A Data Mining Examination on the Romanian Educational System – Teachers' Viewpoint

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Abstract—Seeing as the national educational system has known many difficulties and transformations in the last decades, and its prestige dropped accordingly, we wanted to conduct a study on teachers' quality of life and their view of the educational system. The present paper is an extended version of our latest work [7], a survey on physical education and sport teachers from Cluj-Napoca, the second largest city in Romania. We observed and gathered the viewpoints of the "insiders", the ones implicated directly in the system and applied data mining methods to process the data collected from the questionnaires.

I. INTRODUCTION

IN the last years of the economic crisis [7], the Romanian educational system has known several difficulties: very high dropout level [11], lack of professional training for teachers, absenteeism and undersized wages [18], violence in schools (more than 75% of institutions reported violent acts [12], and a significant decline in the populations' trust in the educational system [15].

The present paper is an extended version of our latest work [7] in which we tried to inquire about the quality of life of physical education and sport teachers from Cluj-Napoca, second largest city in Romania. The study was based on questionnaires which were handed out to all this personnel from the city's pre-university schools and included several indicators used by the European Quality of Life Surveys [29]: economic and financial situation, healthiness, profession, social life, family, accommodation and background, contentment etc. After collecting and codifying the data we applied data mining techniques for classification learning, trying to build decision trees to understand and predict the teachers' outlook on the Romanian educational system.

From all the connections established in our initial experiment [7], we also attempted to determine another significant relationship: between married male subjects and their viewpoint about the educational system, based on their

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perception on how their financial needs are covered by income. We consider that the subjects' perception on this indicator resided in a certain financial difference between them. In light of the indicator's subjective nature, which offered the subjects a mean to auto-evaluate their financial status, we wanted to find out their existent financial situation. As a consequence, we could notice the financial differences between the four categories. Given that our main study refers to the quality of life of physical education teachers, we also included other questions in our interview that referred to the financial factor, analyzing the subjects' economic and financial situation through isolating certain indicators: a second job, financial retribution of the profession, help from parents, material goods in possession, number of holidays spent in the last five years and the number of rooms of the apartment. We also took into consideration indicators that did not make any direct reference to the financial status but may as well influence it: age, location, number of children, marriage status and contentment, Master's degree, life accomplishments, will to emigrate.

In our research we tried to observe the viewpoint of the ones implicated in the educational system, the teachers, and applied data mining methods to process the data collected from the questionnaires.

II. METHODOLOGY

During the scholar year 2011-2012 we distributed printed surveys [7] to 149 teachers, from whom a total of 105 agreed to take part in our study (70,46% response rate). Some of the questions included in the survey referred to [7]: years of activity, justifications and regrets in choosing current profession, view of the educational system, positions and specializations, second job, professional formation, school equipments, job satisfactions, family versus job, performances, financial retribution etc. Based on the obtained data, we acquired the following results referring to the teachers' view of the Romanian educational system:

- <low quality> score offered by 52% of the teachers,
- <so and so> score offered by 27% of the teachers
- <good quality> score offered by 14% of the teachers
- 7% did not to express their opinion on this question.

Because the majority evaluated the system where they worked as a low quality one, we then intended to identify the causes with the most influence on this matter through data mining. We employed these techniques because of their

capacity in processing large quantities of data, and also because of their capability of connecting attributes with no certain visible relation to each other, which offered us some interesting results.

III. RESEARCH LITERATURE

In the research literature we could find national studies evaluating several socio-professional categories, such as [7]: studies conducted by The Romanian Research Institute for Quality of Life for the interval 1990-1999, studies made before and after Romania's integration in the European Union (2003, 2006 and 2010). The latter showed a dramatic drop in the Romanian citizens' quality of life to the level of 1999 and below [15].

Among the research conducted on teachers' quality of life, we mention the results of a Chinese study of the Medical University [5], which showed that it was beneath the one of the main population, mainly due to the time spent to carry on with the changes in the school and the system.

