts from process, must be introduced in the same exact form in database.

Comparability is secured at national tests and at baccalaureate by unique tests and rigorous define of the criteria used for correcting the tests.

Because there are databases with similar structures, they can be used for different operations in NDE, resulting in a complete image of the pupil from gymnasium and college.

There is build a database containing information about:

- persons' identification;
- GPA for V-VIII classes;
- tests marks;
- GPA for IX-XII classes;
- Baccalaureate GPA.

This way, the premises for the study of how did the pupil prepare college admission and university admission are created.

4. Multi-criteria classification

Using multi-criteria classification, schools are sorted and information obtained is used to define strategies for investments in every school.

The 1397 high-schools are ordered using the number of pupils in scholar year 1005-2006.

The list with schools sorted is obtained using data form NDE.

In the future, when the number of pupils will be recorded in optimal time, there will be calculated the average number of pupils for a period of 5 years.

Using databases containing national tests results is build the high-schools hierarchy based on admittance GPA.

The candidates are filling in a list with 90 options. After the criterion of options, high-schools L_j, $j=1, 2, ..., n$, are ordered using the next indicator:

$$Rang_i = \frac{\sum_{i=1}^{nj} r_{ji}}{n_j} \text{, where:}$$

- n_i is the number of places for IX class in school L_i
- r_{ji} is the option rank with which the pupil entered.

This criterion synthesizes numerical components, such as:

- pupil preference for school performances;
- pupil comprehension that the GPA allows him to occupy a place in the school;
- economical considerations regarding the distance between the home and the school.

Another criterion which takes into account the number of pupils, who wants to sustain tests for high-school admittance, shows the occupation degrees of the vacancy places. The results are given in table 7:

Table 7. Occupation degree of the vacancy places

Nr. crt	High-school name	Vacancy places	Number of pupils	Occupation degree
1	NATIONAL COLLEGE " EMIL RACOVITA"	28	6638	237
2	HIGH-SCHOOL "MIRCEA ELIADE"	84	19362	230
3	TEORETICAL HIGH-SCHOOL "LUCIAN BLAGA"	168	29329	175
4	NATIONAL COLLEGE "AUREL VLAICU"	84	14323	171
5	HIGH-SCHOOL "MARIN PREDA"	168	25438	151
6	TEORETICAL HIGH-SCHOOL "ION BARBU"	140	20169	144
7	TEORETICAL HIGH-SCHOOL "NICOLAE IORGA"	140	19037	136
8	TEORETICAL HIGH-SCHOOL "CONSTANTIN BRANCOVEANU"	196	26643	136
9	TEHNICAL COLLEGE "TRAIAN"	196	26109	133
10	TEORETICAL HIGH-SCHOOL "DIMITRIE BOLINTINEANU"	196	25255	129

Setting hierarchy on the criterion provides a realistic distribution of the high-schools based on the options registered at the admission sessions and on the number of vacancy places. The chance that the results not to express real situation is eliminated, for example if the classification was made taking in account only pupils registered, the situation would been inexact, because although this number is quite big, sometimes is smaller than the vacancy places, and in this case, the occupation degree is smaller than 1, and this is not a very good situation, because not all the places are occupied.

The baccalaureate GPA criterion includes aggregate information about pupils' performance. The same tests and the same evaluation system allowed objective evaluation. The results, using this criterion, are based on data from NDE and are found here[6].

If other data from NDE are taken into consideration, high-schools are sorted using different criteria.

5. Multi-rang classification

There are considered the criteria C_1, C_2, ..., C_m and the high-schools L_1, L_2, ..., L_n. It is build the matrix B with *n* rows and *m* columns. It is completed element b_{ij} with aggregate level for characteristic C_i which corresponds to high-school L_i.