Certain studies evaluated the educational systems from an external point of view, which might fail to represent the genuine situation, attributable to many influence factors. According to a study made by the Romanian Institute for Strategies and Evaluation, the large majority of the subjects had a low opinion on the Romanian educational system [10]. The study "School, the way it is" tried to assess the educational system based on teachers' view [18], which was a considerable progress and the problems could be therefore acknowledged from inside out.

In accordance with the Institute of Endocrinology C.I. Parhon research, Romanians disregard sport and physical education: a large majority of the population (60%) has weight problems and 30% are corpulent [28]. Unfortunately, the same conduct happens in schools where physical education and sports are places in an "etc." category, with music and art.

Data mining techniques in education were previously conducted on students, so as to: build up their exam failure profile, students' desire to continue their education [1], to determine students' performance in certain classes and e-learning topics [21]. Data mining was also employed by Eagle and Pentland [4] to discover the evolution in time of social networks, naming the method "reality mining". Other researchers [17] offered their results in data mining applications in sociology over quantitative data, which could be the basis in unraveling diverse sociological problems.

IV. CLASSIFICATION LEARNING

In our initial study [7] extended in this paper, we applied classification learning techniques using the attribute edu_evaluation (the evaluation of the Romanian education system) based on decision tree algorithms, such as Ross Quinlan's C4.5 [20].

This algorithm was developed to create decision trees of random depth in a top-down recursive divide-and-conquer strategy, [7], also using a "pruning" method to substitute

subtrees with leaves [20], so as to diminish overfitting.

Some of the conditions of suggestive decision trees sought in our study were as following: [7]

1. A superior percentage of correctly classified instances (over 50%).

2. Calculation of statistical coefficient k and achieving a result closer to 1.

3. Calculation of Mean Absolute Error (MAE) and obtaining a result close to 0.

A. Indicators (based on our initial study [7])

k statistic was calculated as: [3]

$$k = \frac{P(A) - P(E)}{1 - P(E)} \tag{1}$$

Where

P(A) - the observed agreement among the coders,

P(E) - the expected agreement, the probability that the coders agree by chance.

$$k \in \left[-1; 1\right] \tag{2}$$

Where [3]

k = 1 represents perfect agreement,

k = 0 represents that agreement is equal to chance,

k= -1 represents "perfect" disagreement.

We could find two different methods for calculating P(E) in the research literature: [3]

1) each coder has a personal distribution, based on that coder's distribution of categories.

2) there is one distribution for all coders, derived from the total proportions of categories assigned by all coders.

Using the second method, in Siegel and Castellan's approach [23], [3], P(E) is calculated as:

$$P(E) = \sum_j \left(\frac{\sum_i n_{ij}}{Nk} \right)^2 \tag{3}$$

Krippendorff [13], [3] calculated P(E) (also called 1–De in his terminology) with a sampling-without-replacement methodology, but the difference is negligible with the previous approach:

$$1 - D_e = \sum_j \left(\frac{\sum_i n_{ij}}{Nk} \right) \left(\frac{[\sum_i n_{ij}] - 1}{Nk - 1} \right) \tag{4}$$

Where [3]

The agreement table = N x m matrix,

N - the number of items in the data set,

m - the number of labels that can be assigned to each object - in our example N=105 and m=4,

nij - the number of codings of label j to item i.

We used Mean Absolute Error (MAE) as a scale-dependent measure [24] so as to make precision assessments among data sets, so that dissimilar scales influencing the level of these indicators are not misinterpreted as discrepancies in error [7].

Individual model-prediction errors are usually defined as [25]:

$$e_i = P_i - O_i \ , \ i = 1,2,\ldots,n \qquad (5)$$

Where

Pi - predictions or statistical comparisons of model estimates

Oi - pair wise matched observations.

Measures of average error or model performance [7] are based on statistical summaries of e_i (i = 1, 2,...,n). Accordingly, the Mean Absolute Error (MAE) represents the average of the absolute values of the differences between predictions and the corresponding observation, and was calculated as follows: [25]

$$MAE = n^{-1} \sum_{i=1}^{n} \left| e_i \right| \qquad (6)$$

MAE is a linear score which signifies that all the individual differences are weighted uniformly in the average [8]. Because it is also a negatively-oriented score, ranging from 0 to , we sought out lower MAE values throughout our study [7] (lower values are considered to be better).

B. Generated decision trees

In our initial experiment [7] we presented a part of the experiment based on C4.5 algorithm in RapidMiner and Weka software [26].

We made several attempts, based on different values of C4.5 parameters, such as: [7]

- Min_NumObj - minimum number of instances per leaf.
- Num_Folds - the amount of data used for reduced-error pruning. One fold is used for pruning, the rest for growing the tree.
- Pruned - whether the process of pruning is performed.
- Laplace - whether counts at leaves are smoothed based on Laplace estimator (which initiates all numbering starting with 1 as a substitute of 0)

The generated decision trees had dissimilar sizes (Leaves No. and TreeSize parameters), and a smaller or superior percent of Correctly Classified Instances. We calculated several statistical indicators, from which we present the results of K statistic and MAE.

In order to chose the most suggestive tree [7], we counted on these indicators, on the Correctly Classified Instances, for the decision tree to be suggestive and easy to interpret. Thus,

we preferred a decision tree [7] (Appendix 1) with TreeSize=14 and Leaves No.=11, and a percentage of Correctly Classified Instances = 69.5238%, compared to a tree with 100% Correctly Classified Instances, but TreeSize = 171 and Leaves No.= 140.

In the computation of K statistic we pursued a value close to 1, and for MAE where we pressed on for a value close to 0. Thus, for the selected tree, we obtained: [7]

- Kappa statistic = 0.4346
- Mean absolute error = 0.2237

The generated decision tree in text form, based on [7]:

```
gender = F: low_qual (32.0/10.0)
gender = M
|   marital_status = divorced: low_qual (6.0/2.0)
|   marital_status = married
|   |    income = basic_necess: low_qual (17.0/5.0)
|   |   income  = great_eff_basic: low_qual  (14.0/3.0)
|   |    income = all_confort: good_qual (11.0/4.0)
|   |    income = lower_than_basic: low_qual (6.0/3.0)
|   |    income = n/a: low_qual (1.0)
|   marital_status = bachelor: low_qual (15.0/5.0)
|   marital_status = n/a: n/a (1.0)
|   marital_status = widow: low_qual (1.0)
gender = n/a: n/a (1.0)
```

Some suggestive samples of interpretation of the decision tree's branches [7]:

"If the teachers' gender was female, then they would offer a <low quality> score in the evaluation of the Romanian education system."

"If the teachers' gender was male, and their marital status was <married>, and their current profession income covered only the basic necessities, then they would offer a <low quality> score in the evaluation of the Romanian education system."

"If the teachers' gender was male, and their marital status was <married>, and their current profession income provided them with all the comfort, then they would offer a <good quality> score in the evaluation of the Romanian education system."

Another interesting decision tree (Appendix 2) that was generated in the experiment had the following details: TreeSize=25 and Leaves No.=20, a percentage of Correctly Classified Instances = 57.1429 %, Kappa statistic = 0.1834, and Mean absolute error = 0.2237.

Perhaps it was not as relevant as the previous tree, due to the indicators' value, but nevertheless interesting, because of several different attributes included (locations of the graduated university and masters degree, marriage contentment, place of birth- rural or urban).

The generated decision tree in text form is as following:

```
graduated_fac_location = cj: low_qual (66.0/37.0)
graduated_fac_location = unknown_city
|   urb_rur = rural: low_qual (2.0)
|   urb_rur = urban
|   |   masters_location = n/a: good_qual (3.0)
|   |   masters_location = unknown_city: so_so (5.0/2.0)
|   |   masters_location = cj: so_so (1.0)
|   |   masters_location = sm: so_so (1.0)
|   urb_rur = n/a: so_so (1.0)
graduated_fac_location = b
|   gender = F: so_so (3.0)
|   gender = M: low_qual (5.0/3.0)
|   gender = n/a: n/a (1.0)
graduated_fac_location = other
|   marriage_happy = unhappy: low_qual (1.0)
|   marriage_happy = so_so: low_qual (1.0)
|   marriage_happy = happy: low_qual (3.0/1.0)
|   marriage_happy = n/a: low_qual (1.0)
|   marriage_happy = v_happy: good_qual (2.0)
|   marriage_happy = v_unhappy: low_qual (1.0)
graduated_fac_location = mm: good_qual (1.0)
graduated_fac_location = bh: low_qual (3.0/1.0)
graduated_fac_location = cj_b: so_so (3.0/1.0)
graduated_fac_location = cj_bh: so_so (1.0)
```

Here are some suggestive samples of interpretation of the decision tree's branches:

"If the teachers graduated in Bucharest (graduated_fac_location=b) and their gender was male, then they would offer a <low quality> score in the evaluation of the Romanian education system."