If, to every criterion C_i is associated an importance coefficient p_i and $\sum_{j=1}^{m} p_j = 1$,

then the sums $S_i = \sum_{j=1}^{m} b_{ij} p_j$, i=1,2, ..., n have the signification of an compos criterion. For a concrete situation, are used for multi-rang classification, the criteria:

C_1 – GPA for high-school admittance, which has a 0.3 importance coefficient;
C2 – GPA for baccalaureate test, with a 0.6 importance coefficient;
C3 – number of pupils, with a 0.1 importance coefficient.

The importance coefficients are obtained experimentally, being accorded marks from a lot of 100 persons.

A homogenous lot of 250 persons with graduate studies provided marks, which allowed the correspondence between levels of quality and intervals.

For interval [0;10], the qualifier *very good* is associated with subinterval (8.91;10]. The qualifier good is associated with the subinterval (7.39; 8.91], and for subinterval [5.50; 7.39] is associated the qualifier *satisfactory*. For subinterval [0; 5.50) is associated the qualifier *unsatisfactory*, without giving degrees of comparison.

For the defined subintervals, high-schools are distributed on quality classes like in table 8:

Table 8. The high-schools distribution on quality classes

Class	Number of high-schools after the classification criterion		
	Admittance GPA	Baccalaureate GPA	Aggregate criterion
Very good high-school	141	137	132
Good high-school	704	758	733
Satisfactory high-school	361	311	341
Unsatisfactory high-school	0	0	0

The number of college institutions, which resulted from classification is 1,206. This differs from the total number of the colleges because, for this classification only the institution which presented both data for admission and for baccalaureate were used. There were not taken into consideration the institutions which presented data only for admission or only for baccalaureate. In this category schools of arts, professional schools are found.

Another criterion is the average aggregate rank built on the calculated rank, taking into account the rank calculated after the first GPA and after the last GPA, for the same high-schools. The indicator uses data from tables 3 and 4, resulting calculated ranks used for the average aggregate rank determination, like in table 9:

Table 9. Average rank determinate from admittance GPA

High-school name	Rank after first GPA	Rank after last GPA	Average calculated rank
NATIONAL COLLEGE "SFANTUL SAVA"	1	4	2.50
NATIONAL COLLEGE OF INFORMATICS "TUDOR VIANU"	2	2	2
NATIONAL COLLEGE "UNIREA"	3	7	5
COLLEGE "COSTACHE NEGRUZZI" IASI	4	9	6.50
NATIONAL COLLEGE "MIHAI VITEAZUL"	5	1	3
NATIONAL COLLEGE "ION LUCA CARAGIALE"	6	6	6
NATIONAL COLLEGE "O.GOGA" SIBIU	7	10	8.50
NATIONAL COLLEGE "VASILE ALECSANDRI"	8	5	6.50
TEORETICAL HIGH-SCHOOL 'OVIDIUS' CONSTANTA	9	3	6
NATIONAL COLLEGE "EMIL RACOVITA"	10	8	9

As it results from table 9, the average calculated rank, based on the first admission GPA and on the last admission GPA, is an homogenous indicator, due to the fact that there is not a big difference between the first GPA and the last GPA.

The belonging criteria to a class have an incentive character to allow transition to a superior class or the continuance in a convenient class.

Conclusion

High-school classification for all country is performed using the National Database of Education. The database interrogation gives a series of situations, depending on the necessities, which foster the competition between schools.

In the future, the schools' level of funding will have to take into consideration the inclusion in a quality class of the respective high-school.

In order to apply the strategies to increase the quality of education it is necessary to take the appropriate measures of quality in order to differentiate the schools using criteria to obtain well defined ranks.

The classification process must be expanded for universities and gymnasium schools.

Only this way it will be known the exact quality level for gymnasium schools, high-schools and universities.

The founding level will be estimated using the quality level, and the allocation will be made if the results are satisfying.

The historical quality analyze is another criterion which should be taken into consideration when the options lists are completed. Starting from the quality indicators presented, the educational institutions are evaluated and a hierarchy is derived, based on which the schools are rewarded, and the candidates are guided to choose the closer option to their requirements.

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[4] **http://www.edu.ro**

[5] **http://www.edu.ro/index.php/articles/5474**

[6] **http://www.edu.ro**