"If the teachers preferred not to declare the location of the graduated university (graduated_fac_location= unknown_city) and were born in an urban area, and had their master degree in Cluj-Napoca, or Satu-Mare or did not want to declare the city (masters_location = unknown_city OR cj OR sm), then they would offer a <so and so> score in the evaluation of the Romanian education system."

"If the teachers preferred not to declare the location of the graduated university (graduated_fac_location= unknown_city) and were born in an rural area, then they would offer a <low quality> score in the evaluation of the Romanian education system."

"If the teachers graduated in other city than those provided in the questionnaire (graduated_fac_location=other) and had a very unhappy or unhappy or so_so or happy marriage, then they would offer a <low quality> score in the evaluation of the Romanian education system."

"If the teachers graduated in other city than those provided in the questionnaire (graduated_fac_location=other) and had a very happy marriage, then they would offer a <good quality> score in the evaluation of the Romanian education system."

V. EXTENDED EXPERIMENT

In order to obtain the data for the extended study, we identified and extracted the married male subjects from our main database. After this step, we divided them into four categories (Table 1) (Fig. 1) founded on their answer to the income question, as suggested in our preliminary article [7]. We had 6 subjects belonging "lower_than_basic" category, 17 subjects to "basic_necessities", 14 subjects to "great_effort_basic" and 11 subjects belonged to the "all_comfort" category. We did not take into consideration the teachers that preferred not to respond to this question.

Table 1. Categories based on the income indicator

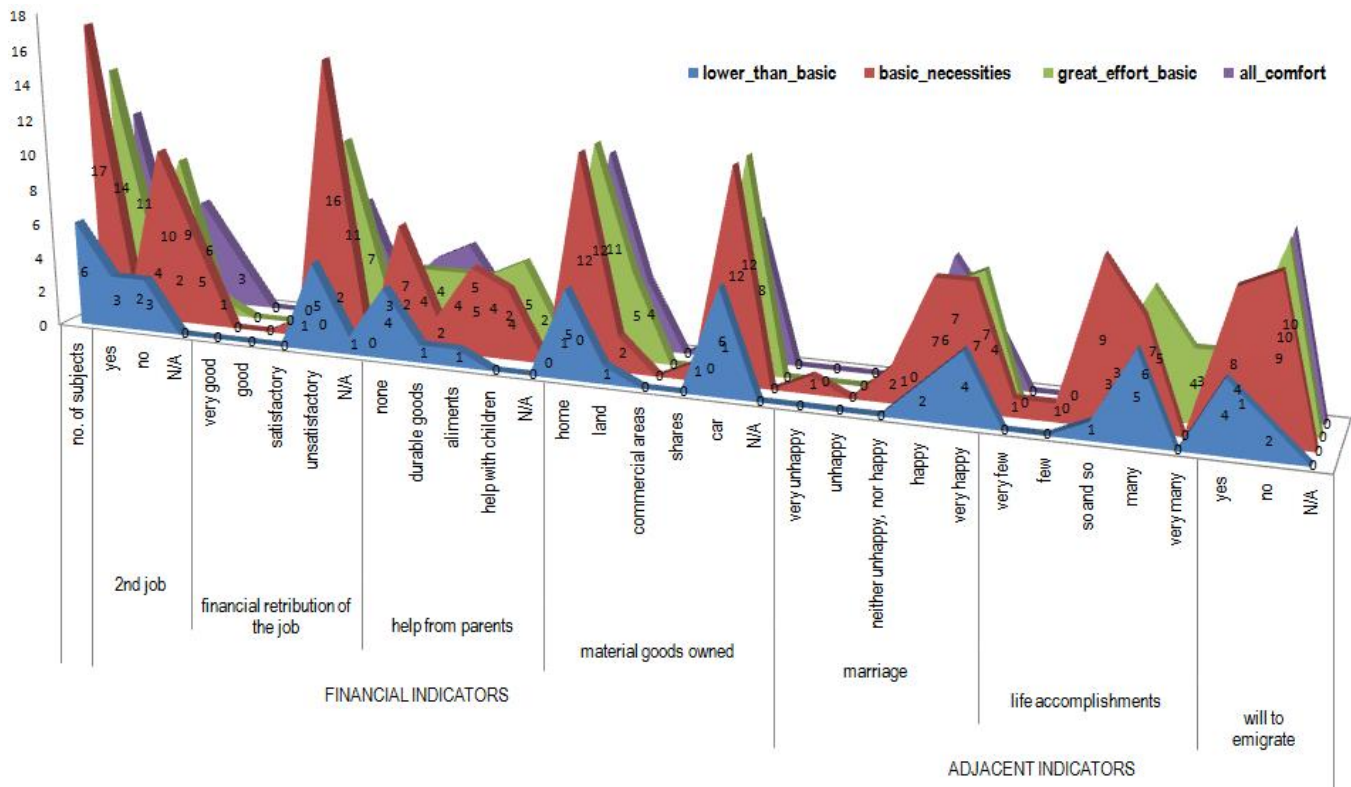|	Average					Financial Indicators																				Adjacent Indicators												
						2nd job			financial retribution of the job					help from parents				material goods owned						marriage					life accomplishments					will to emigrate		
	no. of subjects	age	no. of children	no. of spent holidays in tha last 5 years	no. of rooms in the apartment	yes	no	N/A	very good	good	satisfactory	unsatisfactory	N/A	none	durable goods	aliments	help with children	N/A	home	land	commercial areas	shares	car	N/A	very unhappy	unhappy	neither unhappy, nor happy	happy	very happy	very few	few	so and so	many	very many	yes	no	N/A
lower_than_basic	6	40.83	1.66	1.3	2.83	3	3	0	0	0	0	5	1	4	1	1	0	0	5	1	0	0	6	0	0	0	0	2	4	0	0	1	5	0	4	2	0
basic_necessities	17	42.13	1.96	2.2	3.00	2	10	5	0	0	1	16	0	7	2	5	4	0	12	2	0	1	12	0	1	0	2	7	7	1	1	9	6	0	8	9	0
great_effort_basic	14	44.57	1.64	3.6	3.07	4	9	1	0	0	0	11	3	4	4	4	5	1	12	5	0	0	12	0	0	0	1	6	7	0	0	3	7	4	4	10	0
all_comfort	11	50.72	1.18	3.5	3.27	2	6	3	0	0	2	7	2	4	5	2	2	0	11	4	0	1	8	0	0	0	0	7	4	0	0	3	5	3	1	10	0

Fig. 1 Graphical representation of the categories based on the income indicator

A. Category "lower_than_basic"

We began by analyzing the first category "lower_than_basic" - teachers who affirmed their income was not enough even for the basic necessities. We could observe that their age was between 29 and 63 years old, with an almost equal distribution on 10years time intervals, with an average of 40.83. All except one had children, the group average being 1.66. There was a singular teacher in this category, and the only subject in our study, who had four children. Only one person did not spent his holidays in a Romanian or foreign resort in the last five years, this group having an average of 1.33. Most of them owned a home – an average of 2.8. All the subjects owned a car and one of them even owned a piece of land, while half of them had a second job.

Regarding the financial retribution of their teaching job, five persons declared that it was unsatisfactory and one preferred not to respond. Most subjects did not receive any financial help from their parents, and only two (age below 30) declared their parents assisted them with provisions and durable goods

On the subject of the indicators without direct references to financial status, the situation is as follows: four persons declared their marriage as being "very happy" while two declared considered it as "happy". Life accomplishments were considered "many" by five persons and "so and so" by only one. The will to emigrate for this category was strong: four subjects wanted to emigrate. We evoke that this category was the one to most likely offer a <low quality> score of the Romanian educational system [7].

B. Category "basic_necessities"

We continue by analyzing the second category, which comprised the largest part of the subjects from the four studied groups. They stated their incomes were enough to barely cover their "basic_necessities". Half of the subjects were under the age of 40 (only one being under 30) – the group age average was 42.13. We observed a small age increase in comparison with the previous category. Only five subjects had no children (offspring average for the category =1.96). Five persons from this category didn't get the chance to spend one vacation in a resort over the last five years (a group average of 2.23). Seven persons owned their home and a car, four of them owned only the car, other four the home, one person owned land, stock shares and a car, and the last subject owned his home and also a piece of land. The room average of their homes was exactly 3, comparable with the previous group. The large majority did not have a second job, two of them had, and five preferred not to respond.

On the topic of the financial retribution, 16 persons declared that they were "unsatisfied", while only one was "satisfied". Seven persons did not receive any help from their parents, four of them were aided in raising their children, four were assisted with provisions, one with durable goods while the last one got durable goods and provisions.

Passing on to the adjacent indicators (marriage contentment), we could observe that: seven subjects were "happy" and "very happy", two "so and so" and only one person from the hole study stated to be "very unhappy". The answers regarding life achievements were concentrated in the

"so and so" category, followed by "many". None of them declared to have "very many" accomplishments, while there was one person with "few" and "very few" life achievements. The will to emigrate showed more stability, eight persons being in favor of emigrating abroad while nine against it. Like the previous group, this one is also expected to offer <low quality> score of the Romanian educational system [7].

C. Category "great_effort_basic"

We move on to the third category "great_effort_basic", comprising teachers who were dealing with great effort to cover their current needs. There are 14 persons in this category, half of them being under the age of 40, while five over 55 old. The average continued to grow (compared to the previous categories) reaching a value of 44.57. All of them had children – an offspring average of 1.64. Only two persons couldn't handle to spend a holiday in the last five years – the average increased to 3.57. One subject even declared to had spent 10 holidays in the last five years. Most of them owned a home and a car, while five of them also owning parcels of land. The average of the rooms in their homes remained around 3 (an average of 3.07). Nine subjects did not have a second job, while four of them had and one preferred not to respond.

The financial retribution was appreciated as being "unsatisfactory" by 11 teachers while the rest did not respond. Regarding the help from parents, four of them stated that did not receive any.

Only one teacher considered his marriage as "so and so", while the rest of them were almost equally distributed between "happy" and "very happy". Seven persons declared to have "many" life accomplishments, four of them "very many" while three "so and so". We observed a decrease in the will to emigrate: ten persons were against emigrating abroad while four wanted it. Like the previous two categories, this one is also expected to offer <low quality> score of the Romanian educational system [7].

D. Category "all_comfort"

The last category included the subjects who stated to have everything they needed. The large majority from this category was over the age of 50, with only one subject under 35 years old and the rest between this interval (category age average = 50.72). Only one subject did not have children, the offspring average being 1.18. Regarding the average for the holidays spent in the last five years, it drops almost insignificantly to 3.45. All subjects from this category owned a home, the average of the rooms remaining around 3 (3.27). Eight of them also owned a car, four owned parcels of land and one stock shares. Six subjects did not have a second job, while two of them had and three preferred not to respond.

Regarding the financial retribution of the profession, seven persons declared that is situated at an "unsatisfactory" level, only two considered it "satisfactory" and two didn't respond. Four of the subjects did not receive any help from their parents, while the others were assisted with provisions, help with children and durable goods. Seven teachers considered their marriage as "happy" and four "very happy". Life accomplishments indicator included most answers in the "many" class, being followed by "so and so" and "very many". The will to emigrate dropped drastically, only one person expressing the will to emigrate (surprisingly he was the oldest from our entire study – age of 71). This group is the only one to most likely offer a < high quality> score in the evaluation of the Romanian educational system [7].

VI. CONCLUSION

Following our approach to identify the correlation between teachers' income and the evaluation of the Romanian educational system, we tried to discover what determined our subjects to belong to one of the four income categories. We could not attest, as we thought at the beginning of our study, notable differences with the other financial indicators taken into consideration, all of them being relatively stable to all four categories. Although our groups had a reduced number of subjects and an unequal distribution, we consider worth mentioning that the only indicators that registered notable changes were the ones referring to age, number of holidays and will to emigrate.

The indicator on the holidays spent in the last five years, looks to be a financial sign differentiating the four groups. Therefore, teachers who managed to spend fewer holidays would have more odds to evaluate their incomes as being low.

We can also observe that the age increases directly proportional with the way the subjects evaluate their income. For that reason, teachers who considered their income as not enough for the basic necessities had the lowest age average, of 40.83 years. This number increased to 50.72 years for the ones who declared to have everything they needed. This proportion may be explained by the fact that young do not evaluate objectively their financial status – even though we could see from other indicators that the financial situation was approximately equivalent for all four categories.

The last varying indicator was the will to emigrate. We could see that teachers belonging to the first category were more willing to emigrate than the ones from the last category. This determination could be interrelated with the income and age indicators. The will to emigrate was stronger for the younger teachers, who also felt their incomes did not cover even the basic requirements, while it gradually decreased for older ones who stated to have everything they needed and thus felt no need to emigrate.

In conclusion, we can affirm that the evaluation of the educational system could also have strong ties with the teachers' opportunity to spend a holiday and also with their age.

In our upcoming studies we would like to examine more factors related to Romanian teachers and the educational system, and also apply other sociological and data mining methods.

APPENDIX

Appendix 1.

```
=== Run information ===

Scheme: weka.classifiers.trees.J48 -C 1.0 -M 14
Relation:     edu_system_evaluation - data mining 12.06
Instances:    105
Attributes:   23
Test mode:evaluate on training data

=== Classifier model (full training set) ===

J48 tree
Number of Leaves :   11
Size of the tree :   14

Time taken to build model: 0.99 seconds

=== Evaluation on training set ===
=== Summary ===

Correctly Classified Instances          73               69.5238 %
Incorrectly Classified Instances        32               30.4762 %
Kappa statistic                          0.4346
Mean absolute error                      0.2237
Root mean squared error                  0.3345
Relative absolute error                 70.569  %
Root relative squared error             84.2886 %
Total Number of Instances              105

=== Detailed Accuracy By Class ===
```

	TP_Rate	FP_Rate	Precision	Recall	F-Measure	ROC_Area	Class
	0.982	0.58	0.651	0.982	0.783	0.736	low_qual
	0.429	0.039	0.8	0.429	0.558	0.753	so_so
	0.4	0	1	0.4	0.571	0.817	good_qual
	0.143	0	1	0.143	0.25	0.762	n/a
Weighted_Avg	0.695	0.314	0.764	0.695	0.657	0.754	

Appendix 2.

```
=== Run information ===

Scheme:weka.classifiers.trees.J48 -C 0.25 -M 2
Relation:     edu_system_evaluation - data mining 12.06
Instances:    105
Attributes:   23

Test mode:evaluate on training data

=== Classifier model (full training set) ===

J48 pruned tree
Number of Leaves :   20
Size of the tree :   25


Time taken to build model: 0.02 seconds

=== Evaluation on training set ===
=== Summary ===
```

```
Correctly Classified Instances          60                57.1429 %
Incorrectly Classified Instances        45                42.8571 %
Kappa statistic                          0.1834
Mean absolute error                      0.2734
Root mean squared error                  0.3698
Relative absolute error                 86.2464 %
Root relative squared error             93.182  %
Total Number of Instances              105
```

=== Detailed Accuracy By Class ===

	TP_Rate	FP_Rate	Precision	Recall	F-Measure	ROC_Area	Class
	0.964	0.78	0.576	0.964	0.721	0.638	low_qual
	0	0	0	0	0	0.636	so_so
	0.333	0.067	0.455	0.333	0.385	0.849	good_qual
	0.286	0	1	0.286	0.444	0.883	n/a
Weighted_Avg.	0.571	0.418	0.433	0.571	0.462	0.684	

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